

Standard Specifications for Highway Construction



2017 Edition

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I hereby certify that this Standard Specifications for Highway Construction was prepared under my responsible charge in the Construction Division of the Nebraska Department of Transportation, compiled from specifications prepared, examined, adopted and implemented by the Nebraska Department of Transportation in accordance with established procedures.

This document was originally issued and sealed by James J. Knott, P.E. E-6035 on 8/01/2017 and the original document is stored at the Nebraska Department of Transportation.



These Nebraska Department of Transportation Standard Specifications for Highway Construction, 2017 Edition, are hereby approved for application on highway and related construction contracts as referenced in the contract and shall apply as noted and amended by the contract.

Approved,

A handwritten signature in black ink that reads "Moe Jamshidi".

Moe Jamshidi, PE
Deputy Director – Operations

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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 -- GENERAL INFORMATION, DEFINITIONS, AND TERMS

101.01 -- Abbreviations and Definitions Used in Contracts and Proposal Forms

1. Whenever in the Nebraska Standard Specifications for Highway Construction or in other contract documents, the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

101.02 -- Abbreviations

1. Whenever the following abbreviations and acronyms are used in the Standard Specifications or in the Contract, they are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen.
AASHTO	American Association of State Highway and Transportation Officials.
ACI	American Concrete Institute.
AISC	American Institute of Steel Construction.
ANSI	American National Standards Institute.
ASTM	American Society for Testing and Materials.
ATSSA	American Traffic Safety Services Association.
AWG	American Wire Gage.
AWPA	American Wood Preservers Association.
AWS	American Welding Society.
CFR	Code of Federal Regulations.
DBE	Disadvantaged Business Enterprises.
EBS	Electronic Bidding System.
EEO	Equal Employment Opportunity.
FAA	Federal Aviation Administration.
FHWA	Federal Highway Administration.
IMSA	International Municipal Signal Association.
ICEA	Insulated Cable Engineers Association.
ITE	Institute of Transportation Engineers.
MUTCD	Manual on Uniform Traffic Control Devices.
NDOR/NDR/NDOT	Nebraska Department of Transportation.
NEC	National Electrical Code.
NEMA	National Electrical Manufacturers Association.
NPDES	National Pollution Discharge Elimination System.
ROW	Right-of-Way.

SAE	Society of Automotive Engineers.
SSPC	Steel Structures Painting Council.
UL	Underwriters Laboratories.
USACE	United States Army Corps of Engineers.
VEP	Value Engineering Proposal.

2. Common engineering and construction abbreviations for measurements and work items are:

Items of Work and Units of Measurement

A	Ampere
a	Acre
cd	Candela
cm	Centimeter
Conc.	Concrete
m ³	Cubic Meter
ea	Each
ft	Foot/Feet
ft ² or SF	Square Feet
ft ³ or CF	Cubic Feet
FC	Foot-Candle
ft-lb	Foot-Pound
gal, G or g	Gallon
gpm or GPM	Gallons Per Minute
gps	Gallons per Second
h	Hour
Hz	Hertz
in	Inch
J	Joule
kg	Kilogram
kip	1000 Pounds
km/h	Kilometers per hour
kN	Kilonewton
kPa	Kilopascal
lb	Pound
LF	Linear Foot
L	Liter
L/h	Liters per Hour
L/min.	Liters per Minute
L/s	Liters per Second

lm	Lumen
LS	Lump Sum
lx	Lux
MGal	1000 Gallon
Mg	Megagram
MHz	Megahertz
MPa	Megapascal
M	Meter
µm	Micrometer
mil	1/1000 Inch
Mi or M	Mile
MPH	Miles Per Hour
mm	Millimeter
N	Newton
Pa	Pascal
PVC	Polyvinyl Chloride
psi	Pounds Per Square Inch
s	Second
m ²	Square Meter
Sta	Station
StaM	Station (Metric)
T	Ton
V	Volt
W	Watt
yd ² or SY	Square Yards

101.03 -- Definitions

101.0301 -- Access Connection

1. Any roadway facility by means of which vehicles can enter or leave an arterial highway. This includes: intersections at grade, private driveways, and ramps or separate lanes connecting with cross streets or frontage roads.

101.0302 -- Addendum

1. A written and/or graphic document, issued to all bidders prior to bid opening and identified as an addendum. An addendum modifies or supplements the bid documents and becomes a part of the contract.

101.0303 -- Advertisement

1. A public announcement inviting bids for work to be performed or materials to be supplied.

101.0304 -- Arterial Highway

1. A highway primarily for through traffic, usually on a continuous route.

101.0305 -- Auxiliary Lane

1. The portion of the roadway adjoining the traveled way for parking, speed change, or for other purposes supplementary to through traffic movement.

101.1. 0306 -- Award

1. The decision of the Department to accept the bid of the lowest responsible and responsive bidder for the advertised work. The award is subject to the execution and approval of a satisfactory Contract and Bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

101.0307 -- Backslope

1. The surface of a cut that slopes downward toward the roadway.

101.0308 -- Balance Factor

1. A ratio used to equate the amount of excavation to the amount of fill. Excavation generally will exceed the amount of fill because soil shrinkage occurs during handling and compacting.

101.0309 -- Bid

1. A bidder's offer on Department provided forms (including electronic forms) to perform stated work at the quoted prices. It includes all documents as set forth in paragraph 102.11.

101.0310 -- Bidder

1. Any individual, firm, corporation, or joint venture of individuals, firms, or corporations submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

101.0311 -- Borrow Site

1. The source of approved material required for the construction of embankments, or other portions of earthwork requirements.

101.0312 -- Bridge

1. A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

101.0313 -- Bridge Length

1. The overall length along the centerline of the bridge from end to end of the bridge floor.

101.0314 -- Calendar Day

1. Every day shown on the calendar, including Saturdays, Sundays and holidays, beginning and ending at midnight, except a Calendar Day does not include a day when work cannot be performed because of natural phenomena of such magnitude that they result in the Governor issuing a Disaster Declaration.

101.0315 -- Change Order

1. A written order issued by the Engineer to the Contractor, covering changes within the scope of the contract.

101.0316 -- Channel

1. A natural or artificial waterway.

101.0317 -- Commission

1. The Nebraska State Highway Commission.

101.0318 -- Contract

1. The written agreement executed between the Department and the successful bidder, covering the performance of the work and the furnishing of labor and material, by which the bidder is bound to construct, reconstruct, improve, maintain and/or repair roads, bridges, buildings, and their appurtenances and furnish the labor and materials, and by which the Department is obligated to compensate him/her therefore at the mutually established and accepted rate or price.

2. The Contract includes the Plans, Standard Specifications, Supplemental Specifications, Special Provisions, Proposal Form (including addenda), Bid, Contract form and Contract Bond, Notice to Proceed, and any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

101.0319 -- Contract Bond

1. The security executed by the bidder and the bidder's surety or sureties furnished to the Department to guarantee complete performance of the contract.

101.0320 -- Contract Item

1. An item of work specifically described and for which a price, either per unit, each, or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of the Standard Specification item included in the contract or described in any subdivision of the text of the Supplemental Specification or Special Provision of the Contract.

101.0321 -- Contractor

1. The individual or legal entity contracting with the Department for the construction, reconstruction, improvement, maintenance, and/or repair of roads, bridges, and their appurtenances.

101.0322 -- Contract Time

1. The number of calendar days or the number of working days specified in the contract as the time allowed for the completion of the work, including authorized time extensions.

2. When a calendar date for full or partial completion is shown in the contract, in lieu of a number of working or calendar days, the work contemplated shall be completed by that date, regardless of weather, holidays or other conditions.

101.0323 -- Control of Access

1. The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

Full Control of Access: The authority to control access is exercised to give preference to through traffic by providing access connections with selected roads only and by prohibiting crossings at grade or direct private driveway connections.

Partial Control of Access: The authority to control access is exercised to give preference to through traffic to a degree that, in addition to the access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

101.0324 -- County

1. The County in which the work is to be done, represented by its Board of Commissioners or Supervisors. Reference to any County officer shall be taken to mean such officer of the County as now defined.

101.0325 -- Culvert

1. Any structure not classified as a bridge which provides an opening under any roadway.

101.0326 -- Current Controlling Operation

1. The operation that must be performed on the current day to prevent delay in the final completion of the work.

101.0327 -- DBE - Disadvantaged Business Enterprise

1. A Disadvantaged Business Enterprise (DBE) is a for-profit small business concern:

a. that is at least 51% owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which 51% of the stock is owned by one or more such individuals; and

b. whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

101.0328 -- Department

1. Department means the Nebraska Department of Transportation.

101.0329 -- Detour

1. A temporary official route using existing roads to divert traffic around a roadway project. Detours are maintained and marked by the State or other proper authority.

101.0330 -- Divided Highway

1. A highway with separated roadways for traffic to travel in opposite directions.

101.0331 -- Earthwork Measured in Embankment

1. The calculated compacted volume of the embankment shown in the contract, where balance factors do not apply.

101.0332 -- Easement (Right-of-Way)

1. A right acquired by public authority to use or control property for a designated highway purpose.

101.0333 -- Embankment

1. A raised soil structure.

101.0334 -- Employee

1. A person working on a Department project for the Contractor.

101.0335 -- Engineer

1. The representative duly authorized by the Department acting within the scope of the particular duties assigned or authority given to him/her.

101.0336 -- Equipment

1. All machinery and supplies necessary for the construction, performance, and completion of the Contract.

101.0337 -- Existing Pavement

1. Existing Pavement is the pavement that exists before work starts.

101.0338 -- Expressway

1. A divided arterial highway for through traffic with full or partial control of access and which may have grade separations at intersections.

101.0339 -- Extra Work

1. An item of work and/or provisions for materials not included in the original contract.

101.0340 -- Federal Agencies and Officers

1. Agencies, officers, and their successors of the United States Government.

101.0341 -- Final Acceptance

1. Final acceptance is the date a final payment document is drawn by the Department.

101.0342 -- Foreslope

1. The surface sloping downward and away from shoulder line.

101.0343 -- Freeway

1. An expressway with full control of access.

101.0344 -- Frontage Street or Frontage Road

1. A local street or road adjacent to a highway for service to abutting property.

101.0345 -- Grade Separation

1. A crossing of two highways at different elevations.

101.0346 -- Highway

1. A road or street, including the entire area within the right-of-way, which has been designated a part of the State Highway System.

101.0347 -- Holidays

1. Nebraska legal holidays occur on January 1, the third Monday in January and February, the last Friday in April, the last Monday in May, July 4, the first Monday in September, the second Monday in October, November 11, the fourth Thursday and the following Friday in November, and December 25. If the date falls on Sunday, the following Monday shall be the holiday. If the date falls on Saturday, the preceding Friday shall be the holiday. All dates are subject to possible revision by State Statute or by proclamation of the Governor.

101.0348 -- Inspector

1. The Engineer's authorized representative assigned to make detailed inspections of the work performed and materials furnished by the Contractor.

101.0349 -- Laboratory

1. The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

101.0350 -- Letting

1. The public opening and reading of bids received from bidders for work advertised by the Department, the Local Public Agency, or Political Subdivision.

101.0351 -- Local Public Agency (LPA)

1. A Local Public Agency (LPA) may be a Nebraska city, village, county, township, political subdivision, public corporation, Native American Tribe, Natural Resources District, school district, or other organization with authority to construct, operate and maintain a transportation project.

101.0352 --- Major Item of Work

1. An item whose total original contract cost exceeds 10% of its original group total amount. Items in "Group 10 – General" do not qualify as Major Items of Work.

101.0353 -- Materials

1. Any substance specified for use in the construction of the project. All materials shall be new unless otherwise stated in the contract.

101.0354 -- Median

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

101.0355 -- Median Lane

1. A speed-change lane within the median to accommodate left-turning vehicles.

101.0356 -- Mitigation Site

1. Those areas that will replace waterways or other environmentally sensitive locations, including wetlands, impacted in highway construction.

101.0357 -- NDOT Work Day

1. "NDOT Work Day" is any week day (Monday thru Friday) excluding holidays when the Department is open for normal (not emergency) business.

101.0358 -- Notice to Contractors

1. The advertisement of the provisions, requirements, and instructions pertaining to the work on which bids are to be received, and the manner and time of submitting bids as prepared for the information of bidders.

101.0359 -- Notice to Proceed

1. A written notice to the Contractor establishing the date the Contractor shall begin the contracted work.

101.0360 -- Pavement Structure

1. The combination of sub-base, base course, foundation course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.0361 -- Plans

1. The project drawings, profiles, typical cross sections, general cross sections, standard plans, special plans, summary of soil and materials survey information, aerial photo maps, earthwork computations, design data, and supplemental sheets or drawings, or exact reproductions thereof, approved by the Engineer, which show the location, character, dimensions and details of the work to be done, and which are to be considered as a part of the contract supplementary to the Standard Specifications.

101.0362 -- Point of Delivery

1. A place, determined by the contract or the Engineer, where materials will be received or placed.

101.0363 -- Political Subdivision

1. Any local governments created by the state to help fulfill their obligations. Political subdivisions include, but are not limited to: counties, cities, towns, villages, and special districts such as school districts, water districts, park districts, and airport districts.

101.0364 -- Profile Grade

1. The trace of a vertical plane intersecting the top of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of the trace depending on the context.

101.0365 -- Project

1. The construction to be performed under the contract.

101.0366 -- Project Manager

1. The Department's authorized on-site representative acting within the scope of the particular duties assigned to him/her. The Project Manager shall be responsible for maintaining records of the work performed and monitoring the manner of performance and progress of the work. The Project Manager is responsible for the preparation of the progress and final estimates utilized to compensate the Contractor for the performance of the work.

101.0367 -- Proposal Form

1. The document that includes the description of the location of the work, time and place where bids will be accepted, the general conditions and special provisions. It also includes, by reference, the plans and specifications.

101.0368 -- Proposal Guaranty Bid Bond (Bid Bond)

1. A bond provided by the bidder and obtained from a Surety Company authorized to contract in Nebraska which secures the bidder's bid until the Contract Bond becomes effective.

101.0369 -- Quality Assurance

1. All planned and systematic actions the Department takes to determine that a product or service will satisfy specified quality requirements.

101.0370 -- Quality Control

1. All Contractor/supplier operational techniques and activities that are performed or conducted to fulfill the Contract requirements.

101.0371 -- Ramp

1. A connecting roadway between two intersecting highways at an interchange.

101.0372 -- Right-of-Way

1. Real property used for transportation purposes.

101.0373 -- Road

1. A public way for the purposes of vehicular travel, including the entire area within the right-of-way. A road may be designated as a highway, a street, or a county road.

101.0374 -- Roadbed

1. That portion of a roadway upon which the base course, surface course, shoulders, and medians are constructed. Divided highways are considered to have two roadbeds.

101.0375 -- Roadside

1. The area within the right-of-way, excluding the traveled way, auxiliary lanes, and the shoulders.

101.0376 -- Roadside Development

1. Improvements placed or constructed for the preservation or enhancement of landscape features, rehabilitation and prevention of erosion,

and increasing the effectiveness and enhancing the appearance of the highway.

101.0377 -- Roadway

1. The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

101.0378 -- Roadway Width

1. The clear width measured at right angles to the centerline and measured between the bottom inside face of the curbs, rails, or shoulder breaks.

101.0379 -- Rules and Regulations

1. The document identified as Title 409, Chapter 1, Sections 001 through 005 (inclusive) of the Nebraska Revised Statutes.

101.0380 -- Schedule of Items

1. A list of the contract items for which the bidder is to provide a price to complete the work described by that item.

101.0381 -- Setback Line

1. A line outside of the right-of-way, established by public authority, on the highway side of which the erection of buildings or other permanent improvements is controlled.

101.0382 -- Shoofly

1. A Contractor-built, marked, and maintained route around a specific construction site. When an entrance and/or exit ramp must be built to provide access to a "DETOUR," the ramps will be considered to be shooflies. Maintenance excludes snow removal.

101.0383 -- Shoulders

1. The portion of the roadway contiguous with the traveled way for accommodation of vehicles stopped for emergencies and for lateral support of the pavement structure.

101.0384 -- Soil

1. Those materials listed in the Bureau of Reclamation and Corps of Engineers Unified Soil Classification System.

101.0385 -- Special Provisions

1. Additions, deletions, or revisions to the Nebraska Standard Specifications for Highway Construction or (when applicable) Supplemental Specifications to the Standard Specifications for Highway Construction.

101.0386 -- Specifications

1. The general term comprising all the directions, provisions, and requirements contained in the Nebraska Standard Specifications for Highway Construction, together with such as may be added or adopted as Supplemental Specifications To The Standard Specifications for Highway Construction or Special Provisions, all of which are necessary for the proper performance of the Contract.

101.0387 -- Speed-Change Lane

1. An auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving the through traffic lanes.

101.0388 -- State

1. The State of Nebraska acting through its authorized representatives.

101.0389 -- Station

1. The point on the ground which is part of the line defining the profile of the survey. Distance between full stations is 100 feet (100 m). The beginning point of a survey is station 0, unless otherwise designated.

101.0390 -- Street

1. A public way for the purpose of vehicular travel in a city or village and shall include the entire area within the right-of-way.

101.0391 -- Subcontractor

1. Any individual, firm, or corporation to whom the Contractor or Subcontractor, with the written consent of the Department, sublets any part of the contract.

101.0392 -- Subgrade

1. The upper portion of the roadbed, upon which the pavement structure and shoulders are constructed. Usually, the subgrade depth is 6-inches (150 mm).

101.0393 -- Subsidiary

1. Work and material requirements that are not measured for payment and for which no direct payment is made are considered subsidiary. The bidder must include the cost of performing these requirements in an item for which direct payment is made.

101.0394 -- Substructure

1. The part of the structure below:

- a. The simple and continuous span bearings.
- b. The bottom of the girder or bottom slab soffit.
- c. Construction joints at the top of vertical abutment members or rigid frame piers.

2. Substructures include endwalls, wingwalls, barriers, railings attached to the wingwalls, and cantilever barriers and railings.

101.0395 -- Superintendent

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

101.0396 -- Superstructure

1. The entire structure above the substructure.

101.0397 -- Supplemental Agreements

1. Written agreements executed by the Contractor and the Department or other contracting agency, subsequent to having entered into the contract, covering alterations in the Contract or unforeseen items of construction.

101.0398 -- Supplemental Specifications

1. Specifications adopted subsequent to the current edition of the Nebraska Standard Specifications for Highway Construction. Supplemental Specifications shall prevail over those published in the Nebraska Standard Specifications for Highway Construction whenever in conflict therewith.

101.0399 -- Surety

1. The corporate body registered and/or licensed to do business in Nebraska bound with and for the bidder for the acceptable performance of the contract, the completion of the work, and for the payment of all just claims arising therefrom.

101.0400 -- Tentative Final Acceptance

1. Tentative final acceptance is the date indicated in the "Tentative Final Acceptance" letter to the Contractor accepting all of the work. The Engineer's "Tentative Final Acceptance" letter relieves the Contractor of the responsibility for the care and maintenance of the completed work, of public liability, and for damages due to the actions of the elements or the action of traffic.

101.0401 -- Tentative Start Date

1. The date shown in the proposal on which the Contractor is expected to begin operations.

101.0402 -- Traffic Lane

1. The portion of a traveled way for the movement of a single line of vehicles.

101.0403 -- Traveled Way

1. The portion of the roadway for the movement of vehicles, exclusive of shoulders.

101.0404 -- Unbalanced Bid, Materially

1. A bid that generates a reasonable doubt that award to the bidder will result in the lowest ultimate cost to the Department.

101.0405 -- Unbalanced Bid, Mathematically

1. A bid containing lump sum or unit bid items that do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

101.0406 -- Value Engineering Proposal

1. A proposal developed by the Contractor for modifying the Plans, Specifications, or other requirements of the Contract, usually for the purpose of reducing the total cost of the construction without reducing the design capacity or quality of the finished product.

101.0407 -- Weight

1. A Weight is a measure of force in the English (Metric) system and the units are pounds (Newtons). Mass is measured in slugs or pounds (grams). Most scales used in the highway construction industry measure an object's gravitational force at the scale location. However, the unit of measurement on most scales is grams and these readings are generally not corrected for the existing gravitational force to allow conversion of the measured force to the object's true mass.

2. Certified scale measurements are considered by the Department to be acceptable measures of an object's mass.

101.0408 -- Wetlands

1. Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

101.0409 -- Work

1. Work shall be understood to mean the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project by the Contractor and the carrying out of all duties and obligations imposed by the Contract.

101.0410 -- Working Day

1. A working day is any day, Monday through Friday, when the Contractor is not prevented by weather, soil conditions, or other conditions beyond his/her control from working on the current controlling operation for more than 50% of the hours in his/her normal schedule with more than 80% of his/her normal working force.

2. If any work requiring engineering or inspection by the Department is performed on a Sunday, New Years Day, Memorial Day, Independence Day, (including Monday, July 3 or Friday, July 5), Labor Day, Thanksgiving Day, the day after Thanksgiving Day, or Christmas Day, then that day will be considered a working day.

3. Except as noted in paragraph 2 above, Saturdays, Sundays, Nebraska holidays, Monday, July 3 or Friday, July 5, will not be counted as working days.

101.0411 -- Working Drawings

1. Shop drawings, shop plans, erection plans, falsework plans, framework plans, cofferdam cribbing and shoring plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data, (i.e.: Manufacturer's Recommendations) including a schedule of submittal dates for working drawings where specified, which the Contractor must submit to the Engineer.

101.0412 -- Work Order

1. A written order directing the performance of work or furnishing of materials not included in the original contract.

SECTION 102 -- PROPOSAL REQUIREMENTS AND CONDITIONS AND AWARDING OF CONTRACTS ON STATE HIGHWAY WORK

Requirements for Bidders on Contracts Awarded by the Department

102.01 -- Prequalification of Bidders

1. All persons, (any individual, partnership, association, corporation or joint stock company) proposing to bid on a contract for the construction, reconstruction, improvement, maintenance, or repair of roads, bridges and their appurtenances to be let by the Department shall submit a statement showing his/her experience, equipment, and financial condition; except that such statement may not be required for contracts where the estimate of the Engineer is less than one hundred thousand dollars, or of an emergency nature. Such statement shall be under oath and on a form to be provided by the Department and shall be submitted not later than 10 calendar days before the letting of the Contract or Contracts. The statement shall develop fully the financial ability, adequacy of plant and equipment, organization, prior experience, and such other pertinent and material facts as may be desirable. The Department may require additional information at any time. The statements of bidder's experience, equipment, and financial condition will not be retained in the active file of qualified bidders after the financial condition shown is of a date 15 months prior. Any person whose qualification will expire on or before the date of a letting must submit a new statement and request to be qualified at least 10 calendar days before the letting at which he/she desires to bid. Any person who desires a change in his/her qualification must submit a new statement or a request in writing at least 10 calendar days before the letting at which the change would be effective. Upon the compliance with all laws and rules and regulations relating thereto, such person will be qualified for the amount and class of work to which he/she is entitled. All information furnished the Department shall be confidential.

2. The financial showing required in such statement shall be certified by a public accountant holding a currently valid permit from the Nebraska Board of Public Accountancy or by any certified public accountant holding a currently valid permit.

3. The use of a "Letter of Credit" as an alternate means of showing financial condition may be permitted when the net amount of the "Letter of Credit" does not exceed \$500,000. The "Letter of Credit" must be from a licensed or chartered financial institution. The "Letter of Credit" shall be certified by a public accountant holding a currently valid permit from the Nebraska Board of Public Accountancy or by any certified public accountant holding a currently valid permit.

4. Each person will be qualified upon such statement for an amount of work which he/she can perform properly as evidenced by his/her financial statement and supplementing documents, and his/her competency and responsibility as evidenced by the amount, condition, and availability of equipment, experience of personnel, and previous record with this and other awarding authorities.

5. Each person will be notified of the "maximum qualification" established in his/her case by the Department. The "maximum qualification" established may be increased or decreased at any time if, as determined by the Department, the performance record of the bidder warrants such action.

6. A new statement may be requested at any time if, in the opinion of the Department, significant changes in the responsibility or financial ability of the person have occurred.

7. Any bidder who desires a change in their qualification must submit a request in writing for such change at least 10 calendar days before the letting at which he/she desires to bid with the new qualification.

102.02 -- Reduction of Maximum Qualification

1. Any one or more of the following causes shall be sufficient for the reduction of the contractor's maximum qualification rating for a period of time to be determined by the Engineer:

a. The Contractor knowingly submits false information relating to prequalification.

b. The Contractor does any act or omits doing or performing any act which, in the judgment of the Engineer, evidences a material change in the Contractor's financial responsibility or work capability where, in the judgment of the Engineer, the same will materially prejudice the Contractor's ability to successfully prosecute such public improvement contracts. Such matters may include but are not limited to:

(1) When the Department has determined that the Contractor is in default, delay, or neglect under Section 108.09(1), and the Contractor has failed to cure under 108.09(2). This will apply even if the Surety completes the Contract.

(2) The Contractor delays commencement or completion of any work within the contract period or any extension thereof under circumstances that would give rise to a right in the Contract for liquidated damages or notice of default.

(3) The Contractor continually fails or refuses to remove and replace materials or work found by the Engineer not to be in reasonably close conformity with the contract documents or to correct such material or work so as to cause such materials or finished product to be reasonably acceptable work.

(4) The Contractor continually and, in the judgment of the Engineer, without good cause therefor, fails to carry on the work in an acceptable manner or refuses to comply with a written order of the Engineer within a reasonable time.

(5) Failure to comply with the prompt payment clause.

(6) Failure to repay monies due the Department resulting from overpayments.

102.03 -- Drug-Free Workplace

1. The State of Nebraska requires all bidders on all construction, maintenance, or improvement contracts let by the Department to file and maintain a written Drug-Free Workplace Policy with the Department. By signing the bid signature page the bidder certifies that the company is operating under a written Drug-Free Workplace Policy on file with the Department.

102.04 -- Examination of Plans, Specifications, Special Provisions, and Site of Work

1. The Department will provide detailed Plans and Specifications. The bidder, before submitting a bid, shall carefully examine:

- a. The site of the proposed work.
- b. The proposal form.
- c. The Plans.
- d. The Specifications.
- e. The Supplemental Specifications.
- f. The Special Provisions.
- g. Other required forms.
- h. The Environmental Commitments.
- i. Permits applicable to the work.
- j. The addenda.
- k. The Department's Question/Answer website.

2. The submission of a bid is considered conclusive evidence that the bidder made the examinations required in Paragraph 1 of Subsection 102.04 above and that the bidder is satisfied with and understands the conditions to be encountered in performing the work and other requirements in the Contract.

3. The bidder shall not take advantage of any apparent error or omission in the contract. Upon discovery of such an error or omission, the bidder shall notify the Engineer immediately. The Engineer will then make such corrections or interpretations as necessary to fulfill the intent of the contract.

102.05 -- Federally Funded Contracts -- Equal Employment Opportunity

1. Each Contractor and Subcontractor submitting a bid must certify that he/she has or has not participated in a previous contract or subcontract subject to the equal opportunity clause, as required by Federal Executive Order 11246, and that he/she has or has not filed with the Joint Reporting Committee, the Director of the Office of Federal Contract Compliance, a Federal Government contracting or administering agency, or the former President's Committee on Equal Employment Opportunity all reports due under the applicable filing requirements.

2. The certification is required by the Equal Employment Opportunity Regulations of the Secretary of Labor (41 CFR 60-1.7 (b)(1)), and must be submitted by bidders and proposed Subcontractors only in connection with contracts and subcontracts which are subject to the equal opportunity clause. Contracts and subcontracts which are exempt from the equal opportunity clause are set forth in 41 CFR 60-1.5. (Generally, only contracts or subcontracts of \$10,000 or less are exempt.)

3. Currently, Standard Form 100 (EEO-1) is the only report required by the Executive Orders or their implementing regulations. Standard Form 100 (EEO-1) must be filed by:

a. Employers covered by Title VII of the Civil Rights Act of 1964 and employers covered by Federal Executive Order 11246 who have 100 or more employees in the payroll period for which they are reporting, normally any payroll period in December, January, or February preceding the filing of the report.

b. If Standard Form 100 (EEO-1) was not filed because the bidder has less than the 100 employees requirement, it is proper for the bidder to state that he/she has submitted all required compliance reports due.

4. Bidders who have participated in a previous contract or subcontract subject to the Federal Executive Orders and have not filed the required reports should note that 41 CFR 60-1.7 (b)(1) prevents the award of contracts and subcontracts unless such bidder submits a report covering the delinquent period or such other period specified by the Federal Highway Administration or by the Director, Office of Federal Contract Compliance, U.S. Department of Labor.

102.06 -- Current Qualification

1. Each bidder desiring to bid on work for which prequalification of bidders is required shall submit a request for proposal forms and with such request shall submit, in a format determined by the Department, a complete report of all work then under contract, including subcontracts, and the total value of the work, and the amount of work not completed on all such contracts. A current qualification based on this statement and the bidder's "maximum qualification" will be established by the Department taking into account the rate of progress which is being made in performing the uncompleted work, the requirements for the performance of the work for which the bidder desires to bid, and any other pertinent information that is available to the Department. This current qualification determines the amount of work for which any person is qualified at the particular letting and for which he/she may be awarded a contract or contracts, except that the Department may use a tolerance of not more than 25% of a bidder's current qualification and award the contract or contracts in a total amount which does not exceed by more than 25% the current qualification established by the Department.

2. Contractors requesting a proposal form as a Joint Venture shall provide the Department with all documents establishing the joint venture as a legal entity. The current qualification for the Joint Venture will be established. This current qualification determines the amount of work for which the Joint Venture is qualified at the particular letting and for which it may be awarded a contract or contracts, except that the Department may use a tolerance of not more than 25% of the Joint Venture's current qualification and award the contract or contracts in a total amount which does not exceed by more than 25% the current qualification established by the Department.

3. When bidding in current and subsequent lettings, each Contractor participating in the joint venture shall provide to the Department the

applicable share of the project (must total 100% of the joint venture work) that will be allocated to each participant when determining current qualifications for the participants.

102.07 -- Bid Requirements

1. A proposal form for work for which prequalification of bidders is required will be issued only to those qualified to bid. A bidder will not be considered as qualified for any particular letting if the bidder's qualification will expire on or before the date of the letting.

2. Bidders submitting 2 or more bids in a total amount exceeding their current qualification by more than 25% shall submit the same, subject to the limitations of their current qualification, plus a tolerance of 25%.

3. Nothing in the Rules and Regulations or these Specifications shall prevent the Department from rejecting any bid where, in the opinion of the Department, other circumstances and developments have changed the qualification or responsibility of the bidder.

4. If the qualification of the low bidder expires before the award of a contract, such contract will not be awarded until the qualification of the low bidder has been renewed.

5. A proposal form for work for which prequalification of bidders is required will be labeled with the name of the bidder to whom they are issued and shall not be transferable. Any bid submitted by a bidder other than the person or company to whom the proposal form was issued shall be void.

6. A proposal form will not be issued to any bidder later than 5:00 p.m. of the day preceding the letting.

7. A proposal form for any contract for which prequalification of bidders is required may be issued, at the discretion of the Department, to 2 or more qualified bidders jointly if the classes of work for which the prospective bidders are qualified to perform satisfy, in the aggregate, the qualification requirements for the particular contract. Two or more qualified bidders may not bid jointly to perform any contract for which prequalification of bidders is required unless a proposal form is issued by the Department to those bidders jointly for that purpose.

102.08 -- Interpretation of Quantities in the Schedule of Items

1. The quantities listed in the schedule of items are considered to be approximations, unless otherwise provided, and are to be used for the comparison of bids. Payments to the Contractor will be made for the actual quantities or Plan quantities, if specified, of work performed or materials furnished in accordance with the contract. It is understood that the quantities of work to be done and materials to be furnished may each be increased, diminished, or omitted as hereinafter provided without in any way invalidating the unit bid prices, except as provided in Subsection 104.02 of the current edition of the Nebraska, Standard Specifications for Highway Construction or Supplemental and Special Provisions.

102.09 -- Preparation of Bids

1. The bidder shall use the Department authorized electronic bidding system software when submitting a bid, unless otherwise directed by the Department in the Proposal Form.

2. The bid shall be submitted in a sealed envelope, or submitted by using a Department authorized online bidding exchange, or as directed by the Department. When submitting a sealed envelope, the envelope shall be clearly marked as containing a bid.

3. The Department may reject a bid if an error or warning message appears in the electronic bidding submission received by the Department.

4. In the event there is a discrepancy between the information submitted on the electronic submission and the paper copy of the schedule of items submitted with the bid, the figures on the paper copy of the schedule of items will prevail.

5. The bidder shall pay applicable fees charged by the company providing the electronic bidding software, online bidding exchange or user fees for Internet services to submit a bid.

6. The blank spaces in the schedule of items must be filled in correctly, in ink, typed, or electronically for each item and document necessary to submit a complete bid.

7. The bid shall be legible or it will be rejected.

8. Signatures.

a. Written signatures must be in ink on the line provided in the bid submittal. A bid without both a signature and a printed name in the spaces provided may be considered non-responsive.

b. All corrections and other entries not made by the electronic bidding system must be in ink or typed.

c. Bids submitted over the internet must be signed using electronic signatures as provided by the Department-authorized online bidding exchange provider.

d. Failure of the bidder to properly sign the bid shall make the bid incomplete, and the bid may be considered non-responsive.

9. The Schedule of Items must be properly completed. The following rules will apply:

a. The schedule of items must state the unit price for each item of work contemplated.

b. If the "Unit Price" column is left blank and the quantity of the item is one and an amount is shown in the "Extension" column, then the amount in the "Extension" column will be considered the unit price.

c. If the bidder enters an amount in the "Unit Price" column when "Lump" is shown in the "Unit" column for that item, the "Unit Price" shall govern in the extension of that item.

d. The bidder shall also show the product of the respective unit prices and quantities in the "Extension" column provided for that purpose and the total amount for all groups and combination of groups, as indicated in the schedule of items, necessary for a complete bid for the work.

e. If the "Unit Price" is indicated with a line, the unit price will be considered free no matter what amount is shown in the "Extension" column.

f. If the "Unit Price" is left blank and the quantity of the item is greater than one, the bid is incomplete and the bid is rejected.

g. (1) If the "Unit Price" and "Extension" columns are left blank, the bid will be considered incomplete and rejected except when alternate groups are provided and the Contractor is not required to bid on all alternates.

(2) When alternate groups are included in the proposal forms, the bidder shall complete the schedule of items for only one alternate group, unless specifically required by the contract to complete additional alternate groups.

h. When the schedule of items is divided into groups, a price shall be submitted on each item of work within the group.

i. On alternate groups when the bidder does not intend to submit a bid for a group, the bid for that group must be left blank.

j. In the event of a discrepancy between unit bid prices, extensions or totals, the unit price shall govern.

102.10 -- Contents of Bid

1. The bidder shall include the following in each bid submitted to the Department. Failure to submit any of the following shall cause the bid to be considered non-responsive.

- a. A Schedule of Items.
- b. Required DBE Participation form (if applicable).
- c. Certification of Previous EEO Performance (if applicable).
- d. Equipment Assessment Certification (if applicable).
- e. Hiring Practice Certification.
- f. Drug-Free Workplace Policy Certification.
- g. Noncollusion Declaration.
- h. Compliance Certification for Standard Specifications for Highway Construction Sections 102 and 103.
- i. Bid Bond or approved confirmation of a Bid Bond (See Subsection 102.14).
- j. Other forms, as required by the Department.

2. Written bid signatures must be affixed by a person authorized to sign as shown on the pre-qualification (when pre-qualification is required for the contract), and notarized. Electronic signatures must have authorized digital signatures affixed by a person authorized to sign as shown on the pre-qualification (when pre-qualification is required for the contract), each bidder, in signing the bid by or on behalf of the person, firm, association, or corporation submitting the bid, certifies that:

a. Such person, firm, association, or corporation has not either directly or indirectly entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid.

102.10

- b. All equipment has been assessed for the current year.
 - c. The company is operating under a Drug-Free Workplace Policy, a copy of which is on file with the Department.
 - d. A contract bond for the contract amount will be furnished.
 - e. Reports have been filed regarding EEO participation (Federally funded projects only).
 - f. Disadvantaged Business Enterprises (DBE) goals on designated Federally funded projects will be achieved or "good faith" documentation provided.
3. The bid shall be signed by a person listed on the prequalification statement as being authorized to sign on behalf of the bidder, when prequalification is required for the contract. A signature by a person other than those listed will make the bid nonresponsive.
4. False statements in any of the certifications will constitute perjury.

102.11 -- Bid Submission

1. Bids must comply with all plans, special provisions, addenda, the Specifications (as defined in Subsection 101.0386), Supplemental Specifications to the Standard Specifications for Highway Construction, and the Nebraska Rules and Regulations regarding bid preparation and bid submittal.
2. Bids shall be received until the date and time set forth for the opening and must be, by that time, delivered to the place indicated in the Proposal Form. Except as otherwise directed by the Department, there are two options to submit bids:
- a. **OPTION 1** - A printed bid shall be placed in a sealed envelope and submitted to the Department. The bidder shall indicate in the bid submittal to the Department the bid bond type that applies to the submitted bid. The envelope containing the bid shall be marked by the bidder to indicate its contents.
 - b. **OPTION 2** - Bidders may submit bids electronically over the Internet using a Department authorized online bidding exchange. The bidder shall indicate in the bid submittal to the Department the bid bond type that applies to the submitted bid.
3. The Department retains the discretion to accept as responsive a bid that was not generated using the Department's Electronic Bidding Software.

102.12 -- Ties and Limitations

1. A bid shall not be tied to any other bid except as may be indicated in the proposal form. If the bidder desires to tie his/her bid to his/her bid on any or all of the other bids which may be indicated in the proposal form, such tie shall be clearly indicated in the space provided. The bidder shall not indicate a tie by means other than those shown.
2. If the bidder does not designate a preference in the space provided, it will be assumed that he/she does not desire to tie his/her bid to any of the bids listed therein; and the bid will be considered on that basis. The bidder shall not insert a tie in any other place in his/her bid except in the space provided in the bid.

3. The Engineer reserves the right to make awards that will be in the best interest of the State, and any comment in a bid limiting or qualifying this reserved right shall constitute an irregular bid. However, the bidder may specify one or more of the following:

- a. The maximum monetary value of awards that will be accepted.
- b. The total number of contracts that will be accepted.
- c. The number of contracts of any particular class or classes of work that will be accepted.

4. Such limitations must be indicated in the space provided in the bid. Any limitation in the number of contracts of any particular class or classes of work that the bidder will accept will be considered as applying only to the primary class or classes of work for that contract, as indicated in the Proposal Form.

5. Such limitations indicated by a bidder on one bid shall be applied to all of bidder's bids submitted in the same letting.

6. In the event a bidder indicates multiple limitations on one or more bids, and there is a discrepancy between limitations, the most restrictive of said limitations shall be applied.

7. The bidder shall not make a conditional deduction or reduction in any unit price in any bid.

102.13 -- Disqualification of Bids

1. Any one or more of the following causes shall be sufficient for the disqualification of a bid or bids, if determined by the Department to be in its best interest:

- a. Any tie, statement, qualification, or limitation made by the bidder in violation of, or not permitted by, Subsection 102.12.
- b. Alterations of forms, additions not called for, conditional bids, incomplete bids erasures, or irregularities of any kind.
- c. Incorrect extensions or totals in the bid.
- d. More than one bid on any one project from an individual, a firm or partnership, a corporation, or an association under the same or different names. Reasonable grounds for believing that any bidder has interest in more than one bid for the work contemplated will cause the rejection of all bids in which such bidder is interested.
- e. Evidence of collusion amongst bidders. There is reason to believe that collusion exists among the bidders or if the bidder has been disqualified from bidding or debarred from performing work due to collusion prior to award of the contract.
- f. Bids which are mathematically unbalanced.
- g. Bids which are materially unbalanced.
- h. Bids which are accompanied by bid bonds on forms that are not authorized by the Department or by bid bond forms which are incorrectly completed or are incomplete.

i. Bids in which the bid signature page is completed incorrectly or is incomplete.

102.14 -- Proposal Guaranty Bid Bond (Bid Bond)

1. Unless otherwise provided in the Proposal Form, each bid shall be bonded with a bid bond made payable to the Department in an amount equal to at least 5% of the amount bid. Bid bonds must be executed by corporations authorized to contract as a surety in the State of Nebraska. Any alterations, conditions, or limitations added to the Department's bid bond form will be unacceptable and cause the bid to be rejected. All bid bonds must be current as of the time of the letting and must contain a provision preventing termination of such bond no later than 5 days prior to the letting. In the event the low bidder fails to comply with any requirement regarding the execution of the contract, the Department shall immediately be entitled to recover the full amount of the bid bond as liquidated damages. There are three options to submit the proposal guaranty bid bond:

a. **OPTION 1 - (Project Specific Paper Bid Bond).** The bid bond shall be properly executed on the form provided by the Department.. The properly executed original or exact copy thereof shall be delivered to the Department, in a sealed envelope, with the bid or separately prior to the bid letting.

b. **OPTION 2 - (Project Specific Electronic Bid Bond)** The Department, at its discretion, may allow a bidder to authorize a bonding company to register the bid bond with a Department authorized on-line bond registry service and provide the Department access to the bid bond data to confirm the existence of the bid bond specific to the project and to document that the bond is valid. The bidder must indicate in the bid submittal to the Department that their bid bond is posted on the bond registry service.

c. **OPTION 3 - (Annual Bid Bond).** The Department at its discretion may allow a bidder to place an "Annual Bid Bond" on file with the Department. This bond will cover all projects on which the bidder bids for a 12-month period shown in the bond unless a project specific bid bond is submitted with the bid or separately prior to the bid letting. The original Annual Bid Bond shall be executed on the Department of Road's Bid Bond Form, which may be obtained from the Department. A copy of the original form will be accepted.

102.15 -- Withdrawal of Bids

1. A bidder may withdraw an unopened bid at any time prior to the bid opening time specified in the "Proposal Form".

2. To withdraw a bid, the bidder shall provide a written and signed notice of withdrawal to the address identified in the proposal form. This notice shall be delivered, by letter, email, or FAX prior to the time established for the bid opening. The notice shall be signed by a person authorized to bid as shown in the bidders pre-qualification (when prequalification is required for the contract). It is the Contractor's responsibility to ensure that the notice was received by the Department prior to letting.

3. A withdrawn paper bid will only be returned upon request and only to a person authorized to bid as shown in the bidder's prequalification statement or to an agent authorized in the notice of withdrawal.

4. In the event that the bidder chooses to make changes to the withdrawn paper bid and resubmit it, the notice shall authorize the person to whom the bid is returned to do so and the bidder shall be bound by the signature page on the withdrawn and resubmitted bid.

5. A bidder may also submit a subsequent new bid on a project after a previous bid has been withdrawn.

6. The Department will not accept bids after the bid opening time specified in the proposal form.

102.16 -- Public Opening of Bids

1. Except when specifically authorized in writing by the Department and except as authorized in Subsection 102.15, properly submitted bids will be opened and read publicly at the time and place indicated in the proposal form. The Department reserves the right to reject any bid that has been read when the bid is subsequently found to not meet the requirements of these Specifications. Errors by the bidder in filing his/her bid will not be cause for waiving any of the above requirements and will not be the responsibility of the Department.

2. The "Total Bid" for each bid will be read publicly.

102.17 -- Suspension and Debarment Policy and Procedures

1. Suspension: When circumstances warrant, the Department may "suspend" or exclude persons and/or companies considered for debarment. Causes for suspension include adequate evidence that:

a. A cause for debarment exists, and

b. Immediate action is necessary to protect the public interest. An indictment for a debarment offense will constitute adequate evidence for a suspension action.

2. Debarment

a. The Director may, in his/her sole discretion, debar an individual, a bidder, or its affiliates from bidding, subcontracting, or supplying materials on Department contracts for any illegal activity involving bidding evidenced by any of the following:

(1) An indictment or conviction of a bidding crime; any plea of guilty or nolo contendere to a charge of a bidding crime; any public admission of a bidding crime; any presentation of an unindicted co-conspirator; or any testimony protected by a grant of immunity of any bidder in any jurisdiction indicating involvement in a bidding crime.

(2) Conviction of any offense indicating a lack of moral or ethical integrity as may reasonably be perceived to relate to or reflect upon the business practices of the bidders.

(3) Debarment by any other State or Federal agency for substantially any of the reasons listed above.

(4) Any other activities of an individual, bidder, or its affiliates of a serious or compelling nature that are reasonably perceived to relate to their work as a Contractor.

(5) Making materially false statements on a bid.

b. An individual or a bidder shall be given a debarment hearing if either so requests before or after debarment. The determination as to whether the debarment hearing will be held before or after debarment shall be at the sole discretion of the Director.

(1) The written request for a debarment hearing must be received by the Director no later than 10 days after the receipt of the written notice from the Director. Unless otherwise mutually agreed in writing, the debarment hearing shall be held no later than 14 days after receipt of the individual's or bidder's request for a debarment hearing.

(2) Debarment after hearing. In those situations where the Director decides to hold a debarment hearing prior to deciding whether debarment is proper, he/she shall send written notice to the affected individual, bidder, or their agents by certified or registered mail stating:

(i) That debarment is being considered.

(ii) The general reasons that suggest the debarment.

(iii) That the bidder will be afforded an opportunity for a debarment hearing if requested.

(3) Debarment before hearing. In those situations where the Director determines that debarment is appropriate prior to a debarment hearing, he/she shall send written notice to the affected individual, bidder, or their agents by certified or registered mail stating:

(i) That the bidder or individual has been debarred.

(ii) The general reasons for the debarment.

(iii) That the bidder or individual shall be accorded the opportunity for a debarment hearing if they so request in writing within 10 days of the receipt of the written notice of debarment.

(4) If the bidder or individual notifies the Director that he/she desires a hearing, the debarment hearing will be held no later than 14 days after receipt of the individuals or bidder's request unless mutually agreed otherwise in writing. The Director shall determine in writing whether the individual or bidder will be reinstated.

c. The Director shall appoint a Hearing Examiner to conduct all debarment hearings. The Hearing Examiner shall make a recommendation to the Director, and such recommendation shall include findings of fact and conclusions of law.

d. Except as modified by the Rules and Regulations of the Department, debarment hearings before the Hearing Examiner shall conform to the Code of Civil Procedure applicable to the District Courts of the State. Practice before the Hearing Examiner shall be governed by the Department's Rules and Regulations, Title 407.

e. Debarment shall be for a period of thirty-six months or, in the case of a reciprocal debarment as provided for under Paragraph 2.a.(3) of

Subsection 102.17, the term of the debarment shall be for the same period as the debarment imposed by the other State or the Federal government.

f. The Director may suspend a debarment at any time he/she determines it is in the public interest to do so. Mitigating circumstances may be considered in the decision to lift or suspend a debarment and may include, but shall not be limited to:

(1) The degree of culpability of the debarred individual or bidder.

(2) Restitution by the debarred individual or bidder to the State for any perceived overcharges or damages resulting from the actions of the debarred individual or bidder.

(3) Cooperation by the debarred individual or bidder with the State, the United States, and/or any other political governmental subdivision in the investigation of bidding crimes, including a full and complete account of the individual's or bidder's particular involvement therein.

(4) Disassociation with individuals and firms that have been involved in a bidding crime.

g. The Director, at his/her discretion, may hold a hearing, no later than 15 days prior to the last day of the debarment, and require the debarred individual or bidder to show cause why the debarment should not continue. If the Director, in his/her sole discretion, determines that a debarred individual or bidder has failed to become a responsible bidder, then the Director may continue the debarment for up to 12 additional months. The same show cause procedures shall continue for each successive extension of the original debarment until such time as the Director has determined that the debarred individual or bidder meets the criteria of a responsible bidder.

h. For purposes of debarment, the conduct of a bidder or an individual shall be fully imputed to:

(1) Business firms with which they are or were associated.

(2) Business firms by whom the individual was or is employed.

(3) Parent or subsidiary companies of the bidder.

(4) Business firms in which the individual or bidder has a controlling interest.

i. Debarment of a bidder shall in no way affect the obligations of the bidder to the State for services to the Department already under contract.

j. Every bidder currently qualified by the Department to bid on its contracts shall have a duty to notify the Director if it, any of its employees, officers, board members, or associates are indicted or convicted of a bidding crime within 30 days of the indictment or conviction. Failure to do so is a serious and compelling offense sufficient to result in debarment.

k. Every bidder qualified by the Department to bid on its contracts shall have a duty to notify the Director if the bidder, any of its employees, officers, board members, or associates are contacted by any person with the purpose of engaging in any illegal activities in connection with bidding on

contracts let by the Department or contracts involving federal aid. Notice shall include the name of the person making such overture or bid proposal, the time and place thereof, and the specific nature of the overture or bid proposal.

I. A copy of Section 004 of the Department's Rules and Regulations shall be mailed to each prequalified bidder and to each bidder heretofore debarred or suspended.

3. Procedures for Certification Regarding Debarment.

a. Unless the Bidder submits an explanation of exceptions to the following, by signing and submitting a bid, the bidder swears, to the best of his/her knowledge and belief, that he/she and the principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal Department or Agency.

(2) Have not within a 3-year period preceding this bid been convicted of or had a civil judgment rendered against them for:

(i) Commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction.

(ii) Violation of Federal or State antitrust statutes.

(iii) Commission of embezzlement, theft, forgery, bribery, or falsification or destruction of records.

(iv) Making false statements.

(v) Receiving stolen property.

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in Paragraph 3.a.(2) of Subsection 102.17 of this Specification.

(4) Have not within a 3-year period preceding this bid had one or more public transactions (Federal, State, or local) terminated for cause or default.

b. The inability of a person to provide the certification required above will not necessarily result in denial of participation in a contract. The bidder shall submit an explanation of why he/she cannot provide certification. The certification or explanation will be considered in connection with the Department's or agency's determination whether to enter into this transaction. However, failure of the bidder to furnish a certification or an explanation shall disqualify the bid.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the Department determined to enter into this transaction. If it is later determined that the bidder knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Department may terminate this transaction, cause prosecution for perjury, bring debarment proceedings, or any combination of the above.

d. The bidder shall provide immediate written notice to the Department if at any time the bidder learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms “covered transaction,” “debarred,” “suspended,” “ineligible,” “lower tier covered transaction,” “participant,” “person,” “primary covered transaction,” “principal,” “bid proposal,” and “voluntarily excluded,” as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Federal Executive Order 12549. The Department may be contacted for assistance in obtaining a copy of those regulations.

f. The bidder agrees by submitting this bid that, should the proposed covered transaction be entered into, he/she shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction unless authorized by the Department.

g. The bidder further agrees by submitting this bid that he/she will include this Subsection (102.17), without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

h. A bidder in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction unless he/she knows that the certification is erroneous. A bidder may decide the method and frequency by which he/she determines the eligibility of his/her principals.

i. Except for transactions authorized under Paragraph 3.f. of Subsection 102.17 of these Specifications, if a bidder in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this contract, in addition to other remedies available to the Federal Government, the Department may terminate this contract for cause or default, cause prosecution for perjury, bring debarment proceedings, or any combination of the above.

SECTION 103 -- AWARD AND EXECUTION OF THE CONTRACT

103.01 -- Contract Award

1. The award of the contract will be made by the Engineer to the lowest responsible bidder whose bid complies with all the requirements described. The award will not be made until all necessary investigations have been made into the responsibility of the bidder to whom it is proposed to award the contract. The decision to award or reject shall be made within thirty calendar days after the opening of the bids, unless both parties agree in writing to an extension

2. The right is reserved to limit the work awarded one bidder to the amount that he/she is considered capable of handling, taking into account both his/her capacity to perform work and contracts in force as evidenced by the Contractor's current qualification amount. Should a bidder be the low bidder on two or more bids in a total amount exceeding their qualification, the Department reserves the right to award a contract or contracts in the best interest of the State which do not exceed their current prequalification plus a tolerance of not more than 25%. The State reserves the right to determine which bid(s) will be awarded or rejected.

3. The Engineer reserves the right to request from the low bidder an extension of time to consider their bid for award or rejection. The Contractor then has the right to reject the extension without reprisal.

4. The successful bidder will be notified in writing that his /her bid has been accepted and that he/she has been awarded the contract.

103.02 -- Affirmative Action

1. The Department, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252) and the Regulations of the Department of Transportation (49 CFR, Part 21), issued pursuant to such Act, hereby notifies all bidders that it will affirmatively insure that the Contract entered into will be awarded to the lowest responsible bidder without discrimination on the grounds of race, color, sex, or national origin.

103.03 -- Consideration of Bids

1. Following the bid opening, the Department will compare the responsive bids. Unless otherwise defined in the proposal form, the comparison will be based on the summation of the quantities and the unit bid prices shown in the bid. The bid totals will be available to the public as soon as reasonably possible, not to exceed two working days after the bid letting.

2. The right is reserved to reject any and all bids and to waive technical errors as may be deemed in the Department's best interest.

3. When the Department allows one or more projects to be tied at the option of the Bidder, the Department may consider both tied and untied bids to determine the lowest responsible bidder. When untied bids are not received on projects that are allowed to be tied, the Department may award the contract to a bidder submitting the lowest tied bid, regardless of whether an untied bid on a single project is lower than the tied bid. The Department will act in the best interest of the State when making this determination.

4. All documents and information used in the preparation of a bid shall be retained by all bidders for a period of 60 calendar days after the bid letting and shall be produced to the Engineer upon request. The bidder

awarded the contract shall maintain all documents and information used in the preparation of a bid until three years after project final payment, and the same shall be furnished to the Engineer upon request. Failure to maintain and furnish the documents and information will result in a reduction of the bidder's maximum qualification rating.

103.04 -- Increased, Diminished or Omitted Items

1. It is understood that the quantities of work to be done and materials to be furnished may each be increased, diminished, or omitted without in any way invalidating the unit bid prices, except as provided in Subsection 104.02 of the current edition of the Nebraska, Standard Specifications for Highway Construction or Supplemental and Special Provisions.

103.05 -- Cancellation of Award

1. The Department reserves the right to cancel the award of any contract any time before the execution of the said contract by all parties without any liability against the Department.

103.06 -- Requirements with Respect to Contract Bond

1. Unless otherwise shown in the proposal form, the bidder to whom the Contract is awarded shall furnish within thirty calendar days after the award a Contract bond in a sum equal to the full amount of the Contract. The Contract bond must be executed on the form furnished by the Department. Contract bonds must be executed by corporations authorized to contract as a surety in Nebraska.

103.07 -- Execution of Contract

1. No bid shall be considered binding upon the Department until the execution of the Contract as described below.

2. Unless otherwise shown in the proposal form, the Department will not sign a contract unless:

a. The Contract has been signed by a person authorized to sign for the bidder as shown in the prequalification (when prequalification is required for the contract) and returned to the Department within thirty calendar days from the date of award.

b. The Contractor has provided a satisfactory bond and certificate of insurance within thirty calendar days from the date of award.

3. The Department will not sign the contract when the bidder gives written notice expressing intent not to execute the Contract.

103.08 -- Failure to Execute Contract

1. When a contract is not properly signed by the Bidder or the required documents have not been provided, in the time specified in the contract, the Department may:

a. Annul the award and cancel the bid with forfeiture of the proposal guaranty bid bond (forfeiture not imposed as a penalty, but in liquidation of damages sustained), and adjust the bidder's prequalification downward as specified in Paragraph 5. of Subsection 102.01.

b. Proceed with the execution of the Contract when all required documents have been correctly submitted, and adjust the bidder's

prequalification downward as specified in Paragraph 5. of Subsection 102.01.

c. Award to the lowest, succeeding, responsive bidder and recover the differences from the defaulting bidder, and adjust the bidder's prequalification downward as specified in Paragraph 5. of Subsection 102.01.

103.09 -- Material Guaranty

1. Before any contract is awarded, the successful bidder may be requested to furnish a complete statement of the origin, composition, and manufacture of any materials to be used in the construction of the work, together with samples which may be subjected to the tests provided for in the Standard Specifications to determine their quality and fitness for the work.

SECTION 104 -- SCOPE OF WORK

104.01 -- Intent of Contract

1. The Contractor shall furnish all labor, materials, equipment, and other resources required to complete the work described in the contract.

104.02 -- Alteration of Plans or Character of Work

1. Changes to the Work

a. The Engineer may revise the contract and add or delete items of work as needed to satisfactorily complete the project at any time during the contract.

b. These changes will be provided to the Contractor in writing.

c. These changes in the work to be completed do not invalidate the contract nor release the contract surety.

d. The proposed changes will be reviewed to determine if there will be additional environmental impacts that were not addressed in the environmental documents, permits, agency commitments or the contract. This review shall occur prior to work commencing on the proposed changes.

e. If the changes in the quantities or the work to be completed result in requiring additional time to complete the contract, adjustments to the contract time will be considered in accordance with Subsection 108.02.

2. Changes in Quantities (Directed by the Engineer)

a. Except for changes in quantities of existing major items of work, the work will be paid for at either the contract unit prices for existing items of work or at negotiated prices for new items of work.

b. (1) If a major item of work is increased in excess of 125% or decreased below 75% of the original contract quantity, the Department or the Contractor may request to negotiate a new price for that portion in excess of 125% of the original contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed, provided that the Contractor can demonstrate how his or her costs have been impacted and explains how any fixed costs were distributed to the original quantities of the items affected.

(2) Agreement will be reached for the contract adjustment before the work is begun. When the basis cannot be agreed upon, the Department may order prosecution of the work under the Force Account provision in Subsection 109.05.

(3) Any contractor-exercised option, such as the use of RAP in an asphaltic concrete mix, will not become the basis for an increase in price due to a quantity change.

(4) If the Engineer and the Contractor agree that the bid unit price is the correct unit cost for an overrun or underrun of the contract quantity, that agreement must be documented in some fashion (letter, email, change order).

3. Changes in Quantities (Incidental Overruns and Underruns)

a. The quantities listed in the schedule of items are considered to be approximations; and the final quantities, as determined by final

measurements and the records of work performed, routinely result in overruns or underruns of the original quantities.

b. (1) Except for changes in quantities of existing major items of work, the work will be paid for at the contract unit prices.

(2) (i) If a major item of work is increased in excess of 125% or decreased below 75% of the original contract quantity, the Department or the Contractor may request to negotiate a new price for that portion in excess of 125% of the original contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed, provided that the Contractor can demonstrate how his or her costs have been impacted and explains how any fixed costs were distributed to the original quantities of the items affected.

(ii) Any contractor-exercised option, such as the use of RAP in an asphaltic concrete mix, will not become the basis for an increase in price due to a quantity change.

(iii) If the Engineer and the Contractor agree that the bid unit price is the correct unit cost for an overrun or underrun of the contract quantity, that agreement must be documented in some fashion (letter, email, change order).

(iv) If the Engineer and the Contractor cannot agree upon a revised unit price for a qualifying overrun or underrun of the contract quantity, the Engineer, in his or her sole discretion, shall either pay for the work at the contract unit price or determine an equitable adjustment.

4. Differing Site Conditions

a. The Contractor shall notify the Department in writing of any suspected differing site conditions. Notification shall be made before the existing conditions are disturbed and as soon as the condition is discovered.

b. Differing site conditions are:

(1) Subsurface or latent physical conditions which differ materially from those indicated in the contract, or

(2) unknown physical conditions of an unusual nature which differ materially from those ordinarily encountered and which are generally recognized as inherent to the work of the character provided for in the contract.

c. The term "differing site conditions" shall not apply to those situations where the subsurface or latent physical conditions or an unknown physical condition do not differ significantly from those ordinarily encountered or which are generally recognized in the industry as inherent in the work provided for in the contract.

d. Before the site is disturbed and before any anticipated or additional work is performed, the Engineer shall be given an opportunity to investigate.

e. (1) Upon written notification, the Engineer will investigate the suspected differing conditions and determine whether they differ materially from those indicated in the contract or qualify as an unknown physical condition of an unusual nature; and the Engineer's determination shall be conveyed to the contractor in writing

(2) If the Engineer determines that they do materially differ and will result in an increase (or decrease, as the case may be) in the cost or time required for the performance of any work under the contract, a cost adjustment (excluding loss of anticipated profits) or time allowance adjustment will be made; and the contract will be modified in writing if a change is warranted.

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

5. Extra Work

a. The alterations of the contract, the quantities, or the work described in this Subsection may result in "extra work," as defined in Subsection 101.0338 of these Specifications.

b. The Contractor shall perform unforeseen work for which there is no price included in the contract whenever it is deemed necessary or desirable to complete the proposed improvement. Such "extra work" shall be performed in accordance with the specifications and as directed.

c. Except in emergency conditions, no payment is allowed for "extra work" unless it is authorized by a signed Work Order. The Work Order shall be completed before the Contractor starts the extra work.

d. The order shall stipulate that the work shall be paid for at the stated unit price or lump sum agreed upon previously by the Contractor and Engineer. Failing such agreement, the order shall stipulate that the work shall be done on a force account basis or by having the Engineer track and record construction costs for payment and complete a Supplemental Agreement when the extra work is complete.

e. See Subsection 109.05 of these Specifications for additional information and details regarding payment for "extra work."

104.03 -- Value Engineering Proposals (VEP)

1. These requirements apply to all proposals initiated, developed, and identified as VEPs by the Contractor. To be qualified as a VEP, a proposal must be identified as a VEP at the time of its submission to the Engineer.

2. The Contractor shall submit VEPs to the Engineer in writing with the understanding that the Engineer is not required to approve them. If a VEP is accepted by the Department, an amount not to exceed 50% of the resultant savings will be paid to the Contractor.

3. Each VEP must result in a net cost savings without impairing essential functions and characteristics of the item(s) or of any other part of the project, including but not limited to service life, reliability, economy of operation, ease of maintenance, desired aesthetics, and safety.

4. As a minimum, the following information shall be submitted with each VEP:

a. A statement that the proposal is submitted as a VEP.

b. A statement concerning the basis for the VEP and benefits to the Department together with an itemized list of the contract items and requirements affected by the VEP.

c. A detailed comparison of the estimated costs under the existing contract and under the VEP.

d. Proposed specifications and recommendations as to how such VEP changes are to be accomplished.

e. A statement indicating the time and date by which a change order-supplemental agreement adopting the VEP must be issued so as to obtain the maximum cost effectiveness.

5. a. VEPs will be processed in the same manner described for any other proposal which would necessitate issuance of a change order-supplemental agreement. The Department may accept in whole or in part any VEP by issuing a change order-supplemental agreement which identifies the VEP on which it is based. The Department will not be liable to the Contractor for failure to accept or act upon any VEP submitted pursuant to these requirements or for any delays to the work attributable to any such proposal.

b. Until the Department approves a VEP by a change order-supplemental agreement, the Contractor shall be obligated to the terms and conditions of the existing contract. If an executed change order-supplemental agreement or a work order has not been issued by the date specified in the Contractor's proposal or another date the Contractor may subsequently have specified in writing, the VEP shall be deemed rejected.

6. a. The change order-supplemental agreement effecting the necessary contract modification will establish the net savings agreed upon, will provide for adjustment in the contract prices, and will indicate the net savings to be equally divided between the Contractor and the Department.

b. The Contractor shall prepare and submit the VEP at no additional cost to the Department. All reasonably incurred costs of reviewing and administering the VEP will be borne by the Department. The Department reserves the right to include in the agreement any conditions it deems appropriate for consideration, approval, and implementation of the VEP. The Contractor's share of the net savings constitutes full compensation for designing and developing the VEP and effecting all changes pursuant to the agreement.

7. Acceptance of the VEP by the Department and performance of the work by the Contractor will not change the contract time limit unless specifically addressed in the change order-supplemental agreement authorizing the VEP.

8. The Department expressly reserves the right to adopt a VEP for general use in its contracts. VEPs identical or similar to previously accepted VEPs will be eligible for consideration and compensation provided they were not previously adopted for general application by the Department. When a VEP is adopted for general use, compensation for it will be applied only to those contracts awarded and for which the subject VEP has been submitted before the date of its general adoption.

9. The following will not normally be considered acceptable VEPs:

- a. Changes to basic bridge design.
- b. Changes to basic pavement designs.
- c. Changes requiring different right-of-way limits.

d. Requirements set by permit conditions.

10. VEPs based on prior changes to Department contracts/procedures are not acceptable.

11. The Engineer shall be the sole judge of the acceptability of a VEP.

12. Subject to the provisions contained herein, the Department or any other public agency shall have the right to use all or part of any accepted VEP without obligation or compensation of any kind to the Contractor.

13. Subsection 104.02, which pertains to adjustment of contract unit prices due to alterations of contract quantities, will not apply to the items adjusted or deleted as a result of affecting the VEP by change order-supplemental agreement.

14. A VEP will not be accepted if the proposal is prepared by an Engineer or the Engineering Firm who designed the contract plans.

104.04 -- Maintenance of Detours, Shooflies, and Temporary Accesses

1. The Contractor shall at all times, to the extent practicable, provide private dwellings, commercial properties, businesses, and public facilities access to and from the nearest intersecting public road or street. Accommodations shall be made to ensure local traffic which has its origin or destination within the limits of the project has access to all private dwellings, commercial properties, businesses, and public facilities. Shooflies or temporary, accesses constructed for public use shown in the contract or as directed by Engineer shall be maintained by the Contractor.

2. a. The Contractor shall not close any road without the permission of the Engineer.

b. It is understood that although a road is closed, limited access must be maintained for authorized local traffic.

3. When the contract show a "DETOUR", it will be routed, marked, and maintained by the Department, county, or city.

4. a. When the contract requires the Contractor to build "shooflies" or "temporary accesses", the Contractor shall be responsible for their maintenance.

b. (1) The Contractor shall receive "Equipment Rental" payments as described in Section 919 for maintenance of shooflies and temporary accesses.

(2) The Contractor shall also receive payment for all materials used in the maintenance of shooflies and temporary accesses.

c. The Contractor shall maintain all shoofly or access roadways to the as built condition as shown in the contract throughout its use.

d. If the Contractor fails to perform required shoofly and temporary access maintenance and it becomes necessary for the Department to perform the maintenance, the cost of labor, equipment, and material required to perform the maintenance (calculated in accordance with the methods described in Subsection 109.05) will be deducted from money due the Contractor.

104.05 -- Removal and Disposal of Unforeseen Structures and Obstructions

1. a. The Contractor shall remove unforeseen obstructions or structures that conflict with the work.

b. Whenever it is possible, structures shall not be removed until replacement structures are operational.

c. Material from existing structures which, in the opinion of the Engineer, can be used elsewhere shall remain the property of the State. This material shall be removed without damage, in sections which may be readily transported, and stored neatly by the Contractor as provided elsewhere in these Specifications.

d. Unless otherwise provided in the contract, removal of unforeseen structures and obstructions will be paid for as "extra work".

2. The Contractor shall remove and dispose of minor obstructions or obstacles encountered in the roadway, borrow pits, or material pits without compensation. Minor obstructions include, but are not necessarily limited to, such items as:

a. Abandoned pipes less than 10 feet (3 m) long and less than 30 inches (750 mm) in diameter.

b. Abandoned cable.

c. Boulders 40 inches (1 m) in diameter or smaller.

d. Scrap iron.

e. Fences.

f. Trash.

g. Stumps.

h. Logs less than 18 inches (450 mm) in diameter and 20 feet (6 m) in length.

i. Concrete pieces less than 1 cubic yard (0.75 m³).

j. House foundations [(less than 10 feet (3 m) long)].

3. The above list of typical minor items will not be considered minor when several minor items are unearthed and the total volume exceeds 26 cubic yards (20 m³). This exclusion does not apply to items visible on the ground surface at the time of contract letting.

104.06 -- Rights In and Use of Materials

1. a. The Engineer may authorize the use of soils found in the excavation that are suitable for completing other bid items of work. The Contractor will be paid for both the removal of the soils at the corresponding contract unit price and for the pay item for which the removed soils are used. No charge for the soils used will be made against the Contractor.

b. If the Contractor removes soils to complete other items of work, this soil shall be replaced with acceptable soils without compensation. Unless authorized by the Engineer, the Contractor shall not excavate or remove any soils from within the right-of-way limits that are not within the excavation limits established in the field.

2. Unless otherwise provided, material from any existing structure may be used temporarily in the erection of the new structure. Salvage material shall not be cut without the approval of the Engineer. Extreme care shall be taken to avoid damage to the salvage material.

104.07 -- Final Cleaning Up

1. As part of completion of the work and before acceptance and final payment, the Contractor shall remove all rubbish or litter that the Contractor generated, excess materials, falsework, temporary structures, and equipment from the project site, borrow sites, and all State property occupied in connection with the work. All parts of the work shall be left in a neat and presentable condition. Additionally, the project shall be restored in accordance with environmental documents, permits, agency commitments and the contract.

2. Final Cleanup shall be at no additional cost to the Department.

104.08 -- Removal of Unexpected Waste and Contaminated Soil

1. Should the Contractor encounter any previously unidentified suspected hazardous materials, the Engineer shall be immediately notified. The Contractor shall immediately suspend operations in the area involved until such time that the Engineer provides the Contractor with direction and permission to proceed. The Department reserves the right to direct the Contractor to complete the work, or to contract with another entity to complete the work.

2. When directed to do so by the Engineer, the remedial work will be paid for as Extra Work.

SECTION 105 -- CONTROL OF WORK

105.01 -- Authority of Engineer

1. The Engineer will decide all questions regarding:
 - a. The quality and acceptability of materials furnished.
 - b. The work performed.
 - c. The manner of performance and progress of the work.
 - d. Interpretation of the Contract.
 - e. Fulfillment of the contract by the Contractor.
 - f. Compensation.
 - g. Disputes pertaining to mutual rights between Contractors.
 - h. Determination of the existence of differing site conditions.
 - i. Determination of working days or calendar days.
 - j. Working drawing details.

2. The Engineer's decisions shall be final, and he/she shall have authority to enforce those decisions and orders which the Contractor fails to carry out promptly.

3. a. The Engineer will have the authority, but not the duty, to suspend the work either wholly or partially if the Contractor fails to:

(1) Correct conditions unsafe to Department personnel or the traveling public.

(2) Carry out provisions of the contract.

(3) Carry out contract related decisions of the Engineer.

(4) Follow the plans and specifications.

(5) Comply with any governing Federal, State or Local environmental quality regulation.

b. Work may also be suspended by the Engineer to protect the State's interest and for conditions considered unsuitable for prosecution of the work.

c. While the Engineer may initially notify the Contractor verbally, the Engineer will notify the Contractor in writing of all suspensions.

4. Contractor is solely responsible for worksite safety for employees of Contractor or any lower tier subcontractor or supplier, and Contractor understands that State has no duty concerning worksite safety to Contractor, Contractor's subcontractors at any tier, or to employees of Contractor or any project subcontractor or supplier.

105.02 -- Plans and Working Drawings

1. The plans will be supplemented by such Contractor provided working drawings (shop plans) as are necessary to adequately control the work. It is mutually agreed that all authorized alterations affecting the requirements and information given in the plans shall be in writing and reviewed by the Engineer.

2. Contractor provided working drawings shall consist of such detail as may be required of the Contractor for the prosecution of the work. They

shall include but are not necessarily limited to shop details. The Contractor shall not perform any fabrication work until the shop details have been reviewed by the Engineer. Erection plans, masonry layout diagrams, and plans for cribs, cofferdams, falsework, and form work, as well as any other working drawings not previously mentioned, may be required of the Contractor and may be subject to the Engineer's review.

3. No changes shall be made in any working drawing after it has been reviewed except by a written acknowledgement from the Engineer.

4. Department review is solely for the Department's purposes and the Department has no duty to review the working drawings for compliance with the terms of the contract or applicable standards. It is expressly understood that the Engineer's review will not relieve the Contractor of its sole responsibility for all aspects of the working drawings. In no event shall the Department be responsible for any aspects of the Contractor's working drawings.

5. The contract prices include the cost of furnishing all working drawings.

6. a. The Contractor shall provide electronic working drawings in a Portable Document Format (PDF). The PDFs shall be sized to print on an 11x17 inch sheet of paper and have a minimum resolution of 300 dpi. Each sheet of the shop drawings shall have a space provided for an electronic stamp that measures 2.5 inches x 3.5 inches when printed.

b. Electronic working drawing files shall be named with the following file naming format:

Control Number_Brief Description_Date.pdf

For example: 12345_FloorDrains_05Feb2015

12345_FloorDrainCoverLetter_05Feb2015

c. The project number, control number, and project location as it appears on the plans shall be shown on the front sheet of each Shop Drawing file. Structure numbers shall be included, if applicable.

7. No electronic working drawings shall be submitted to the Engineer unless they have been checked by the Contractor. The electronic submittal shall be accompanied by a Contractor's letter of approval in a PDF format. This letter shall also be named with the format shown in the example above. The letter of approval shall clearly indicate that the Contractor is responsible for any errors on the working drawings.

8. a. Electronic submittals shall be submitted by email to the following address:

DOR.ShopDrawings@nebraska.gov

b. Attachments shall be limited to 25 MB of data per email. Larger files shall be separated and sent in multiple emails.

c. Electronic working drawings will only be accepted from the Prime Contractor.

9. Any reference to hard copy shop drawings in the contract shall be considered void.

105.03 -- Conformity with Plans and Allowable Deviations

1. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, typical sections, dimensions, material requirements, and tolerances shown in the contract or indicated in the specifications.

2. a. The Engineer has the authority to totally reject nonconforming materials or work or to accept them at a reduced cost.

b. If the nonconforming materials or work are allowed to remain in place at a reduced cost, the Engineer will provide written notice to the Contractor of the monetary deduction that will be imposed.

c. If the nonconforming materials and/or work are rejected, the Contractor shall remove and replace or otherwise correct the work and materials at no additional cost to the Department.

105.04 -- Coordination of Plans, Specifications, Special Provisions, and Supplemental Specifications

1. a. These Specifications, the supplemental specifications, the plans, special provisions, and all supplementary documents are essential parts of the contract. 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 project.

b. In case of a discrepancy:

(1) Supplemental specifications shall govern over the *Standard Specifications*.

(2) Special provisions shall govern over *Standard Specifications*, supplemental specifications, and the plans.

(3) Plans shall govern over *Specifications*.

(4) Special plans shall govern over standard plans.

(5) Computed dimensions shall govern over scaled dimensions.

c. When cross-references are made between Divisions in the *Standard Specifications*, the Contractor shall be responsible for determining whether the referenced Divisions have been subsequently voided, superseded, or amended by the supplemental specifications or special provisions.

2. The Contractor shall not take advantage of any apparent error or omission in the plans or specifications. Upon discovery of such an error or omission, the Contractor shall notify the Engineer immediately. The Engineer will then make such corrections or interpretations as necessary to fulfill the intent of the plans and specifications.

105.05 -- Cooperation of Contractor

1. The Contractor shall keep one complete set of the plans and specifications on the worksite at all times.

2. The Contractor shall cooperate with the Engineer, Inspectors, and other Contractors in every way possible.

3. a. The Contractor shall designate a superintendent who will be on the worksite at all times when work is being performed. The designated superintendent may be an employee of an approved Subcontractor.

b. The designated superintendent shall be:

(1) Capable of reading and thoroughly understanding the plans and specifications.

(2) Experienced in the type of work being performed.

(3) Authorized to act as the Contractor's agent.

(4) Authorized to receive instructions from the Engineer or an authorized representative.

(5) Authorized to execute the orders or directions of the Engineer without delay and to promptly supply such materials, equipment, tools, labor, and incidentals as may be required.

105.06 -- Cooperation with Utilities

1. The Department will notify all known utility companies, pipeline owners, railroads, or other parties affected by the work and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other facilities within or adjacent to the limits of construction made as soon as practicable.

2. Water lines, gas lines, wire lines, service connections, water and gas valve boxes, light standards, cableways, signals, and all other utility facilities within the limits of the proposed construction are to be moved by the owners at no expense to the Contractor, except as otherwise provided for in the contract.

3. It is understood and agreed that the Contractor has considered in the bid all of the permanent and temporary utility facilities in their present or relocated positions as shown in the contract and that no additional compensation will be allowed for any delays, inconvenience, or damages sustained due to any interference from the said utility facilities or the operation of moving them.

105.07 -- Cooperation Between Contractors

1. The Department reserves the right at any time to contract for and perform other additional work on or near the work covered by the contract.

2. a. When separate contracts are let within the limits of any one project, Contractors shall conduct their work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors.

b. Contractors working on the same project shall cooperate with each other. In case of a dispute, the Engineer shall intervene; and his/her decision shall be final and binding on all parties.

3. Each Contractor involved shall assume all liability, financial or otherwise, in connection with the contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of 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 assume all responsibility for work not

completed or accepted because of the presence and operations of the other Contractors.

4. The Contractor shall, as far as possible, arrange the work and place or dispose of the materials being used so as not to interfere with the operations of other Contractors within the limits of the same project.

5. The Contractor shall coordinate the work with the other Contractors.

105.08 -- Authority and Duty of the Inspector

1. Department inspectors are authorized to inspect all work performed and all materials furnished. Such inspection may extend to the preparation, fabrication, or manufacture of the materials. The inspector has the authority to reject work or materials until any issues can be decided, including the right to suspend work. The inspector is not authorized to alter or waive the provisions of the contract or act as a supervisor for the Contractor. The inspector is not authorized to accept work performed or materials furnished.

105.09 -- Inspection

1. a. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Contractor or fabricator shall allow and provide safe, free, and immediate access to all parts of the work and furnish whatever assistance and information may be required to make a complete and detailed inspection.

b. Inspection of the work does not constitute acceptance of the work.

2. a. At any time prior to final acceptance of the work, the Contractor shall remove, uncover, or provide other means for examination of portions of the finished work if directed to do so. After the examination, the Contractor shall restore the work to the standard required by the contract.

b. Should the same work prove compliant, the work of examining, uncovering and covering, removing and replacing, or making good the parts removed shall be paid for as "extra work". Should the work prove noncompliant, even though it may be determined to be acceptable, those same items of work shall be done at no additional cost to the Department.

3. The Department may elect to reduce or eliminate inspection on some phases of the work. However, work done or materials used with or without inspection by the Department may be ordered removed and replaced without compensation if the work does not meet contract requirements.

105.10 -- Removal of Noncompliant and Unauthorized Work

1. Work which does not conform to the contract requirements will be considered noncompliant unless found to be acceptable under the provisions of Subsection 105.03.

2. Noncompliant work found to exist before the final acceptance of the work shall be removed immediately and replaced at no additional cost to the Department.

3. Work done contrary to the instructions of the Engineer, work done contrary to the lines or limits shown in the contract or those established by the Engineer's construction stakes, or any "extra work" done without proper authority will be considered unauthorized; and no payment is authorized for

this work. The Engineer may require unauthorized work to be removed or replaced at no additional cost to the Department.

4. If the Contractor fails to comply with directions given by the Engineer, as provided in Paragraphs 2. and 3. of this Subsection, the Engineer shall engage another party or use other appropriate means to remedy, remove, and/or replace noncompliant and unauthorized work and collect money for the costs from the Contractor or the Bonding Company.

105.11 -- Restriction on Moving and Use of Heavy Equipment

1. The movement of heavy equipment to and from the work and over the pavement structure and structures which are a part of the work shall be done in compliance with the laws governing the operation of vehicles on the highways of the State. A special permit will not relieve the Contractor of liability for damage which may result from the moving of equipment.

2. In the case of earthwork and shouldering to be done in connection with pavement widening and resurfacing, no tractor-drawn earth moving equipment shall be operated or driven on or across the pavement except as authorized by the Engineer.

3. In the performance of the contract work, earth moving equipment equipped with flotation or pneumatic tires may be operated over concrete pavement, concrete base courses, and bituminous or asphaltic concrete surfaces which are a part of the project, provided the load on any single axle does not exceed 34,000 pounds (15,500 kg). This will not relieve the Contractor of liability for damage which may result.

4. Trucks shall comply with all Federal, State, and local laws governing vehicular operation.

5. No crane, excavator, or dragline shall be operated with any part of the machine resting directly upon a pavement, bituminous or asphaltic concrete surface, base course, or structure without the written permission of the Engineer.

6. Under no conditions, shall machines equipped with metal lugs or similar projections on the treads be operated on the surface of a concrete pavement, asphaltic concrete surface, base course or structure.

7. Crawler type equipment shall be operated in a manner that will avoid damage to paved and base course surfacing and shall not move on or off a concrete pavement, asphaltic concrete surface, base course or structure except at places where the compacted earth adjacent to the slab is at least 2 inches (50 mm) higher than the surface of the pavement or base course or where a substantial timber approach has been built at the edge of the slab to prevent damaging the edge of the slab or surface course. Any damage shall be repaired as directed by the Engineer at no expense to the Department.

8. Equipment mounted on either crawler tracks or pneumatic tires shall cross bridges at such speed and at such a location with reference to the centerline of the bridge as the Engineer directs.

9. Construction equipment mounted on pneumatic tires and whose axle loading and spacing do not conform to the statutory limitations or posted capacity of the bridges will not be allowed to cross bridges unless the Contractor obtains written permission from the Engineer.

10. Construction equipment mounted on crawler tracks with a gross weight of more than 23 tons (21 Mg) will not be allowed to cross any bridge without specific written permission from the Engineer.

11. Construction equipment mounted on crawler tracks with a gross weight of more than 15 tons (13.6 Mg) will not be allowed to cross any bridge having timber stringers or a timber floor without specific written permission from the Engineer granted for that particular bridge.

12. Hauling vehicles will be allowed to move on new concrete pavement or concrete base courses under the following provisions:

a. The concrete shall have reached its design strength.

b. When moving equipment on or across concrete or asphalt pavement, the contractor shall provide at least a 12 inch (300 mm) thick ramp of compacted earth or other suitable material which will support the vehicle and prevent damage to the pavement.

c. The distance from the edge of the pavement to the edge of any wheel of the vehicle shall be not less than 2 feet (600 mm) except as the vehicle enters or exits the new pavement.

13. The Contractor shall be responsible for all damages done by the equipment.

105.12 -- Use of Land

1. When using land outside of the highway right-of-way for any purpose, the Contractor must have consent of the owners. The Contractor shall be solely responsible for negotiating the terms for use and access.

105.13 -- Tentative Acceptance of Portions of the Project

1. a. If at any time during the prosecution of the work the Contractor completes to the satisfaction of the Engineer a unit or portion of the work, such as a structure, an interchange, or a section of road, grading, or pavement, the Engineer may tentatively accept that unit.

b. The section or unit that is being tentatively accepted will be inspected, tentatively accepted in writing, and turned over to the Department for maintenance.

c. Such tentative acceptance shall not in any way be construed as final acceptance of the entire project.

d. The Contractor will not be held responsible for care and maintenance of the completed work and for damages to portions of the project which have been tentatively accepted.

e. If the traveling public should cause damage to the tentatively accepted work, the Contractor will not be held responsible and shall assist the State in identifying the responsible party. The Contractor shall, at a minimum, especially if present at the time of the damage, record and furnish to the Department all pertinent information regarding the accident (who caused the damage; when the damage occurred; and how the damage occurred, etc.).

2. Maintenance of lighting systems, trees, plants and shrubs, and erosion control measures like silt fence and bale checks that are located in tentatively accepted areas shall continue to be the Contractor's responsibility

until the project is finally accepted. If the Contractor fails to perform maintenance in a tentatively accepted area, then upon written notification by the Engineer, the tentative acceptance shall be revoked.

3. a. The Contractor will not be held responsible for damages to portions of the project which have been tentatively accepted in writing by the Engineer prior to final approval and acceptance of the project, provided such damages are due to the actions of the elements or to the action of traffic.

b. The Contractor shall be responsible for any damages which may have resulted from defective work or because of noncompliance with the plans, specifications, or any other contract requirements.

c. The Contractor shall be responsible for any direct or collateral damage that results from the performance of the work required in the contract.

105.14 -- Final Inspection

1. Upon notification by the Contractor that the work has been completed, the Engineer shall make a prompt final inspection. If any part of the work has not been completed in accordance with the requirements of the contract, the Contractor shall be advised as to the particular defects to be remedied.

2. When a final inspection verifies all work is complete, the Engineer shall tentatively accept the work. The Engineer will send the Contractor a letter relieving him/her of further responsibility for the care and maintenance of the completed work. In addition, the letter shall also relieve the Contractor of further public liability provided that all equipment and materials have been removed from the right-of-way.

3. The Contractor shall remain responsible for any damages which are due to or caused by defective work or because of noncompliance with the contract.

SECTION 106 -- CONTROL OF MATERIAL

106.01 -- Sources of Supply of Materials

1. Unless otherwise provided, materials used in the work shall be new and conform to the requirements of Subsection 105.03.

2. In order to expedite the inspection and testing of materials, the Contractor shall advise the Engineer at least two weeks before delivery of materials.

3. Subject to the approval of all regulatory agencies, the Contractor will be allowed to drill wells within the right-of-way limits for the purpose of securing water for the contracted construction. The Contractor shall comply with Nebraska State Title 178, Chapters 10 and 12. The water well driller/Contractor must be Nebraska licensed. No charge will be made for any water removed from these wells. When a well is no longer needed, it shall be abandoned in accordance with applicable laws and regulations (see Nebraska State Title 178, Chapter 12).

106.02 -- Samples, Tests, and Cited Standards

1. All materials are subject to inspection and testing by the Engineer before incorporation in the work. However, the Engineer may waive any of the requirements regarding determination of quality for small quantities of materials and small or noncritical structures. Any work using untested and unacceptable materials without written permission of the Engineer shall be performed at the Contractor's risk subject to the conditions in Subsection 105.03.

2. All materials being used are subject to inspection, tests, and rejection at any time.

3. Sampling and testing shall be done by the Department, its agents, or the Contractor as specified.

4. Upon request, copies of all test results will be furnished to the Contractor. The results may be posted on the Department's website at the discretion of the Engineer in lieu of furnishing the results.

5. The frequencies and methods of sampling and testing materials, including those required for a definite purpose and not covered by the contract, will be sampled and tested according to the Department's *Materials Sampling Guide* and *Standard Methods of Tests*, unless otherwise specified. The testing of materials not covered by the Department's *Standard Methods of Tests* will be tested according to the standard test methods of AASHTO and ASTM. All testing and sampling will be performed in accordance with the latest documents or publications in effect at the time of letting. If there is a difference in the test methods, the order of precedence will be as follows:

Precedent Order

- Department's Standard Method of Tests
- AASHTO
- ASTM

6. The following provisions will apply when the Department uses the specifications or methods from the sources named below:

a. (1) ASTM - American Society for Testing and Materials. The ASTM designation number refers to the Society's latest adopted or tentative standard as published in its entirety in the bound volume. The standard or

tentative standard in effect on the bid advertising date will apply in each case.

(2) Copies of any separate ASTM specifications or test methods may be obtained from American Society for Testing and Materials.

b. (1) AASHTO - American Association of State Highway and Transportation Officials. An AASHTO designation number refers to the organization's currently published *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* or any adopted revisions.

(2) All standards or revisions in effect on the bid advertising date will apply.

(3) Copies of *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* may be obtained from American Association of State Highway and Transportation Officials

106.03 -- Plant Inspection

1. The Engineer may choose to inspect materials at the source. In this event, the following conditions shall be met:

a. The Contractor and the producer or manufacturer of any materials shall assist and cooperate with the Engineer's inspections.

b. The Engineer shall have unrestricted rights to enter areas of the plant involved in the manufacture or production of the materials being furnished to the Department.

c. When requested by the Engineer, the Contractor shall arrange for an approved building, or room in an approved building, for use by the inspector. This building or room shall be:

(1) Located conveniently near the plant.

(2) Independent of any building or room used by the material producer.

(3) In conformance with the requirements of Section 901.

d. Adequate safety measures shall be provided and maintained.

2. The Department may retest and reject previously tested and conditionally accepted materials.

106.04 -- Delivery, Storage, and Handling of Materials

1. All materials shall be handled and stored to preserve their quality and fitness for the work. During the handling of all aggregates or other construction materials, special care shall be taken to prevent contamination. Furthermore, aggregates shall be handled in such a manner as to prevent segregation.

2. Vehicles, including railway cars and barges used in transporting construction materials, must be kept clean, free from contamination, in proper working condition, and capable of preventing the loss of materials during transportation.

3. a. The Engineer may require that materials be stored above ground, covered, or similarly protected in weatherproof buildings.

b. Stored materials are subject to initial or additional inspection before their ultimate incorporation in the work and shall be located to facilitate that inspection.

c. Any space needed for storage purposes and for the placing of plant and equipment shall be provided by the Contractor at no additional cost to the Department. The Contractor may be allowed to store material and equipment within the right-of-way at locations approved by the Engineer, but shall be responsible for the restoration and repair of any damage to turf or other plant life resulting from such operations.

4. The Contractor shall include the cost of handling, transporting, and placing materials in the contract unit price for the relevant pay item.

106.05 -- Unacceptable Materials

1. All materials not conforming to the requirements of the contract shall be considered unacceptable unless approved under the provisions of Subsection 105.03.

2. Materials not meeting the requirements of the contract will be rejected and shall be immediately removed from the project unless the defects are corrected and approved by the Engineer. If the Contractor fails to comply promptly with any order of the Engineer made under the provisions of this Subsection, the Engineer has the authority to remove and replace defective material and to recover the cost of removal and replacement from the Contractor or the bonding company.

106.06 -- State-Furnished Materials

1. When the contract provides that certain materials required to complete the work be furnished by the State, they will be made available to the Contractor at the locations specified in the contract. The Contractor shall be responsible for loading all material.

2. When the Department furnishes materials, the Contractor shall sign the DR Form 146, "Stock Requisition", acknowledging receipt.

3. a. The Contractor shall be responsible for all receipted materials.

b. The Contractor shall be responsible for all losses or damages occurring to State furnished materials while the materials are in the Contractor's possession. Any demurrage or storage charges shall also be the responsibility of the Contractor. The cost of damages, demurrage, or storage shall be recovered from the Contractor or the bonding company. Lost or damaged material shall be replaced in kind by the Contractor at no additional cost to the State.

4. The Contractor shall include the cost of handling, loading, transporting, and placing all State-furnished materials in the contract unit price for the relevant pay item.

106.07 -- Buy America

1. The Buy America rule requires that steel or iron materials be produced domestically, and only those products which are brought to the construction site and permanently incorporated into the completed project are covered. Construction materials, forms, etc., which remain in place at the Contractor's convenience, but are not required by the contract, are not covered.

2. To further define the coverage, a domestic product is a manufactured steel construction material that was produced in one of the 50 States, the District of Columbia, Puerto Rico, or in the territories and possessions of the United States.

3. All manufacturing processes to produce steel or iron materials (i.e., smelting, and any subsequent process which alters the steel or iron material's physical form or shape, or changes its chemical composition) must occur within one of the 50 states, the District of Columbia, Puerto Rico, or in the territories and possessions of the United States, to be considered of domestic origin. This includes processes such as casting, rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes epoxy coating, galvanizing, painting, and any other coating that protects or enhances the value of the material. The manufacturer shall include a statement on the material test report or certification that all material described above except the coating material is a domestic product.

4. Raw materials used in the steel or iron materials may be imported. All manufacturing processes to produce steel or iron materials must occur domestically. Raw materials are materials such as iron ore, limestone, waste products, etc., which are used in the manufacturing process to produce the steel or iron products. Waste products would include scrap; i.e., steel no longer useful in its present form from old automobiles, machinery, pipe, railroad tracks and the like. Also, steel trimmings from mills or product manufacturing are considered waste. Extracting, crushing, and handling the raw materials which is customary to prepare them for transporting are exempt from Buy America. The use of pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States may be used in the domestic manufacturing process for steel or iron materials.

5. Notwithstanding this requirement, a minimum of foreign steel or iron materials will be permitted if its value is less than 1/10% of the total contract cost or \$2,500, whichever is greater.

6. Upon completion of all work utilizing steel or iron products, the prime Contractor shall furnish a letter to the State on company letterhead and signed by an officer of the company stating that documentation is on file certifying that all steel or iron materials brought to the construction site and permanently incorporated in the project will comply in all respects with the Buy America requirements.

SECTION 107 -- LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 -- Laws to be Observed

1. a. The Contractor shall keep fully informed of and observe and comply with all of the following which affect those engaged or employed on the work or affect the conduct of the work:

- (1) Federal and State laws.
- (2) Local laws and ordinances.
- (3) Orders and decrees of bodies or tribunals having any jurisdiction or authority.

b. The Contractor shall protect and indemnify the State and its representatives against any claim arising from the violation of any of the above listed items whenever violated by the following entities or any of their employees:

- (1) The Contractor.
- (2) Subcontractor(s) at any tier.
- (3) Suppliers of materials or services.
- (4) Any others engaged by the Contractor.

2. a. The Contractor shall provide all safeguards, safety devices, protective equipment, and trained personnel, and take any other actions necessary to protect the life and health of employees on the project.

b. (1) State personnel will not perform any surveying, inspection, or testing in an affected area until the Contractor has erected all safety devices required by Federal, State, or local ordinances.

(2) The Contractor's failure to erect and maintain safety devices will be cause for considering placement of safety devices as the current controlling operation.

c. Delays incurred due to the Contractor's failure to provide and maintain the required safety devices will not be considered for extending the contract time allowance.

3. The Contractor shall perform all excavation in accordance with the requirements in the One-Call Notification System Act.

4. Environmental Quality Compliance:

a. Whenever the Contractor violates any governing Federal, State or Local environmental quality regulation and/or is in noncompliance with any environmental commitment, the violating activity must cease immediately until the appropriate remedy can be determined by: the Engineer, the NDOT Environmental Section, the Federal Highway Administration (for projects utilizing Federal-aid) and other agencies, as deemed appropriate. The Engineer, with assistance from the NDOT Environmental Section and the FHWA, will provide a written order confirming the appropriate corrective action to the Contractor. Work can resume to normal conditions once the Engineer determines that the violation or non-compliance has been addressed in accordance with the order for corrective action.

b. The use of dredged material containing any unsuitable items (e.g., trash, debris, car bodies, etc.) or toxic pollutants shall not be permitted.

c. To the maximum extent practicable, fill material must not permanently restrict or impede the passage of normal or expected high flows or cause the relocation of the waterway.

d. If the fill material creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable.

e. Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

f. No activity is authorized under any permit which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal *Endangered Species Act*, or which is likely to destroy or adversely modify the critical habitat of such species. The Contractor shall notify the Engineer if any listed species or critical habitat might be affected or is near the project and shall not begin work on the activity until notified by the Engineer that the requirements of the *Endangered Species Act* have been satisfied and that the activity is authorized. Information on the location of threatened and endangered species and their critical habitat can be obtained from the U.S. Fish and Wildlife Service and National Marine Fisheries Service.

g. No activity which may affect historic properties listed, or eligible for listing, in the *National Register of Historic Places* is authorized until the Engineer has complied with the provisions of 33 CFR 325, Appendix C. The Contractor shall notify the Engineer immediately if the authorized activity may affect any historic properties listed, determined to be eligible, or which the Contractor has reason to believe may be eligible for listing on the *National Register of Historic Places*, and shall not begin the activity until notified by the Engineer that the activity is reauthorized. Information on the location and existence of historic resources can be obtained from the State Historical Preservation Officer and the *National Register of Historic Places*.

h. Migratory Birds

(1) The Department will, to the extent practicable, schedule the letting of projects such that clearing and grubbing can occur outside of the primary nesting season in Nebraska which has been determined to generally occur between April 1 and September 1. Work on structures, such as but not limited to bridges and culverts, should occur outside the primary swallow nesting season, April 15 to September 30, unless approved methods of avoiding nesting have been taken on the bridge and/or culvert structures. The nesting dates above are a guide only, nesting can occur outside of those dates. Work outside of those dates is not exempt from compliance with the Migratory Bird Treaty Act.

(2) The Contractor shall, to the extent possible, schedule work on structures, such as but not limited to bridges and culverts, and clearing and grubbing activities to occur outside the primary nesting season in Nebraska. However, if circumstances dictate that project construction or demolition must be done when nesting migratory birds may be present, a survey of the number of active nests and species of birds shall be conducted

by qualified personnel representing the Contractor, and assisted by the Project Manager (PM), NDOT Environmental Section staff, or the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) - Wildlife Services Office. If the survey finds that nests will be impacted by the proposed construction, the Contractor may be responsible for delays.

(3) The following guidance is provided for compliance with the Migratory Bird Treaty Act for construction of NDOT projects:

(i) The Contractor shall submit a plan to the NDOT regarding how he intends to accomplish bridge demolition or clearing and grubbing of the project to avoid conflict with nesting migratory birds.

(ii) The Contractor must submit a temporary erosion control plan tailored to fit the plan for clearing and grubbing.

(iii) If construction operations result in unavoidable conflict with nesting migratory bird's eggs or young, which will result in "taking" nests and their contents, the Contractor should notify the NDOT Project Manager (PM). The PM shall notify the Environmental Section of Planning and Project Development by telephone at 402-479-4766.

(iv) The NDOT Environmental Section will then determine if assistance in conducting the survey will be provided by the NDOT Environmental Section (if available) or from the USDA APHIS - Wildlife Services Office and arrange for assistance with the survey of nest numbers, bird species, etc. Results of the survey shall be maintained by the DEPARTMENT until project completion.

(v) If the nesting survey is required, and the project was awarded prior to the nesting season, and the Contractor did not accomplish clearing/grubbing and/or work on bridge/culvert structures outside the nesting season, the Contractor will reimburse the Department for each survey required at \$1,000 per survey. If the project was awarded during the nesting season, and construction activities are such that clearing/grubbing and/or work on bridge/culvert structures must be accomplished prior to any other activity on the project, then there will be no charge assessed for the initial survey. The Contractor is responsible for removing all trees surveyed, that do not contain active nests, and for taking appropriate measures on bridge/culvert structures, within 3 days of the survey. Reimbursement for additional surveys may be charged if the Contractor fails to remove the trees within 3 days of the survey, and requires an additional survey. Survey reimbursement will be determined on a project specific basis, considering the project timeline and associated activities.

(vi) If an active nest is found during the survey, the Contractor should do everything possible to restructure his activities and leave the nest undisturbed until the young fledge. Fledging could occur within a week, or up to a month, after the survey depending on the species of bird and whether the nest contained eggs or young. Also depending on the species of bird and their sensitivity to disturbance, a buffer of up to 30 feet surrounding the tree with the active nest could be required.

(vii) If construction cannot be rescheduled to allow the birds to fledge, and it is determined as an unavoidable "take" circumstance, the Contractor shall stop all work within 30 feet of the active nest and

coordinate with the Construction Project Manager to determine how to proceed. The Construction Project Manager will then coordinate with the NDOT Environmental Section and they will facilitate coordination with the US Fish and Wildlife Service and the Federal Highway Administration (for projects using Federal-aid) to determine the appropriate way to address the active nest. No work shall occur within 30 feet of the active nest until US Fish and Wildlife Service coordination is complete and the requirements of the Migratory Bird Treaty Act are satisfied.

(viii) It is the Contractor's responsibility to schedule his work to accommodate the process of conducting a survey(s) and submitting the necessary documentation if avoidance is not practicable. The Contractor shall be responsible for using any legal and practical method to prevent the nesting of birds in order to prevent the need for any survey and prevent the need for additional surveys. It is understood and agreed that the Contractor has considered in the bid all of the pertinent requirements concerning migratory birds (including endangered species) and that no additional compensation, other than time extensions if warranted, will be allowed for any delays or inconvenience resulting in these requirements.

i. Delays incurred as a result of the Contractor's failure to comply with Environmental Quality Regulations will not be considered for extending the contract time allowance. Any cost resulting from the delay shall be borne by the Contractor.

j. The Contractor shall perform washout of concrete mixers, delivery trucks, and other delivery systems in designated areas only.

107.02 -- Permits, Licenses, and Taxes

1. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the lawful prosecution of the work. These costs shall be included in the unit bid prices for the relevant items in the contract.

2. a. Reference is made to the *Nebraska Revenue Act of 1967*, and amendments thereto, which imposed a "Sales and Use Tax". The following information to obtain tax exemption on purchased materials is provided for use in submitting proposals.

b. Each Contractor awarded a contract for Nebraska public highway work will be issued a "Purchasing Agent Appointment" signed by the Engineer and an "Exempt Sale Certificate". The "Exempt Sale Certificate" should be reproduced, completed, and furnished to vendors by the Contractor or Subcontractor when making purchases as a purchasing agent of the Department.

c. The "Exempt Sale Certificate" is to be used by the Contractor (or Subcontractor) when purchasing tangible personal property to be actually incorporated into the completed project. It does not apply to either of the following:

(1) The purchase of materials to be used or consumed but not incorporated into the contract work, including but not limited to, form lumber, scaffolding, etc.

(2) The purchase or rental of machines, equipment, or tools owned or leased by the Contractor and used in performing the contract work.

3. All construction equipment located in Nebraska on the 1st day of January is subject to Nebraska property taxes for that year. Contractors shall notify the appropriate county officials to insure equipment is assessed.

4. Site Approval:

a. When borrow is obtained from a borrow site or waste excavation is placed at sites which are not shown in the contract, or the Contractor plans to use a plant or stockpile site which is not shown in the contract, the Contractor shall be solely responsible for obtaining all necessary site approvals. The Department will provide the procedures necessary to obtain approvals from the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Nebraska State Historical Society, Nebraska Game and Parks Commission, and Nebraska Department of Natural Resources on the NDOT website. The Contractor shall also be responsible for obtaining a Discharge Number from the Nebraska Department of Environmental Quality (NDEQ) that allows work under the current Construction Stormwater Permit. The Contractor shall also be responsible for obtaining any and all other permits required by local governments.

b. It is anticipated that it may require 60 calendar days or more for the Contractor to obtain the necessary approvals. The Contractor shall not begin work at borrow or waste sites until the necessary approvals are obtained. No extension of completion time will be granted due to any delays in securing approval of a borrow or disposal site unless a review of the time frames concludes that there were conditions beyond the Contractor's control.

5. The Contractor shall understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site. For reference, the general permit is posted on the Department's website. Additionally, the Contractor, as evidenced by their signature on this proposal, agrees and understands that, if awarded the contract on this project, he/she:

a. becomes a co-permittee, along with the owner(s), to the Nebraska Department of Environmental Quality NPDES General Permit for Storm Water Discharges from construction sites on this project;

b. is legally bound to comply with the Clean Water Act to ensure compliance with the terms and conditions of the storm water pollution prevention plan developed under the NPDES permit and the terms of the NPDES permit; and

c. will hold the owners harmless for damages or fines arising as a result of noncompliance with the terms of the storm water permits and authorizations associated with the work on this project.

107.03 -- Patented Devices, Materials, and Processes

1. Without exception, contract prices are to include all royalties and costs arising from patents, trademarks, and copyrights in any way involved in the work. Whenever the Contractor is required or desires to use any design, device, material, or process covered by letters, patent, or copyright, the Contractor shall obtain the right for this use by legal agreement with the patentee or owner. A copy of this agreement shall be provided to the Engineer.

2. However, whether or not such an agreement is made or provided, the Contractor and the surety in all cases shall indemnify and save harmless the Department from any and all claims for infringement by reason of the use of any such patented design, device, material, process, trademark, or copyright in connection with the work agreed to be performed under the contract.

3. The Contractor and the Contractor's surety shall also indemnify the Department for any costs, expenses, and damages which it may be obligated to pay by reason of any such infringement at any time during the prosecution of or after the completion of the work.

107.04 -- Pavement Opening Permits

1. The Engineer may authorize the Contractor to allow third parties bearing valid permits to make openings in the highway. Permits will provide that all repair work will be paid for by the permit holder.

2. The Engineer may order the Contractor to make repairs to openings made by third parties. Any repairs ordered by the Engineer will be paid for as "extra work" in accordance with Subsection 109.05.

107.05 -- Federal Participation

1. All Federally funded work will be administered by the Department, subject to the inspection and approval of officials of the Federal government. These inspections do not make the Federal government a party to this contract and will in no way interfere with the rights of either party hereunder.

2. Federal Projects of Division Interest (PoDI) are designated in the Contract. These projects are subject to routine inspections by the Federal Government. The Federal Government may be involved in the approval of changes to the Contract.

107.06 -- Sanitary Provisions

1. The Contractor shall provide and maintain in a neat, sanitary condition accommodations for the use of the employees as may be necessary to comply with the requirements of Federal, State, and local Boards of Health regulations.

107.07 -- Public Convenience and Safety

1. The Contractor shall insure the orderly movement of traffic through or around the work at all times. The Contractor may not close any road unless required by the plans or authorized under Subsection 104.05. Temporary traffic control devices and layouts shall conform to the Contract, and the MUTCD.

2. a. No materials of any kind shall be stored in the median or within 30 feet (10 m) of the edge of the traveled way, except that they may be placed in the median or on the foreslopes if they are used or removed the same day. In no case shall material be allowed to remain overnight within the 30 feet (10 m) zone specified above.

b. Equipment not actively engaged in construction operations shall not be parked within 20 feet (6 m) of the edge of the traveled way, or in the median, except during unavoidable temporary suspensions of the work. No equipment shall be parked within 30 feet (10 m) of the edge of the traveled way, or in the median, overnight, on holidays, or on weekends.

c. In those cases where the road is closed to public traffic, no material or equipment may be stored within the limits set forth above unless the storage site is physically inaccessible to vehicles. In those cases where the requirements of Subsection 104.05 require that access to locations within the closed portion of the road be maintained, storage of materials and equipment within those same limits will only be allowed for hazards not deemed practical to move; and then only if adequately protected with barricades and flashing lights or other devices approved by the Engineer.

3. a. (1) All slow moving construction vehicles and equipment which operate on the highway at speeds 15 mph (24 km/h) lower than the posted legal minimum speed or lower than 35 mph (56 km/h) if a minimum speed is not posted then all construction equipment working within the traffic lanes or shoulders of a highway under "traffic maintained" conditions shall be equipped with rotating or flashing yellow beacons or strobe type beacons which comply with the *Nebraska Rules of the Road*.

(2) Rotating or flashing type beacons shall be operated on all such equipment which is parked on or within the traffic lanes or shoulders of the highway under "traffic maintained" conditions.

(3) Trucks and pickups traveling in the normal flow of traffic shall operate the beacons only when close to the work.

b. Rotating or flashing yellow beacons shall be provided with a minimum 50 candlepower bulb and shall be sealed so as to be dust and water tight. Strobe type beacons shall have yellow colored domes. All beacons shall be maintained in good operating condition and shall be mounted level on the equipment to provide for 360 degree visibility, day or night, for a minimum distance of 800 feet (245 m). The use of magnetically mounted beacons will be permissible if they meet requirements for visibility and level mounting as set forth above.

4. Slow moving vehicles as defined by the *Nebraska Rules of the Road* shall have a "slow moving emblem." This is in addition to other lighting devices required by law.

5. a. The Contractor shall furnish flaggers to direct traffic whenever construction equipment or vehicles operate on, across, or directly adjacent to the roadway being used by the traveling public. Additionally, the Engineer may require flagging at any time to enhance the public's safety and insure the orderly movement of traffic through or around the work.

b. Except in the cases of incidental flagging, flagging shall be performed by flaggers trained and certified according to the Department's flagger certification program described in Section 422. Incidental flagging shall be defined as flagging required in emergency situations or in situations not expected to last for more than 15 minutes. In those cases where traffic is repeatedly stopped or otherwise controlled for time totaling more than 15 minutes, even though the individual activity is of less than 15 minutes duration, the requirement for a certified flagger is not waived.

c. When certified flagging is necessary, the Department will pay for flagging, either at the contract price or at a negotiated price if there is no price established in the contract.

6. a. When the road under construction is being used by the traveling public, special attention shall be paid to keep both the subgrade

and newly laid surfacing in such condition that the public can travel over the same in relative comfort and safety.

b. The Engineer may direct that surfacing be opened to traffic if shoulders are not completed within the time limits for the completion of shoulders as provided in Subsection 304.03. When surfacing is opened to traffic under such conditions, the Contractor will not be relieved of any responsibility on any portion of the work so opened to traffic until tentative acceptance has been given, except as provided in Subsection 107.14.

7. a. The Contractor shall conduct all operations to minimize any drop-offs (abrupt changes in roadway elevation) exposed to traffic.

b. (1) Unless otherwise specified in the Contract, drop-offs greater than 2 inches tall at the shoulder edge that are adjacent to the traveled way shall be protected by a wedge of compacted stable material capable of carrying traffic (the wedge being 1 vertical to 3 horizontal or flatter). An edgeline warning stripe shall also be placed on the traffic side of the drop-off.

(2) The Engineer shall authorize other methods, such as concrete barriers or Type II Barricades, to protect drop-offs when conditions do not allow a wedge of compacted, stable material.

(3) Unless otherwise ordered by the Engineer, drop-offs up to 2 inches (50 mm) may remain exposed with appropriate warning signs alerting motorist to the condition.

c. Open trenches which span all or part of the traveled way and/or auxiliary lanes shall be no wider than 18 inches (450 mm) and must have a steel-plate cover placed and anchored over them. The plate shall have sufficient strength so as to only allow a maximum vertical deflection of 1/2 inch (12.5 mm). A wedge of suitable material shall create a smooth transition between the pavement and the steel plate. Warning signs shall be used to alert motorists to the presence of the steel plates.

8. When so provided in the Contract, surfacing and base courses shall be constructed with one or more lanes of the roadway open and maintained for traffic. The Contractor shall regulate traffic flow in accordance with the Engineer's direction.

9. When the road is accessible to vehicles, even if closed to the traveling public, the Contractor shall use traffic control devices such as Type II barricades, or object markers to locate and mark hazards within the project limits.

10. When the project is open to public vehicular traffic and the plans call for a culvert extension with excavation less than 15 feet (4.6 m) from the edge of the traveled lane, two double-sided Type III barricades shall be installed on the shoulder, one on each side of the excavation. Also, one double-sided Type III barricade with a Type A light shall be installed on the shoulder 100 feet (30 m) in advance of the excavation.

11. If a hazard exists and barricades, warning signs, or other devices are in place, then even when the contract is complete, these warning devices may not be removed until the Engineer has replaced the devices.

107.08 -- Use of Explosives

1. When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored and used in compliance with Federal, State, and local laws and ordinances; and all storage places shall be clearly marked "DANGER-EXPLOSIVES". All permits shall be obtained by the Contractor. The Contractor shall be liable for property damage, injury, or death resulting from the use of explosives.

2. The Contractor shall notify each property owner and utility company having structures or facilities within 1,600 feet (500 m) of work sites where explosives may be needed. The notice shall be given sufficiently in advance to enable the owners to protect their property.

107.09 -- Preservation and Restoration of Property, Trees, Monuments, etc.

1. The Contractor shall preserve, protect, and prevent damage to all public and private property. This includes any underground or overhead utilities, structures, and facilities, whether shown in the contract or not.

2. The Contractor shall protect from disturbance or damage all land monuments and property markers until the Engineer has witnessed or otherwise referenced their location and shall not remove them until directed.

3. The Contractor shall not cut, injure, remove, or destroy any trees or shrubs unless directed by the Engineer.

4. When or where any direct or indirect damage or injury is done to public or private property because of any act, omission, neglect, or misconduct related to the execution or nonexecution of the work, the Contractor shall restore or replace the property to a condition similar or equal to that existing before such damage or injury was done. The restoration or replacement shall be done at no additional cost to the Department.

107.10 -- Archaeological and Paleontological Discoveries

1. Should the Contractor encounter any fossils, meteorites, Native American relics, or other articles of historical or geological interest, such articles shall become the property of the State. The Engineer shall be immediately notified when any such articles are uncovered, and the Contractor shall immediately suspend operations in the area involved until such time that arrangements are made for their removal and preservation.

107.11 -- Hazardous Materials Discoveries

1. Should the Contractor encounter any previously unidentified suspected hazardous materials, the Engineer shall be immediately notified. The Contractor shall immediately suspend operations in the area involved until such time that arrangements are made for their proper treatment or removal.

107.12 -- Invasive Species Control

1. The Contractor shall prevent the transfer of invasive plant and animal species. The Contractor shall wash equipment at the contractor's storage facility prior to entering the construction site. The Contractor shall

inspect all construction equipment and remove all attached vegetation and animals prior to leaving the construction site.

107.13 -- Right-of-Way

1. The Department will provide all land and easements for the right-of-way shown in the contract.

107.14 -- Responsibility for Damage, Injury, or Other Claims

1. The Contractor shall indemnify and save harmless the Department and all of its representatives from any and all actions, fines or claims brought because of injuries or damages to persons or property caused by the actions or omissions of the Contractor or the Contractor's employees or agents.

2. The Contractor shall be responsible for all damage or injury to any property during the prosecution of the work, resulting from any act, omission, neglect, or misconduct, in the manner or method of executing said work satisfactorily, or due to the nonexecution of said work or at any time due to defective work or materials and said responsibility shall continue until the work shall have been completed and accepted.

3. Prior to beginning any work, the Contractor is required to meet with all involved local governmental entities and advise them of any intentions to use their local roads. The Contractor shall be responsible for resolving claims concerning damage to local roads caused by his/her operation.

107.15 -- Liability Insurance

1. Prior to execution of the contract, the Contractor shall obtain insurance coverage to fully protect it from loss associated with the work, and have at a minimum the insurance described below:

a. General Liability:

(1) Limits of at least:

(i) \$ 1,000,000 per Occurrence

(ii) \$ 2,000,000 General Aggregate

(iii) \$ 2,000,000 Completed Operations Aggregate

(iv) \$ 1,000,000 Personal and Advertising Injury

(2) Contractor shall be responsible for the payment of any deductibles.

(3) Coverage shall be provided by a standard form Commercial General Liability Policy (CG0001 or equivalent) covering bodily injury, property damage including loss of use, and personal injury.

(4) The General Aggregate shall apply on a Per Project Basis.

(5) The State of Nebraska, Department of Transportation, shall be named as an Additional Insured on a primary and non-contributory basis including completed operations for three (3) years after final acceptance and payment.

(6) Contractor agrees to waive its rights of recovery against the State of Nebraska, Department of Transportation. Waiver of Subrogation in favor of the State of Nebraska, Department of Transportation shall be added to the policy.

(7) Contractual liability coverage shall be on a broad form basis and shall not be amended by any limiting endorsements.

(8) If work is being performed near a railroad track, the 50' railroad right-of-way exclusion must be deleted.

(9) Products and completed operations coverage in the amount provided above shall be maintained for the duration of the work, and shall be further maintained for a minimum period of three years after final acceptance and payment.

(10) Coverage shall be included for demolition of any building or structure, collapse, explosion, blasting, excavation and damage to property below surface of ground (XCU coverage).

(11) Policy shall not contain a total or absolute pollution exclusion. Coverage shall be provided for pollution exposures arising from products and completed operations as per standard CG0001 Pollution Exclusion or equivalent. If the standard pollution exclusion as provided by CG0001 has been amended, coverage must be substituted with a separate Pollution Liability policy of \$1.0 million per occurrence and \$2.0 million aggregate. If coverage is provided by a "claims made" form, coverage will be maintained for three years after project completion. Any applicable deductible is the responsibility of the Contractor.

b. Automobile Liability:

(1) Limits of at least:

(i) \$ 1,000,000 CSL per Accident

(2) Coverage shall apply to all Owned, Hired, and Non Owned Autos.

(3) If work is being performed near a railroad track, the 50-foot railroad right-of-way exclusion must be deleted.

(4) Contractor agrees to waive its rights of recovery against the State of Nebraska, Department of Transportation. Waiver of Subrogation in favor of the State of Nebraska, Department of Transportation, shall be added to the policy.

(5) Automobile liability coverage shall be obtained from an insurance carrier who is licensed with the Nebraska Department of Insurance.

c. Workers' Compensation:

(1) Employer's Liability limits:

(i) \$500,000 Each Accident

(ii) \$500,000 Disease – Per Person

(iii) \$500,000 Disease – Policy Limit

(2) Contractor agrees to waive its rights of recovery against the State of Nebraska, Department of Transportation. Waiver of Subrogation in favor of the State of Nebraska, Department of Transportation shall be added to the policy.

(3) Workers' compensation coverage shall be obtained from an insurance carrier who is licensed with the Nebraska Department of Insurance.

(4) Where applicable, the Longshore and Harborworkers Compensation Act endorsement shall be attached to the policy.

d. Umbrella/Excess:

(1) Limits of at least:

(i) \$1,000,000 per Occurrence

(2) Policy shall provide liability coverage in excess of the specified Employers Liability, Commercial General Liability and Automobile Liability.

(3) The State of Nebraska, Department of Transportation, shall be an "Additional Insured."

(4) Contractor agrees to waive its rights of recovery against the State of Nebraska, Department of Transportation. Waiver of subrogation in favor of the State of Nebraska, Department of Transportation shall be provided.

e. Pollution Liability:

(1) When "hazardous wastes" or contaminated or polluted materials must be handled and/or moved, the Contractor shall obtain Pollution Liability Coverage with minimum limits of \$1,000,000 per occurrence and \$2,000,000 aggregate.

(2) If, during the course of construction, hazardous wastes, contaminated or polluted material are discovered on the project, the Contractor shall immediately cease any operation that may disturb these materials, and shall immediately notify the Engineer of all facts related to the discovery of these materials.

(3) Unforeseen work related to the discovery of hazardous, contaminated or polluted materials on the project, and the extra cost, if any, of pollution liability coverage will be handled as "extra work."

f. Additional Requirements:

(1) The Contractor shall provide and carry any additional insurance required by the Special Provisions.

(2) Except as otherwise provided herein, all insurance shall be kept in full force and effect until after the State releases the Contractor from all obligations under the contract.

(3) (i) If any of the work is sublet, equivalent insurance shall be provided by or on behalf of the subcontractor or subcontractors (at any tier) to cover all operations.

(ii) Approved trucking subcontractors (at any tier) who are being utilized only for the purpose of hauling materials shall be exempt from the requirements of Paragraphs 1.a., 1.d. and 1.e. of Subsection 107.15.

(iii) (a) When a Contractor or subcontractor chooses to employ a trucker by carrying the driver on his or her payroll and entering into a lease agreement for the truck, the owner-operator of the truck shall be

required to comply with the Automobile Liability provisions of Paragraph 1.b. of Subsection 107.15

(b) Furthermore, it shall be the duty of the Prime Contractor to ensure that the owner-operator of the truck has such insurance in effect. The Prime Contractor shall maintain evidence that any truckers so utilized (at any tier) are insured to the minimum limits specified and be able to furnish documentation of the same on demand.

(c) Failure to ensure that insurance coverage exists and failure to maintain evidence thereof shall be considered a breach of the contract.

(4) Any insurance policy shall be written by an insurance company with a Best's Insurance Guide Rating of A – VII or better.

(5) Prior to execution of the contract, Contractor shall provide the State of Nebraska, Department of Transportation evidence of such insurance coverage in effect in the form of an Accord (or equivalent) certificate of insurance executed by a licensed representative of the participating insurer(s). Certificates of insurance shall show the Nebraska Department of Transportation as the certificate holders.

(6) Failure of the owner or any other party to review, approve, and/or reject a certificate of insurance in whole or in part does not waive the requirements of this agreement.

(7) The limits of coverage set forth in this document are suggested minimum limits of coverage. The suggested limits of coverage shall not be construed to be a limitation of the liability on the part of the Contractor or any of its subcontractors/tier subcontractors. The carrying of insurance described shall in no way be interpreted as relieving the Contractor, subcontractor, or tier subcontractors of any responsibility or liability under the contract.

(8) If there is a discrepancy of coverage between this document and any other insurance specification for this project, the greater limit or coverage requirement shall prevail.

107.16 -- Opening of Sections of the Project to Traffic

1. The Engineer may direct that all or part of the project, in which the road is closed, shall be opened to traffic during construction or at any time prior to completion of construction and before final acceptance of the work. Opening such sections will not constitute final acceptance of the work or a waiver of any contract provisions.

2. a. In the event that the opening of a closed road occurs during the orderly progression of the work, the section will be inspected, completed work will be tentatively accepted in writing, and the section turned over to the Department for maintenance.

b. (1) Whenever the Department permits the public use of a highway undergoing construction, repair, or maintenance in lieu of using a detour route, the Contractor shall not be held responsible for damages to those portions of the project upon which the Department permitted public use, if such damages are the result of no proximate act or failure to act on the part of the Contractor.

(2) If the traveling public should cause damage to the roadway, the Contractor shall assist the State in identifying the responsible party. The Contractor shall, at a minimum, especially if present at the time of the damage, record and furnish to the Department all pertinent information regarding the accident (who caused the damage; when the damage occurred; how the damage occurred; etc.).

c. The Contractor shall remain responsible for any damages which are due to or caused by defective work or because of noncompliance with the contract.

3. a. The Engineer may direct that all or part of the project be opened to traffic when:

(1) The work is not progressing satisfactorily or the work has been delayed for reasons attributable to the Contractor.

(2) The Department finds it in the public interest to open the project to traffic (such as during the winter months).

b. In such cases and except for damages due to the ordinary action of traffic, the Contractor shall not be relieved of any responsibility or liability for maintaining the work. Furthermore, the Contractor shall conduct the remaining construction operations with minimum interference to traffic and without additional compensation for any added cost of the work due to the opening of the project to traffic.

4. a. Only upon receipt of specific written authorization covering traffic control devices from the Engineer may the Contractor cease to maintain warning signs, barricades, warning lights, and all other traffic control devices regardless of whether the Contractor erected the device or it was erected by a third party.

b. Warning signs, barricades, warning lights, and all other traffic control devices shall not be removed if the hazard has not been eliminated.

5. The Engineer may issue a written order relieving the Contractor of public liability in areas where the Contractor has, with the Engineer's approval, removed his/her equipment from the right-of-way and completed all work.

107.17 -- Contractor's Responsibility for Work

1. a. Until final written acceptance of the Contractor's work by the Engineer, the Contractor shall be responsible for the protection, care, and upkeep of the work, all associated storage sites, and other areas used to execute the contract. The Contractor shall take every precaution against injury or damage to the work due to the weather or from any other cause.

b. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to the work due to any cause before final acceptance at no additional cost to the Department except as follows:

(1) (i) The Contractor shall not bear the expense for damage to the work resulting from natural phenomena like the weather when these phenomena are of such magnitude that they result in the Governor issuing a Disaster Declaration.

(ii) Evacuation and remobilization of equipment, repair of Contractor's equipment, or repair and replacement of Contractors material

are not eligible for compensation. The Contractor is responsible for protecting material to be used in the work. The repair or replacement of damaged material will not be eligible for compensation when the Contractor fails to take reasonable precautions to protect material.

(2) The Contractor will not be liable for damage or injuries caused by acts of war or governmental authorities.

(3) The Contractor shall not be held responsible for damage caused by the traveling public on those portions of the project where the Department has permitted public use of the road in lieu of using a detour route and the damage is not the result of any proximate act or failure to act on the part of the Contractor.

2. In case of suspension of the work, the Contractor shall, at no additional cost to the Department:

- a. Be responsible for the work.
- b. Take such precautions to prevent damage to the project.
- c. Provide appropriate drainage and erosion control.
- d. Erect any necessary temporary structures, signs, or facilities.
- e. Maintain all newly established plantings, seedings, and soddings furnished under the contract.
- f. Protect new trees and other important vegetative growth against injury.

3. The Contractor must at all times have in place and maintain adequate erosion control measures as described in the contract.

4. If the traveling public should cause damage to the roadway, the Contractor will not be held responsible and shall assist the State in identifying the responsible party. The Contractor shall, at a minimum, especially if present at the time of the damage, record and furnish to the Department all pertinent information regarding the accident (who caused the damage; when the damage occurred; and how the damage occurred, etc.).

107.18 -- Contractor's Responsibility for Utility Property and Services

1. The accuracy of information furnished with respect to utility owner and railroad facilities (facilities) is not guaranteed, and the Contractor must verify all such information.

2. The Contractor shall notify all utility and railroad companies who may have facilities in the work area and secure their assistance in locating and identifying all facilities.

3. The Contractor shall determine the actual locations of all underground and above ground facilities before starting any work that may cause damage to such utilities. The Contractor must protect and keep operational all encountered utility facilities. The Contractor shall promptly notify the facility owner of any damage to the facilities. The restoration of damaged facilities shall be done at no additional cost to the Department.

4. Where operations are adjacent to properties of railway, telegraph, telephone, power, or other utility facilities, work shall not begin until all arrangements necessary for their protection have been made by the

Contractor and the Contractor has explained the arrangements to the Engineer.

5. a. The Contractor shall cooperate with any affected utility owner to insure that:

- (1) Removal and relocation of facilities progresses in a reasonable manner.
- (2) Relocation work is not unnecessarily duplicated.
- (3) Interruption of service is kept to an absolute minimum.

b. In the event of a project-related interruption to utility services, the Contractor shall promptly notify the utility owner and the Engineer. The Contractor shall cooperate fully in the prompt restoration of service.

6. Fire hydrants shall be kept visible and accessible to the Fire Department at all times. No materials shall be stored within 15 feet (4.6 m) of any fire hydrant.

7. The Contractor shall schedule work in such a manner as to protect existing utility facilities until they are relocated, abandoned, or replaced. When partial grading is necessary before a utility owner can perform such work, the Contractor shall coordinate efforts with the utility owner to provide the utility owner adequate time to plan and complete its work.

8. The Contractor shall perform all work required beyond the pole lines after the poles have been moved. If the poles rest within an area outside the right-of-way limits from which borrow is to be taken, the Contractor shall use such equipment as may be required and/or employ hand labor methods to avoid causing damage to the poles or wires.

9. Unless otherwise provided in the contract, utility facilities shall be moved by their owners when necessary to preclude damage during construction.

107.19 -- Personal Liability of Public Officials

The Department's authorized representatives shall not be liable, either personally or as employees of the State, for any action taken in performance of their authorized duties.

107.20 -- No Waiver of Legal Rights

1. Whether before or after final acceptance and payment for the work, the Department will not be prevented from:

- a. Correcting any time allowance, measurement, estimate, or certificate made before or after completion of the contract.
- b. Showing the true character of the materials furnished or work performed and determining their conformance to the contract.
- c. Recovering from the Contractor or his/her surety, or both, such damage as it may sustain by reason of the Contractor's failure to comply with the contract.

2. Neither the acceptance of the work by the Department, nor any payment for or acceptance of any or all of the work, nor any extension of time granted for completion of the work, nor any possession taken by the Department shall operate as a waiver of:

- a. Any portion of the contract.
- b. Any power herein reserved.
- c. Any right to damages.

3. A waiver of any breach of contract shall not be held to be a waiver of any other or subsequent breach.

SECTION 108 -- PROSECUTION AND PROGRESS

108.01 -- Subletting or Assigning of Contract

1. a. (1) The Contractor will not be allowed to sublet, assign, sell, transfer, or otherwise dispose of any portion of the contract or any right, title, or interest therein; or to either legally or equitably assign any of the money payable under the contract or the claims without the prior written consent of the Engineer.

(2) The Contractor shall perform with its own organization contract work amounting to not less than 30% (or a greater percentage if specified elsewhere in the contract) of the total original contract price.

(3) Any items designated in the contract as "specialty items" may be performed by subcontract.

(4) The cost of any subcontracted "specialty items" may be deducted from the total contract cost before computing the percentage of work required to be performed by the Contractor.

(5) Subcontracts, or transfer of contract, will not release the Contractor of any liability under the contract and bonds.

b. Certain items of work may be performed without a subcontract. A list of items not requiring a subcontract is available from the Engineer.

2. The performance of any work by a Subcontractor before the date of written consent by the Department shall subject both the Contractor and Subcontractor to the imposition of appropriate sanctions by the Department.

3. a. The Contractor's request to sublet work shall be made electronically to the NDOT Construction Engineer using project management software identified by the Department. A signed subcontract agreement shall be on file in the Contractor's office when the request is made. The subcontract agreement must provide that the subcontracted work will be completed according to the terms of the contract. The required and special provisions contained in the proposal shall be included in any subcontract.

b. On Federal-aid projects, a digital copy in an acceptable format (such as *.pdf format) of the signed subcontract agreement, at any tier, shall be included with the subcontracting request. For projects with DBE goals, DBE subcontracts, at any tier, must include executed subcontracts, written agreements, or lease agreements used to meet DBE goals and show labor cost, material prices, overhead and profit.

4. Second tier subcontracts will be allowed.

a. All requests for second tier subcontracting shall be submitted to, and approved by the Contractor before they are forwarded to the NDOT Construction Engineer for approval.

b. Work subcontracted by a DBE firm to a non-DBE subcontractor will not be counted toward the DBE goal.

5. All subcontract documents relating to the contract shall be maintained during the course of the work and preserved for a period of three years after final payment. These documents shall be available for inspection by authorized representatives of State and Federal agencies. Copies of subcontract agreements shall be furnished to the Department upon request.

6. On projects requiring submittal of certified payrolls, all Subcontractor payrolls shall be checked by the Contractor before submittal to the Engineer.

7. a. The Contractor, and subcontractor(s) when subletting work to lower tier subcontractors, shall include language which can be identified as a "Prompt Payment Clause" as a part of every subcontract for work and materials.

b. (1) The language constituting the "Prompt Payment Clause" will require payment to all first tier subcontractors for all labor and materials -- for work completed to date --- within 20 calendar days of receipt of progress payments from the Department for said work. Similar language in a contract between a subcontractor and a lower-tier subcontractor will require payment to the lower tier subcontractor for all labor and materials --- for work completed to date --- within 10 calendar days of receipt of progress payments from the Contractor for said work.

(2) The language constituting the "Prompt Payment Clause" will also stipulate the return of retainage within 30 calendar days after the satisfactory completion of the work by the subcontractor as evidenced by inclusion of the work on a progress payment.

(3) Additionally, the language constituting the "Prompt Payment Clause" shall stipulate the Subcontractor's obligation to return to the Contractor or Subcontractor, as the case may be, any overpayments which result from adjustments to measured and recorded quantities as part of the preparation of subsequent progress payments or the final records. Overpayments shall be returned to the Contractor or Subcontractor, as the case may be, within 20 calendar days of receiving notice of the adjusted quantities and the amount of the overpayment.

c. The Contractor or Subcontractor, as the case may be, may withhold payment only for just cause and shall not withhold, delay, or postpone payment without first receiving written approval from the Department.

d. (1) The failure by the Contractor to comply with the "Prompt Payment Clause" without just cause, including the timely return of retainage, is a breach of this contract which may result in the Department withholding the amount of payment from the Contractor that should have been paid to the Subcontractor, termination of this contract, or other such remedy as the Department deems necessary. The remedy shall be in the sole discretion of the Department and in no event shall a Subcontractor have rights, or cause of action, against the Department under this Section.

(2) Additionally, the failure of any subcontractor to comply with the "Prompt Payment Clause" without just cause, including the timely return of retainage to lower tier subcontractors, or by failing to return overpayments in a timely manner, may result in the Department withholding subcontract approval for other work.

8. a. (1) For Davis Bacon (DBRA)-covered projects and Non-DBRA-covered projects, a Contractor or Subcontractor may wish to use another individual owner-operator or trucking company to supplement his or her hauling fleet. (The Department will not recognize multiple individuals claiming to be collectively identified as a single "owner operator".)

(2) This supplemental individual or company must either become a subcontractor (first tier or lower tier, as the case may be) or be otherwise documented by the utilizing Contractor or subcontractor by entering into a lease agreement for the trucks and showing the driver (or drivers) from the supplemental company on the Contractor's or subcontractor's payrolls in the manner described below.

(3) Payrolls will only be accepted from the Contractor or approved subcontractors.

b. (1) If the decision is made to subcontract the hauling, the Contractor must first notify the NDOT Construction Office to request subcontract approval. As part of the subcontract approval process --- at any tier --- the proper certificates of insurance must be provided before approval will be granted.

(2) Additionally, on DBRA-covered projects, the Contractor must submit payrolls for all subcontractors --- at any tier.

c. (1) Owner/Operators of trucks hired by a Contractor or subcontractor to supplement his or her hauling fleet are not subject to Davis Bacon wage requirements. However, they must still be shown on a payroll prepared by the Contractor or subcontractor for whom they are working with the notation "owner/operator."

(2) Any other employees of the "owner/operator" must appear on the certified payroll in complete detail and must be compensated according to the wage rates established for the project.

d. In the event a Contractor or subcontractor elects to not subcontract the supplemental driver or drivers but instead chooses to "carry the workers/truckers on their payroll," the following requirements must be met:

(1) The Contractor's or subcontractor's certified payroll must contain the names of all workers/truck drivers, and the payroll should identify their supervisors (including "owner-operators").

(2) Pay checks for the workers/truckers in question must be drawn against the Contractor's or subcontractor's payroll or other account.

(3) Owner/Operators need only be identified as such on the payroll. Additional drivers, if any, from the "owner-operator's" company must appear on a payroll in complete detail and be compensated according to the wage rates established for the project.

(4) The Contractor or subcontractor must enter into a lease agreement for the trucks driven by such drivers, and the lease agreement must show that the compensation for the leased equipment is on a time basis and not based on the amount of work accomplished. The lease agreements must be available for inspection by NDOT personnel.

(5) Any supplemental truckers employed under this arrangement must still carry the minimum automobile liability coverage specified in the contract. It shall be the duty of the Contractor to ensure that the supplemental truckers have such coverage in effect. Evidence of proper insurance must be presented for verification on demand.

108.02 -- Contract Time Allowance

1. a. The proposal will show a "tentative starting date" on which the Contractor is expected to begin operations and a specified number of working days or calendar days to complete the work.

b. After the award and execution of the contract, the Department will issue a written Notice to Proceed, ordinarily, but not necessarily coinciding with the tentative starting date. The Contractor shall not begin work prior to the Notice to Proceed date except as permitted in paragraph 3 or 4 of Subsection 108.02. The work and the determination, count, and reporting of working days or calendar days shall commence on the Notice to Proceed date. The Contractor may, however, make a written request to the NDOT Construction Engineer to begin work on a different date.

(1) Requests for a revised starting date must be received by the NDOT Construction Engineer seven calendar days prior to either the proposed revised starting date or the tentative starting date, whichever is earlier. The NDOT Construction Engineer will review the request, make an approval determination, and written Notice to Proceed will be issued accordingly.

(2) If an earlier starting date is approved by the NDOT Construction Engineer, the work and the determination, count, and reporting of working days or calendar days shall start on the revised starting date unless the Contractor gives a subsequent written notice at least seven calendar days in advance of the revised starting date. Such notice shall indicate the date to which the start has been changed and the reason for the change. However, unless authorized by the NDOT Construction Engineer, the work and the determination, count, and reporting of working days or calendar days shall not be delayed beyond the "tentative starting date" shown in the contract.

(i) If the Contractor elects to begin work before the "tentative starting date", no consideration will be given for a suspension of the working day or calendar day count or for an adjustment of the contract time allowance because of:

- (a) delays in obtaining the necessary right-of-way;
- (b) delays in obtaining the necessary environmental or other permits;
- (c) delays in delivery of materials, except for critical defense materials; or
- (d) delays due to any other conditions or restrictions stipulated in the contract.

(ii) In the event that known or visible utility lines or conduits, fences, or any other conflicting appurtenances are encountered during the performance of the work before the "tentative starting date," no consideration will be given for a suspension of the working day or calendar day count or for an adjustment or extension of the contract time allowance, nor will any additional compensation be allowed for any delays, inconvenience, or damages sustained by the Contractor due to interference from the conflicting appurtenances.

(iii) In the event that unknown or unforeseen utility lines, conduits, or any other conflicting appurtenances are encountered during the performance of the work before the "tentative starting date", the Engineer may, at his or her discretion, give consideration for:

- (a) a suspension of the working day or calendar day count;
- (b) an adjustment or extension of the contract time allowance; or
- (c) additional compensation for any delays, inconvenience, or damages sustained by the Contractor due to interference from the conflicting appurtenances

(iv) If a later starting date is approved by the NDOT Construction Engineer, the work and the determination, count, and reporting of working days or calendar days shall start on the revised starting date or on the actual starting date, whichever is earlier. The Contractor shall give the Engineer three NDOT work day's notice of the intent to start work prior to the revised starting date.

(v) The Contractor assumes responsibility for all additional costs resulting from his/her requested change in the start date. This includes those cases when the contract is "tied" or related to another contract.

2. a. The determination of the days which constitute "working days" or "calendar days" to be charged against the time allowance for completion of the work shall be made by the Engineer in accordance with the definitions shown in Subsections 101.0314 and 101.0404.

b. The determination, count, and reporting of working days or calendar days shall begin on the actual beginning date of any work or on the date established in the written Notice to Proceed, whichever is earlier. The determination and count shall continue until all work is completed unless the Engineer authorizes a temporary suspension of the operations in accordance with Subsection 108.06.

c. If the time allowance for the contract has been established on a calendar day basis, the Contractor is expected to schedule the work and assign whatever resources are necessary to complete the work in the time allowance provided regardless of the weather. Accordingly, regardless of anything to the contrary contained in these Specifications, the Department will not consider delays caused by inclement or unseasonable weather as justification for an extension of the contract time allowance unless:

(1) weather phenomena alleged to have contributed to or caused the delay is of such magnitude that it results in the Governor issuing a Disaster Declaration, and

(2) weather phenomena alleged to have contributed to or caused the delay can clearly be shown to have directly impacted the work on the critical path identified on the contractor's schedule.

d. Working days or calendar days will be charged during temporary work suspensions when the work suspension resulted from the Contractor failing to:

- (1) Correct conditions unsafe for State employees or the general public.
- (2) Meet environmental quality regulations.
- (3) Carry out provisions of the contract.
- (4) Carry out orders given by the Engineer.

e. When a Contractor is the apparent low bidder for work included in two or more time allowances, the individual time allowances shown in the proposal shall apply. The use of a combined time allowance for work included in two or more time allowances will not be allowed.

3. Working Day Time Allowance. Although the work is to be documented on the weekly report of working days, the Contractor will not be charged working days on a project where the contract time allowance is based on working days when performing the following types of work:

a. After receipt of the Notice to Proceed, and prior to the date established in the Notice to Proceed, and after notifying the Department, the following items of work may be performed without the charge of working days, provided that the work is not otherwise restricted in the contract (including but not limited to environmental provisions), the Contractor is not engaged in any other items of contract work included in the contract time allowance and provided that the performance of such work does not interfere with the normal use of the road by traffic,:

- (1) Driving test piling
- (2) Channel excavation work that facilitates bridge and culvert work.
- (3) Clearing and grubbing or other environmentally-related tasks to satisfy environmental commitments or avoid environmental impacts.
- (4) Clearing and grubbing work and the furnishing and placement of right-of-way markers in order to facilitate relocation or rehabilitation of utilities, relocation of other facilities, or other non-project construction work.
- (5) Pre-watering of excavation or borrow areas.
- (6) Ground preparation for landscape planting.
- (7) Installation of traffic control provided the signs are properly covered until work begins.
- (8) Contractor-provided construction surveying and staking.
- (9) Environmental commitments that are required to be performed prior to the start of construction. This includes activities such as bird netting of bridges, tree-topping, and mowing for the burying beetle.
- (10) The production and stockpiling of aggregates.
- (11) Potholing existing underground utilities to determine their exact locations prior to construction of new underground construction within the limits of construction.

(12) Abatement of hazardous materials such as asbestos and lead.

(13) Any work which does not require an inspector and performed entirely outside the limits of the project.

b. Clearing and grubbing performed subsequent to the date established for the start of work on the project, provided that weather and soil conditions, as determined by the Engineer, are such that other items of work included in the same contract time allowance cannot be performed, except channel excavation work described in Paragraph 4.a. of this Subsection.

c. Backfilling of bridge abutments after the grading operations have been suspended for a period of time awaiting completion of structures, provided that all other items included in the grading group of the contract have been completed.

d. Maintenance operations performed during described maintenance periods for bituminous base, provided that all other items included in those contract groups have been completed.

e. Landscape maintenance work during the establishment period for landscape plantings, and for the work of any subsequent replanting.

f. (1) Minor miscellaneous or finishing work, provided that:

(i) the Contractor does not delay in prosecuting the minor miscellaneous or finishing work;

(ii) the Contractor, subject to weather and soil conditions being suitable, begins and prosecutes the remaining work without interruption;

(iii) all significant pay items (and work subsidiary to them, e.g. bridge painting) are complete; and

(iv) all other work has been completed to the extent that the work could be opened to traffic.

(2) The Engineer shall be the sole judge of which work is deemed to qualify as minor miscellaneous or finishing work and whether or not the Contractor has begun and prosecuted the remaining work without interruption.

(3) At such time that the Engineer advises the Contractor that only minor miscellaneous or finishing work remains, the determination and count of working days will be suspended and the Contractor shall have three working days to commence that work. If the Contractor allows more than three working days to elapse before commencing the minor miscellaneous or finishing work or fails to prosecute the remaining work without interruption, then the contractor will have failed to satisfactorily prosecute the remaining work; and the minor miscellaneous or finishing work will become the current controlling operation. The determination and count of working days will resume and continue until final completion of all work.

4. Calendar Day Time Allowance. Although the work is to be documented on the weekly report of working days, the Contractor will not be charged calendar days on a project where the contract time allowance is based on calendar days when performing the following types of work:

a. After receipt of the Notice to Proceed, and prior to the date established in the Notice to Proceed, and after notifying the Department, the following items of work may be performed without the charge of calendar days, provided that the work is not otherwise restricted in the contract (including but not limited to environmental provisions), the Contractor is not engaged in any other items of contract work included in the contract time allowance and provided that the performance of such work does not interfere with the normal use of the road by traffic:

(1) Driving test piling

(2) Channel excavation work that facilitates bridge and culvert work.

(3) Clearing and grubbing or other environmentally-related tasks to satisfy environmental commitments or avoid environmental impacts.

(4) Clearing and grubbing work and the furnishing and placement of right-of-way markers in order to facilitate relocation or rehabilitation of utilities, relocation of other facilities, or other non-project construction work.

(5) Pre-watering of excavation or borrow areas.

(6) Ground preparation for landscape planting.

(7) Installation of traffic control provided the signs are properly covered until work begins.

(8) Contractor-provided construction surveying and staking.

(9) Environmental commitments that are required to be performed prior to the start of construction. This includes activities such as bird netting of bridges, tree-topping, and mowing for the burying beetle.

(10) The production and stockpiling of aggregates.

(11) Potholing existing underground utilities to determine their exact locations prior to construction of new underground construction within the limits of construction.

(12) Abatement of hazardous materials such as asbestos and lead.

(13) Any work which does not require an inspector and performed entirely outside the limits of the project.

b. (1) Minor miscellaneous or finishing work, provided that:

(i) the Contractor does not delay in prosecuting the minor miscellaneous or finishing work;

(ii) the Contractor, subject to weather and soil conditions being suitable, begins and prosecutes the remaining work without interruption;

(iii) all significant pay items (and work subsidiary to them, e.g. bridge painting) are complete;

(iv) all other work has been completed to the extent that the work could be opened to traffic; and

(2) The Engineer shall be the sole judge of which work is deemed to qualify as minor miscellaneous or finishing work and whether or not the Contractor has begun and prosecuted the remaining work without interruption.

(3) At such time that the Engineer advises the Contractor that only minor miscellaneous or finishing work remains, the count of calendar days will be suspended. Subject to weather and soil conditions being suitable, the Contractor shall have three calendar days to begin and prosecute the work without interruption. If the Contractor fails to do so, the count of calendar days will resume and continue until final completion of all work.

5. The Engineer will make available on the Department's website the Department's charge of working days or calendar days. If the Contractor does not concur with the charge of days, the Contractor shall provide a written explanation of the basis of nonoccurrence within 14 days from the date the information was made available. If the Contractor fails to do so, the charge of days shall be deemed to have been accepted by the Contractor.

6. a. If the Contractor finds that they will be unable to complete the work within the number of days allowed by the contract, the Contractor may make a written request to the Engineer promptly for a time extension. Such a request shall:

(1) Describe the nature of the delay involved.

(2) Describe the conditions beyond the Contractor's control which are responsible for the delay.

(3) State the length of time that operations have been delayed or it is anticipated that they will be delayed and submit sufficient evidence to substantiate the fact that the delay resulted from conditions beyond the Contractor's control.

b. If the Engineer finds that the delay was caused by conditions beyond the Contractor's control, the Engineer will either:

(1) Authorize a temporary suspension of operations.

(2) Adjust the number of working days or calendar days previously charged.

(3) Grant, in writing, an extension of the working day or calendar day time allowance consistent with the facts presented.

c. The action taken will depend upon the nature and extent of the delay involved. The Engineer's decision shall be final and conclusive.

7. If the time allowance for the contract has been established on a calendar day basis, the Contractor is expected to schedule the work and assign whatever resources are necessary to complete the work in the time allowance provided regardless of the weather. Accordingly, regardless of anything to the contrary contained in these Specifications, the Department will not consider any delay resulting from natural phenomena, including the

weather, as justification for an extension of the contract time allowance unless:

a. the phenomenon alleged to have caused the delay is of such magnitude that the Governor issues a Disaster Declaration, and

b. the phenomenon alleged to have caused the delay can clearly be shown to have directly impacted the work on the critical path identified on the Contractor's schedule.

8. When the Contract requires work to be performed in cold weather, loss of efficiency due to prosecution of the work during cold weather will not be considered in determining whether work days will be adjusted.

9. a. The Department will not consider delayed material delivery and/or fabrication justification for a contract time extension unless:

(1) The Contractor provides written documentation that the delay was caused by an industry-wide strike, natural disaster, area-wide shortage, or other unusual market condition occurring after contract award, or

(2) The Contractor demonstrates that the delay was due to demand for critical defense materials such as steel, copper, or aluminum.

b. A request for a time extension due to delays in material deliveries or fabrication should include the following items:

(1) A letter from the Contractor explaining the situation, including how the delay will affect the remainder of the project.

(2) A letter from the supplier, (raw material or finished product as appropriate) or fabricator confirming the pertinent material order dates and causes for the delay.

(3) Information about the Contractor's efforts to obtain the material from other suppliers.

c. After reviewing the request, the Engineer may:

(1) Authorize a temporary suspension of operations.

(2) Adjust the number of working days or calendar days previously charged.

(3) Grant, in writing, an extension of the working day or calendar day time allowance consistent with the facts presented.

(4) Deny the request.

10. A shortage of labor available to work on the project will not be considered justification for a contract time extension.

11. a. The Engineer will evaluate all contract modifications, extra work not in the original contract, or additional work resulting from additional quantities of contract items and may then grant additional working days or calendar days to the contract time allowance as follows:

(1) When the Engineer determines that the contract time was not impacted, no additional working days or calendar days will be added to the contract time allowance.

(2) When the extra work or additional work is clearly shown to be the current controlling operation, additional working days or calendar days may be granted on the basis of the actual working days or calendar days charged for performing the work.

(3) Additional working days or calendar days may be added to the contract time allowance administratively or as part of other settlements or agreements when the Engineer determines the additional days are equitable.

(4) When the time required to perform the extra or additional work is difficult to measure and is not addressed under Paragraphs 12.a. (i), (ii), or (iii) above, time extensions may be granted in proportion to the value of the extra and additional work compared to the total amount of the original contract. Further consideration may be given when the Contractor can show that the extra or additional work required more time than its proportional value. Similarly, the Engineer will not be restricted to this method when the value of the extra work is grossly disproportionate to the time required to complete it.

b. Increases in the quantities of work associated with traffic control items measured by the day will not be considered for extending the contract time allowance. Overruns of traffic control items that are measured by methods other than time will be considered for extending the contract time allowance.

108.03 -- Prosecution of Work

1. The Contractor shall start work and the determination and count of working days or calendar days will begin on the date specified in the written "Notice to Proceed".

a. If, after the Notice to Proceed has been issued, circumstances prevent the Contractor from beginning work on the date specified in the written Notice to Proceed, the Contractor may request from the Department a new starting date, in writing, three NDOT work days before the original date specified in the written Notice to Proceed.

(1) This request must include the reason for the change.

(2) The start date may be postponed if in the discretion of the Engineer, the postponement is not detrimental to the Department, or if the contract is amended to address the issue of the delay.

108.04 -- Limitation of Operations

1. The Engineer reserves the right to designate where the work shall start.

2. The Contractor shall work to minimize interference with traffic. The Contractor shall have due regard to the location of detours and to the provisions for handling traffic. The Contractor shall not open up work to the prejudice of work already started.

3. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional section.

4. Placing right-of-way markers shall be one of the first orders of work.

108.05 -- Contractor Employees, Methods, and Equipment

1. The Contractor shall employ sufficient labor and equipment for completing all work required by the contract.

2. All Contractor employees must have sufficient skill and experience to perform their assigned work. All employees engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment so as to perform all work in accordance with the contract, and industry standards.

3. Any Contractor employee or Subcontractor employee who, in the judgment of the Engineer, does not perform the work in a proper and skillful manner or acts unprofessionally or disorderly shall, at the written request of the Engineer, be removed from the worksite and not allowed on site again without the approval of the Engineer.

4. Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may withhold payments which become due and suspend the work until such orders are implemented.

5. a. All equipment shall be of sufficient size and proper mechanical condition to meet the requirements of the contract, and industry standards. The Engineer may require replacement of any unsatisfactory equipment.

b. Specified equipment and methods shall be used and followed unless changes are authorized by the Engineer.

c. The Contractor may request a change of method or equipment from the Engineer. The written request shall include a complete description of the methods and equipment and an explanation of the reasons for the change. If approval is given, the Contractor will be responsible for producing work that conforms with original contract requirements.

d. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Engineer will direct the Contractor to discontinue the use of the substitute methods or equipment and complete the remaining construction with the originally specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality or take other action as the Engineer may direct.

6. When the Engineer grants permission to use any particular methods, equipment, or appliances, this action does not:

a. Relieve the Contractor from furnishing other equipment or appliances or adopting other methods when it appears necessary to prosecute the work as specified.

b. Bind the Department to accept work which does not meet contract specifications.

c. Preclude the Engineer from requiring other methods, equipment, or appliances at any time when in his/her judgment the methods, equipment, or appliances which he/she has allowed the Contractor to use prove to be inadequate, insufficient, or unsatisfactory.

108.06 -- Temporary Suspension of Work

1. a. The Engineer has the authority to suspend the work, wholly or in part, for such periods as may be deemed necessary due to conditions considered unfavorable for prosecution of the work.

b. The Engineer has the authority to suspend work for the Contractor's failure to carry out orders given by the Engineer or for failure to comply with any provision of the contract.

c. While the Engineer may initially notify the Contractor verbally, the Engineer will notify the Contractor in writing of all suspensions.

d. The Contractor shall not suspend work without the Engineer's written authorization.

2. Suspensions of Work Ordered by the Engineer:

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

b. 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, suppliers, or Subcontractors at any approved tier and not caused by the weather, the Engineer will make an adjustment (excluding profit) and modify the contract accordingly. The Engineer will notify the Contractor of the determination of whether or not an adjustment of contract is warranted.

c. No contract adjustment will be allowed unless the Contractor submits the request for adjustment as described in Paragraph 2.a. of this Subsection.

d. No contract adjustment will be allowed under this clause 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.

108.07 -- Contractor's Work Schedule

1. The Contractor shall employ sufficient labor, materials, and equipment to complete the contract requirements on or before the expiration of the contract time allowance.

2. a. The Contractor shall develop a progress schedule. The schedule shall be submitted and reviewed with the Engineer at the Preconstruction Conference. This schedule shall show:

- (1) Completion of all work within the specified contract time.
- (2) The proposed order of work.

(3) Projected starting and completion times for major phases of the work and for the total project.

(4) Whether portions of the work are to be accomplished by the Contractor or a Subcontractor.

(5) The schedule shall be developed using a method that will clearly and unmistakably identify the critical path of interrelated tasks or items of work required to complete the project. (The critical path is defined as the sequential path of activities through a network diagram from beginning to end of the project which provides for the completion of the project in the least amount of time.) The Contractor shall provide sufficient material, equipment, and labor to meet the completion times in this schedule.

b. The Contractor shall furnish the necessary copies of the schedule to the Engineer.

c. Progress estimates, except for certain authorized materials which may be paid for as provided in Subsection 109.07, will not be made until the Contractor has submitted a schedule that meets contract requirements.

d. The Department will accept a progress schedule indicating an early completion but cannot guarantee the Department's resources will be available to meet the accelerated schedule. No additional compensation will be allowed if the Contractor is not able to meet his/her accelerated schedule due to the unavailability of the Department's resources.

3. a. If the Contractor's progress falls behind their schedule, the Engineer may request that the Contractor submit a revised progress schedule that demonstrates how and when the Contractor intends to complete the work. The revised project schedule shall be submitted within seven days.

b. The Engineer may suspend progress payments until the revised schedule is submitted if the Contractor fails to submit a revised progress schedule within seven days.

c. If the Contractor's progress falls behind their schedule, the Contractor shall take whatever action is necessary to expedite completion of the work.

4. When the Contractor's operations are materially affected by changes to the contract, the Engineer may request a revised progress schedule.

a. The Contractor shall submit the progress schedule within seven days after receipt of the Engineer's request.

b. This revised progress schedule shall show how the Contractor proposes to prosecute the balance of the work.

c. The Contractor's progress schedule shall include any contract requirements regarding the order of performance of the remaining work.

5. If the Contractor fails to make satisfactory arrangements to adjust their performance and schedule within seven days, their qualification for submitting bids at future lettings may be suspended until the Contractor's performance and schedule demonstrate that the contract will be completed

by a time satisfactory to the Department. The Engineer will also issue a written decision as to whether to allow the Contractor to proceed or to stop work and terminate the contract.

6. When the Contractor desires to change the current schedule, they must submit the revised schedule to the Engineer at least seven days before any significant deviation from the current schedule.

7. The Engineer's review of the Contractor's schedule shall not constitute agreement by the Department that the Contractor can complete the work by the date shown in that schedule.

108.08 -- Liquidated Damages

1. Liquidated damages are intended to compensate for damages incurred by the Department due to the Contractor's failure to complete the work within the time period allowed by the contract. Such amounts are not to be considered as penalties.

2. The Department utilizes the following formula to calculate liquidated damages when a contract is not completed on time. The value of liquidated damages determined by this formula represents a portion of the Department's costs incurred because of delays in completing the contract.

LIQUIDATED DAMAGES FORMULA

$$LD = \frac{R \times C}{T}$$

- where: LD = Liquidated damages per working day or calendar day (rounded to the nearest dollar).
- C = Original contract amount (includes all work completed and unfinished).
- T = Original number of calendar days or working days, whichever is specified in the contract.
- R = 0.06 for working day contracts.
- R = 0.12 for calendar day contracts.

3. a. The Contractor agrees:

(1) To pay, according to the formula in Paragraph 2. of this Subsection, liquidated damages for each working day/calendar day beyond the number of working days/calendar days authorized for completion of the contract, and

(2) To authorize the Engineer to deduct liquidated damages from any money due or coming due the Contractor.

b. If no monies are due the Contractor, the Department shall have the right to recover liquidated damages from the Contractor, from the surety, or from both the Contractor and the surety.

4. Liquidated damages will not be assessed for any days covered by an approved time extension. Deductions or payment of liquidated damages will not release the Contractor from further obligations and liabilities to complete the entire contract.

108.09 -- Completion of Contracts in Default

1. The Engineer shall give the Contractor and the Contractor's surety written notice of default, delay, and/or neglect, as appropriate, whenever the Contractor:

- a. Fails to perform the work with sufficient employees, equipment, or materials to ensure the contract's prompt completion.
- b. Does not perform work which meets the standards established in the contract.
- c. Neglects or refuses to remove excess or unacceptable materials.
- d. Fails to correct any work rejected as defective or unsuitable.
- e. Discontinues the prosecution of the work without the Engineer's approved written authorization.
- f. Fails to resume work within 30 days after the Engineer directs resumption of work.
- g. Becomes insolvent, declares bankruptcy, commits any act of bankruptcy or insolvency, or allows any final judgement to stand unsatisfied for a period of ten days.
- h. Makes an assignment for the benefit of creditors.
- i. Is a party to fraud in the performance of the contract.
- j. For any other cause does not carry on the work in an acceptable manner.

2. If the Contractor or Contractor's surety does not proceed according to the Department's default, delay and/or neglect notice within ten days of its receipt, the Department has 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 worksite as may be suitable and acceptable and may enter into an agreement with others for the completion of the contract according to the terms and provisions thereof, or use such other methods as shall be required for the completion of the contract in an acceptable manner.

3. All costs and charges incurred by the Department, together with the cost of completing the work under contract, shall be deducted from any money due or which may become due the Contractor. In case the expense so incurred by the Department shall be less than the sum which would have been payable under the contract if it had been completed by the Contractor, then the Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the State the amount of said excess.

108.10 -- Termination Clause - National Emergency

1. The Department may terminate the contract or a portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

2. When a contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits shall be considered.

3. Reimbursement for organization of the work, other overhead expenses (when not otherwise included in the contract), and moving equipment and materials to and from the job will be considered, the intent being that the Contractor shall receive an equitable settlement.

4. At the Contractor's option, the Department will purchase any acceptable materials obtained or ordered by the Contractor for the work but not incorporated in the project at their actual costs as shown by receipted bills and actual cost records at such point of delivery as may be designated by the Engineer.

5. Termination of a contract or a portion thereof shall not relieve the Contractor of his/her responsibilities for the completed work, nor shall it relieve the surety of its obligation for and concerning any just claim arising out of the actual work performed.

108.11 -- Termination Clause - Other Reasons

1. The contract, or portions thereof, may also be terminated for the convenience of or if in the best interest of the State by written notice at the sole discretion of the Engineer.

2. When a contract or portions thereof is terminated under the terms of this Subsection, final settlement shall be made in accordance with the provisions of Subsection 108.10.

SECTION 109 -- MEASUREMENT AND PAYMENT

109.01 -- Measurement of Quantities

1. Field Measured Quantities

a. (1) After the work is completed and before final payment is made for the contract, the Engineer will make final measurements, if required, to determine the quantities of various items of work performed.

(2) When the work is performed according to the lines, grades, dimensions, and at the locations shown in the contract, the Engineer may elect to pay the plan quantity and not take actual field measurements.

(3) The Contractor will be paid for the actual quantity of work performed in accordance with these Specifications as shown by the plan quantities or the final measurements.

b. Unless otherwise specified, all longitudinal measurements will not consider the slope of the measured item but will measure the horizontal distance between end points. Deductions will be made for individual fixtures in the roadway having an area greater than 1 square yard (1 m²).

c. On all transverse measurements for area of base courses and flexible or rigid surface courses, the dimensions to be used in calculating the pay area shall be the neat dimensions shown in the contract or ordered in writing by the Engineer.

d. When requested by the Contractor and approved by the Engineer, in writing, material specified to be measured by the cubic yard (meter) may be measured by determining the weight on approved scales, the weight then being converted to cubic yards (meters) for payment purposes. Factors for conversion from dry weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such measurement of pay quantities is used. The weight of any water in the aggregate shall be deducted before using the conversion factor.

e. When requested by the Contractor and approved by the Engineer, material specified to be measured by the pound or ton (kilogram) may be measured on scales equipped with an automatic device which signals or stops the flow of material when a predetermined net weight, set on the scales, is reached. This procedure must produce a total net weight for each load at least equal to the predetermined net weight. The quantity to be measured for payment will be the predetermined net weight.

f. Portable Scales:

(1) Scales shall be installed on adequate foundations and in accordance with the manufacturer's recommendations. They shall have sufficient capacity to determine the weight of a fully loaded truck.

(2) The Contractor shall calibrate the scales accurate to 0.5% of a fully loaded truck in the Engineer's presence, or the scale shall have a current Nebraska Department of Agriculture inspection certificate. Documentation showing that scales were calibrated by a scale company service crew during the current season is also acceptable.

(3) The scale shall be cross-checked daily for accuracy by comparing its results with a load's gross weight on an approved commercial scale.

(4) If the scales are not able to weigh all axles at once, the approaches shall be extended so that the entire hauling unit will be level as each axle is measured.

(5) Suitable protection shall be provided against wind currents that may affect the accuracy of the scales. The platform of the scale shall be kept clean and free from accumulations of materials.

g. When requested by the Contractor and approved by the Engineer, any material specified to be measured by the cubic yard (meter) in the vehicle at the point of delivery may be struck off to a predetermined height in the truck boxes in lieu of the specified top of boxes. Wood or metal attachments to the truck boxes may be required to delineate the predetermined height and must have sufficient rigidity to remain stable during strike-off procedures.

h. When requested by the Contractor and approved by the Engineer, Water to be measured by the 1,000 Gallons (MGAL) [Kiloliter (kL)] may be measured by determining the weight on approved scales, the weight then being converted to 1,000 Gallons (MGAL) [Kiloliter (kL)] for payment purposes. Below are factors for conversion from weight measurement to volume measurement.

To Convert Tons (Mg) to 1,000 Gals (MGAL)	Divide By
Water	4.17 Tons/MGAL (1.00 Mg/kL)

i. The Contractor shall provide a scale ticket for each load showing the project number, truck number, date, type of material, and net weight. The Contractor shall use a method of calculating the net weight acceptable to the State.

2. Established Quantities

a. If the contract provides that payment is to be made on established quantities, final measurements will not be made unless errors in the contract are discovered or authorized alterations are made. If no alterations are made, the Contractor will be paid for the established quantities in accordance with these Specifications. If alterations are authorized, final measurements will be made over the affected sections or areas of the project in accordance with the relevant Section of the *Specifications*.

3. Groups of work tied by the Department shall allow items from these groups to be performed as part of the work for any of the groups that are tied.

109.02 -- Scope of Payment

1. The Contractor shall accept the Department's compensation as full payment for:

a. Furnishing all materials, labor, tools, and equipment necessary to complete the work and for performing all work included in the contract.

b. Loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties which may be

encountered during the prosecution of the work until the final acceptance by the Engineer.

c. For all risks of every description, except as noted, connected with the prosecution of the work.

d. For all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified.

e. For any use or infringement of patented, trademarked, or copyrighted items.

109.03 -- Responsibility for Payment

1. Payment for the contracted work will be made by the State of Nebraska. A county or other agency may provide the Department funds for any portion of a project.

109.04 -- Compensation for Altered Quantities

1. When the accepted quantities of work vary from the quantities in the contract, the Contractor shall accept payment at the original contract unit prices for the accepted quantities of work done. No allowance will be made for any increased cost except as provided in Section 104 or as negotiated.

2. When the contract is modified by a supplemental agreement, the Contractor shall accept payment in full for the work as modified by the supplemental agreement.

3. Except as allowed in Sections 104 and 108, the Department will make no pay adjustment or allowance for the Contractor's:

- a. Increased operating expense.
- b. Loss of expected reimbursement.
- c. Loss of anticipated profit.

109.05 -- Payment for Extra Work

1. Payment for extra work shall be made in accordance with one of the following procedures:

a. A supplemental agreement will be issued to incorporate the agreed unit prices established in the DR Form 188, "Work Order".

b. A supplemental agreement will be completed following completion of the work to pay for labor, materials, and equipment specified in the Work Order. The payment for labor, materials, and equipment will be determined in accordance with Paragraphs 6., 7., and 8. of this Subsection.

c. A DR Form 58, "Force Account Agreement" will be completed before the work begins to provide for the labor, materials, and equipment necessary to complete the work specified in the DR Form 188, "Work Order"; and DR Form 204, "Weekly Force Account Statements", will be prepared during the course of the work. The payment for labor, materials, and equipment will be determined in accordance with Paragraphs 6., 7., and 8. of this Subsection.

2. No "extra work" will be paid for unless unit prices, wages, material costs, and rental rates (or the method used to determine them) have been agreed upon in writing before such work is started.

3. When payment is accomplished according to the procedures shown in Paragraphs 1.b. and 1.c. of this Subsection, the Engineer and the Contractor shall compare records of labor, equipment, and material used on a daily basis and promptly reconcile any differences between them.

4. The Contractor shall accept the compensation provided in Paragraphs 6., 7., and 8. of this Subsection as full payment for "extra work" done, including any amounts for overhead, profit, administration, bond, and the use of tools and equipment not specifically identified in the DR Form 188, "Work Order."

5. When "extra work" is performed by an approved Subcontractor, the Prime Contractor shall receive a negotiated amount not to exceed 5% of the compensation provided to the subcontractor for completion of the work.

6. a. For all labor, including the foreperson in direct charge of the extra work, the Contractor shall receive 120% of the amount paid for the following:

- (1) Wages.
- (2) Property damage insurance.
- (3) Liability insurance.
- (4) Worker's compensation insurance premiums.
- (5) Unemployment insurance contributions.
- (6) Social security taxes.
- (7) Health and welfare benefits.
- (8) Pension fund benefits.
- (9) Other benefits.

(Benefits (7), (8), and (9) must be required by a collective bargaining agreement or other employment contract generally applicable to the classes of labor employed on the work.)

b. The wages for any foreperson employed on both "extra work" and other work shall be prorated between the two classes of work.

7. For all material entering permanently into the work and for specialty items of work not performed by the Contractor's or Subcontractor's own forces, the Contractor shall receive 115% of the actual cost, as evidenced by receipted bills, of such materials (including freight and hauling charges) or specialty items of work.

8. a. For specific machinery, special equipment, or tools (including fuel and lubricants) identified in the DR Form 188, "Work Order", and deemed necessary to complete the "extra work", the Contractor shall be allowed 115% of the rental price established by applying the prevailing Departmental policies and formulas to the rates established in the *Rental Rate Blue Book for Construction Equipment* published by EquipmentWatch.

b. When it is necessary for the Contractor to rent such equipment, the Contractor shall be allowed 115% of the actual rental price, if reasonable and substantiated by a receipted bill.

9. a. In any case where the Contractor feels that additional compensation is due for "extra work" or material neither clearly covered in

the contract nor ordered in writing by the Engineer, the Contractor shall give written notice of their intention to make a claim for such additional compensation before the work begins.

b. If such notification is not given or if the Engineer is not afforded an opportunity to keep an account of the actual costs incurred by the Contractor, the Contractor's claim for such extra compensation will not be allowed.

c. Notification by the Contractor and the fact that the Engineer has had an opportunity to keep an account of the costs incurred shall not be construed as providing the validity of the claim. The validity of the claim shall be determined by the Engineer.

109.06 -- Cancelled Items

1. The Department shall have the right to cancel the portions of the contract relating to the construction of any item therein by the payment to the Contractor of a fair and equitable amount covering all items of cost incurred before the date of cancellation or suspension of the work by order of the Engineer.

2. If the Contractor chooses, material ordered for the cancelled work and delivered to the location of the work (or such other location designated by the Engineer) shall be retained by the Department. The Contractor shall be compensated for the actual cost of the material plus 10% to cover overhead, handling, other costs, and profit.

109.07 -- Partial Payment

1. a. When the Contractor's progress meets or exceeds their approved progress schedule, the Contractor will receive monthly progress payments based on the quantities of work completed during the preceding month.

b. The Engineer will not include on any progress estimate payment for any item for which required materials certifications have not been received.

c. The Engineer will prepare and submit progress estimates to reflect the amounts earned, but the actual payments of these estimates may be deferred.

d. The Department may delay making progress estimate payments for any work performed before the "tentative starting date" shown in the contract until the normal anticipated payments would be made if the work had commenced on that date.

2. When the value of the work completed during a semi-monthly period exceeds \$5,000, the Contractor will receive semi-monthly progress estimates from which the Department shall make such retentions as may be allowed by the contract, provided that the nature and quality of the completed work are satisfactory and provided further that the progress of the work conforms to the requirements of Subsection 108.07.

3. a. Retentions of the total estimate amounts earned will be made in accordance with the requirements of the contract on all progress estimates.

b. Under normal circumstances, the Department will not retain any earnings on a progress estimate. However, the Department reserves the right to retain such amounts as are necessary for material deficiencies, anticipated liquidated damages, unpaid borrow, and for other reasons to protect the Department's interests.

c. The Contractor will receive monthly progress estimates based on the quantities of plant material, including trees, shrubs, and vines, properly planted, and on which satisfactory establishment procedures are being made.

4. Stockpiled Material

a. (1) Upon presentation by the Contractor of receipt of payment, billing invoices, or such other documentation sufficient to satisfy the Engineer and verify the Contractor's or subcontractor's actual costs for the materials, payments may also be allowed for acceptable nonperishable materials purchased expressly to be incorporated into the work and delivered in the vicinity of the project or stored in acceptable storage places within Nebraska.

(2) Materials not stored in the immediate vicinity of or on the actual project site must be clearly marked to identify the project on which they are to be used, must be segregated from similar materials at the storage site, and cannot be included in a supplier's inventory of material available for sale for other purposes.

(3) All items eligible for partial payment as stored materials must be available for verification, sampling, and measurement. A receipt of payment shall be submitted to the Department within 60 days of receipt by Contractor.

b. The amount to be included in the payment will be determined by the Engineer, but in no case shall it exceed 100% of the value of the materials. This value may not exceed the appropriate portion of the value of the contract item or items in which such materials are to be incorporated, nor shall the quantity in any case exceed the total estimated quantity required to complete the project.

c. Payment will not be approved when the documented value of such materials amounts to less than \$1,000.00, when the progress of the work is not in accordance with the requirements set forth in Subsection 108.07, or when the material can reasonably be expected to be incorporated into the work and eligible for payment as completed work on a progress estimate within 15 days of being placed into storage.

d. Deductions at rates and in amounts which are equal to the payments will be made from estimates as the materials are incorporated in the work.

e. Payment for the materials shall not in itself constitute acceptance, and any materials which do not conform to the specifications shall be rejected in accordance with Subsection 106.05.

f. The Contractor shall be responsible for all damages and material losses until the material is incorporated into the work and the work is accepted.

g. Partial payment will not include payment for fuels, supplies, form lumber, falsework, other materials, or temporary structures of any kind which will not become an integral part of the finished construction.

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

5. The Department will withhold partial payments if the Contractor or Subcontractor does not submit and maintain the required insurance certificates.

6. When payrolls must be submitted, the Department may withhold partial payments if the Contractor does not provide all payrolls (including Subcontractor payrolls) within 14 days of each payroll ending date.

7. Before the final acceptance of the work, the Department will withhold payment for any defective or questionable work until the defect is corrected.

8. a. If the Contractor has furnished all known required records and reports to the Department, interest will be paid to the Contractor at the rate provided in Nebraska Statute No. 39-1349 on the amount retained and on final payment due. Commonly required records and reports include, but are not limited to:

(1) Certifications of materials incorporated into the project.

(2) UI Form 16, "Certification As To Contribution Status" (secured from the State Department of Labor for the most recently completed calendar quarter).

(3) Contractor's weekly payroll reports with form WH-348, "Statement of Compliance" (Federally funded projects only).

(4) When applicable, a DR Form 441, "Identification of DBE Goal Achievement," and a DR Form 442, "Identification of Work Performed."

b. Interest will be computed beginning on the 61st day after completion of work as evidenced by the Department's letter of tentative acceptance. Should it become necessary for the Contractor to do additional work after tentative acceptance, the tentative acceptance date will be adjusted accordingly. The interest period will run continuously until the date final payment is tendered to the Contractor provided that the time interval stated in Paragraph 8.c. of this Subsection is not exceeded.

c. The Contractor is allowed 14 calendar days from the date of notice to:

(1) Reply to the project manager's written notification of optioned pit material quantities and costs involved in a project (such reply shall be directed to the Department's Right-of-Way Division).

(2) Provide signed records or documents, such as Change Order-Supplemental Agreements, requested in writing by the Department.

(3) Provide all required records and reports, such as payrolls, materials certifications, etc., requested in writing by the Department.

d. In the event the time interval stated in Paragraph 8.c. of this Subsection is exceeded, deductions to the interest time period will be made

for the actual number of days taken to provide the documentation beyond the first 60 days following tentative project acceptance.

109.08 -- Acceptance, Final Payment, and Termination of Contractor's Responsibility

1. As soon as possible after tentative acceptance of all the work, the Engineer shall measure the completed work and/or compute the quantities of work for which payment is to be made. Before final settlement is made, the Department shall be satisfied with the completed work.

2. When the Engineer is satisfied that all items of the work have been found to be consistent with the terms of the contract, a final estimate including the retained percentage due the Contractor shall be released for payment. Release of the final estimate shall constitute final acceptance of the work and completion of the contract subject to the provisions and requirements of the bond.

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

4. a. If at any time during the prosecution of the work the contractor completes to the satisfaction of the Engineer a unit or portion of the work, such as a structure, an interchange, or a section of road or pavement, the Engineer may tentatively accept that unit.

b. The section that is being tentatively accepted shall be inspected, completed work will be documented as being tentatively accepted in writing, and the section will be turned over to the Department for maintenance.

c. The Contractor will not be held responsible for care and maintenance of the completed work and for damages to portions of the project which have been tentatively accepted before final project acceptance provided such damages are due to the actions of the elements or the action of traffic.

SECTION 110 -- WAGES AND CONDITIONS OF EMPLOYMENT

110.01 -- Scope

1. These contract Required Provisions shall apply to all work performed on the contract by the Contractor with their own organization and with the assistance of workers under their immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

2. The Contractor shall insert in each of their subcontracts all of the stipulations contained in the Special Provisions and these Required Provisions.

a. Any supplier furnishing material to the project from a plant or facility at or near the site of the work, and set up for that purpose exclusively, shall be considered a Subcontractor for labor compliance purposes only and shall comply with all requirements for labor as set forth in the proposal.

b. A plant or facility is considered to serve a project "exclusively" if not more than 10% of sales from the plant or facility are made to others.

3. A breach of any of the stipulations contained in these Required Provisions may be grounds for termination of the contract.

110.02 -- Labor Laws Cited

1. The Contractor shall comply with Federal and State wage and labor laws.

110.03 -- Employment of Labor

1. General

a. No person under the age of sixteen (16) years, and no one whose age or physical condition is such as to make their employment dangerous to their health or safety, or to the health and safety of others shall be employed on any project. This paragraph shall not be construed to deny the employment of older people or physically handicapped persons, otherwise employable, where such persons may be safely assigned to work which they can ably perform.

b. No person currently serving sentence to a penal or correction institution shall be employed on any project.

c. Except as specifically provided under this Section, workers who are qualified by training or experience to be assigned to projects of this character shall not be discriminated against on any grounds whatsoever.

2. Equal Opportunity

a. Selection of Labor

(1) During the performance of this Contract, the Contractor shall not discriminate against labor from any other state.

b. Nebraska Fair Employment Practices Act

(1) The Contractor shall not discriminate against any employee or applicant for employment, to be employed in the performance of this Contract with respect to hire, tenure, terms, conditions, or privileges of employment, because of race, color, religion, sex, disability or national origin. The Contractor agrees to post in a conspicuous place or places a

notice to be provided by the State Highway Department which sets forth excerpts of the Act.

c. Nebraska Equal Pay Act

(1) The Contractor shall not discriminate on the basis of sex by paying wages to employees of one sex at a lesser rate than the rate paid to employees of the opposite sex for comparable work on jobs which have comparable requirements. An abstract of the Nebraska Equal Pay Act is included on the notice which is provided by the Department.

3. Payrolls

a. Payrolls and basic records relating thereto will be maintained during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working on the site of the work.

b. The Contractor's and subcontractor's payroll records shall be available for inspection by authorized representatives of the Department and authorized representatives of federal agencies.

c. The wages of labor shall be paid in legal tender of the United States, except that this condition will be considered satisfied if payment is made by a negotiable check, on a solvent bank, which may be cashed readily by the employee in the local community for the full amount, without discount or collection charges of any kind. Where checks are used for payment, the Contractor shall make all necessary arrangements for them to be cashed and shall give information regarding such arrangements.

d. No fee of any kind shall be asked or accepted by the Contractor from any person as a condition of employment on the project.

e. No laborers shall be charged for any tools used in performing their respective duties except for reasonably avoidable loss or damage thereto.

f. Every employee on the work covered by this Contract shall be permitted to lodge, board and trade where and with whom they elect and the Contractor shall not directly or indirectly require as a condition of employment that an employee shall lodge, board or trade at a particular place or with a particular person.

g. No charge shall be made for any transportation furnished by the Contractor to any person employed on the work.

h. No individual shall be employed as a laborer on this contract except on a wage basis, but this shall not be construed to prohibit the rental of trucks or other equipment from individuals. No such rental agreement, or any charges for gasoline, supplies, or repairs on account of such agreement, shall cause any deduction from the wages accruing to any employee except as authorized by the regulations hereinbefore cited.

4. Safety and Accident Prevention

a. In the performance of this Contract, the Contractor shall comply with all applicable Federal, State and local laws governing safety, health and sanitation. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on their own responsibility or as the contracting officer may determine, reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

SECTION 111 -- PLANS AND SPECIFICATIONS

111.01 -- Distribution of Plans and Specifications

1. The Department will place review copies of the plans and specifications on file in the offices of:
 - a. All NDOT District Engineers.
 - b. Central Headquarters, Nebraska Department of Transportation, Lincoln, Nebraska.
 - c. NDOT website.
2. The plans and specifications may be in electronic format.
3. Plans and Proposals are available for purchase on the NDOT Storefront website.

SECTION 112 -- MOBILIZATION

112.01 -- Description

1. This work shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of offices, buildings and other facilities necessary for work on the project; and for all other work and operations which must be performed or costs incurred before beginning work at the project site. It shall also include pre-construction costs which are necessary direct costs to the project and are of a general nature rather than directly attributable to other pay items under the Contract.

2. The Contractor must include all costs that he/she expects to incur for all movements of his/her equipment and personnel. Additional payments will not be made should the Contractor elect to move his/her equipment and/or crew to another project site before the contracted work is complete or if the Contractor fails to adequately assess the actual cost of Mobilization for the contracted work.

112.02 -- Method of Measurement and Basis of Payment

1. No measurement is required.

2. a. The partial payment for any Mobilization item will be limited to an amount not to exceed 10% of the total amount bid, including Mobilization, for the group in which the Mobilization occurs. In the event the lump sum bid for "Mobilization" exceeds 10% of the total group amount, the amount in excess of 10% of the total group amount will not be paid until the Engineer has made tentative acceptance of the work included in the proposal.

b. When it is necessary to delay tentative acceptance because of a required observation period, the entire amount for "Mobilization" may be paid upon tentative acceptance of the other work.

3. Subject to the limitations stated in Paragraph 2. of this Subsection, partial payments will be made as follows:

a. Following contract execution, the Department will pay up to 25% of the total amount bid for "Mobilization". This payment is limited to the Contractor's documented costs of obtaining Contract Bond and Railroad Protective Liability Insurance premiums. These costs must exceed \$200.00.

b. Upon completion of 5% of a group's originally contracted work, excluding Mobilization, the Department will pay 50% of that group's Mobilization amount.

c. Upon completion of 10% of a group's originally contracted work, excluding Mobilization, the Department will pay 100% of that group's Mobilization amount.

4. When "Mobilization" is not shown as a separate pay item for a group in the proposal, the work described in this Section will be considered subsidiary to other pay items in the group.

SECTION 113 -- PARTNERING

113.01 -- Description

1. "Partnering" is an approach to contract administration whereby all parties to the contract, as well as individuals and entities associated with or affected by the contract, commit themselves to working together to complete the contract in the most cost effective ways possible while operating within the provisions of the contract.

2. a. The "partnering" approach is expected to be utilized on all projects. It may be informal in nature, or it may be expressly called for in the proposal (formal partnering program).

b. When provisions for a formal partnering program are not included in the contract, one may be initiated if all parties to the contract agree to its inclusion in the contract.

113.02 -- Contract Requirements

1. Formal partnering programs shall include a preconstruction "partnering workshop" and regularly scheduled meetings throughout the construction period stated in the contract.

2. a. The Contractor shall be responsible for employing a facilitator trained in the recognized principles of partnering to conduct the partnering workshop. The workshop is expected to be of no more than one or two day's duration.

b. The facilitator shall be responsible for:

(1) Encouraging open discussions which examine the concerns of both parties.

(2) Guiding the parties to establish a hierarchical protocol which attempts to resolve disputes through discussion rather than litigation.

(3) Achieving an understanding between both parties that will help define fundamental responsibilities of each party.

(4) Training all parties to be sensitive to the limitations of the other parties while trying to find ways to help each other perform at an optimum level.

(5) Assisting with the preparation of a non-binding "partnering agreement" to be signed by the parties attending the workshop.

3. The Contractor shall provide a location for regularly scheduled meetings during the construction period. The Contractor shall encourage the attendance of Subcontractors, affected utilities, concerned businesses, residents, and the Engineer's staff at these meetings so that any and all conflicts can be resolved at the earliest possible date and at the lowest managerial level possible.

113.03 -- Method of Measurement and Basis of Payment

1. Informal partnering will not be measured for payment and is considered subsidiary to other items of work for which direct payment is made.

2. a. When a formal partnering program is called for in the proposal or when the Contractor and the Department mutually agree to implement a formal partnering program, the Department will share equally in the cost of

the facilitator, the facility, meals, and incidentals directly associated with the partnering workshop.

b. The Department will prepare a supplemental agreement to reimburse the Contractor for the Department's share of the costs for the facilitator, the facility, meals, and incidentals directly associated with the partnering workshop.

c. The Department will not share in the Contractor's or any other participant's (except the facilitator) travel, lodging, or per diem costs.

SECTION 114 -- CONSTRUCTION STAKING

114.01 -- Description

1. Department and Contractor Responsibilities:

Each project will have the construction staking done by either the Contractor or the Department. When the pay item "Construction Staking" is shown in the bid proposal Schedule of Items and in the contract, then the Contractor shall accomplish the requirements in Paragraph 3. of this Subsection. When the Department has the responsibility to accomplish the construction staking shown in Paragraph 2. of this Subsection, then the pay item "Construction Staking" will **not** be shown in the contract or the Schedule of Items.

2. Department provided construction stakes, lines, and grades shall include:

a. The Engineer will furnish and set construction stakes or benchmarks establishing lines and grades and will furnish the Contractor with all necessary information relating to them. For bridges, the Contractor may require the Engineer to furnish stakes determining the centerlines of all substructure units, together with stakes determining the angles of the wings or retaining walls.

b. The Contractor shall furnish, free of charge, all additional stakes, templates, and other materials necessary for marking and maintaining all reference points and lines. The Contractor shall construct the work in accordance with the Engineer's stakes and marks, making use of them before they are disturbed.

c. The Contractor shall be responsible for the preservation of all stakes and marks. The cost of replacing any stakes or marks destroyed or disturbed by the Contractor shall be charged against, and deducted from, the payment for the work at the rate of \$125 per hour for each hour of Department time spent replacing the Contractor disturbed reference points.

d. The Department will not be responsible for delays due to lack of stakes unless the Contractor, when moving onto the work, has given one week's notice that such stakes are needed. Thereafter, 48 hour notice is required.

3. Contractor provided construction stakes, lines, and grades:

a. The contract and the bid proposal Schedule of Items will show the pay item "Construction Staking" when the Contractor is responsible for staking requirements.

b. Contractor Construction Staking shall consist of:

(1) Establishing or reestablishing the project centerline.

(2) Referencing or re-referencing all necessary control points.

(3) Running a circuit of bench levels to check or reestablish plan benchmarks.

(4) Setting other benchmarks as needed.

(5) Staking right-of-way or restaking right-of-way where needed if it has been previously staked and performing all construction layout and reference staking necessary for the proper control and satisfactory completion of all structures, grading, paving, drainage, and all

other appurtenances required for the completion of the construction work and acceptance of the project.

(6) Provide station lath for concrete paving (100 feet interval) and asphalt paving (200 feet interval) projects.

(7) Providing flagging and signage for traffic control.

c. Construction Requirements:

(1) (i) The construction staking shall be done by personnel who are trained and experienced in construction layout and staking of the type and kind required in the contract.

(ii) If the Contractor subcontracts the "Construction Staking" the Subcontractor shall not be the Preliminary Engineering (PE) or Construction Engineering (CE) Consultant performing or having already performed services on the project. The Subcontractor will not be allowed to perform any additional PE or CE services on the project.

(iii) All right-of-way monuments and lines shall be established by a registered Land Surveyor employed by the Contractor.

(iv) It is recommended that the crew chief be NICET Certified Level III or a registered Land Surveyor.

(v) It is recommended that 50% of the survey crew be NICET Certified Level II.

(2) All stakes, references, lines, grades, and batter boards which may be required for the construction operations shall be furnished, set, and properly referenced by the Contractor in a manner consistent with standard engineering practices and in accordance with the Department's *Construction Manual* or alternate procedures approved by the Engineer. The Contractor shall be solely and completely responsible for the accuracy of the line and grade of all features of the work. Any errors or apparent discrepancies found in previous surveys, plans, specifications, or special provisions shall be immediately called to the attention of the Engineer by the Contractor for correction or interpretation before proceeding with the work.

(3) Field notes shall be kept in standard, bound field notebooks or in a Department approved computer file. The data shall be clear, orderly, and neat; consistent with standard engineering practices; and in accordance with the Department's notebook procedures. The Contractor shall provide the notebooks, which become the property of the Department upon completion of the project. The field notebooks shall be subject to inspection by the Engineer at any time.

(4) The Contractor shall be responsible for the placement and preservation of adequate ties and references to all control points, whether established by him/her or found on the project, necessary for the accurate reestablishment of all base lines or centerlines shown in the contract. All land ties (i.e., section corners, fractional section corners, etc.) that may be lost or destroyed during construction shall be carefully referenced and replaced by a licensed Nebraska Land Surveyor in accordance with the Department's *Construction Manual*. A copy of the completed survey and references to the corner or accessory shall be filed with the State Surveyor and with the County Surveyor for the county or counties in which the survey corner exists within 30 days of the date the activity is completed.

(5) On road projects, the circuit of bench levels to check the plan benchmarks shall be run the full length of the project. At bridge sites, the circuit shall include four benchmarks; if possible, two on each end of the structure.

(6) The Engineer will make all necessary final checks, measurements, and surveys that involve the determination of final pay quantities. He/she may check the accuracy and control of the work, as established by the Contractor's construction staking, at any time as the work progresses. These checks made by the Engineer in no way relieve the Contractor of his/her responsibility for the accuracy of the engineering layout.

(7) The Contractor shall correct any deficient staking or construction work which resulted from inaccuracies in the staking operations or from the Contractor's failure to report inaccuracies in the contract or survey data furnished by the Department.

(8) Following a written request by the Contractor, the Engineer may approve the start of construction staking operations before the tentative or anticipated beginning date.

114.02 -- Method of Measurement

1. Construction staking and surveying will be measured as a lump sum for all surveying and staking requirements.

114.03 -- Basis of Payment

1. Pay Item

Construction Staking

Pay Unit

Lump Sum (LS)

2. Payment is full compensation for all work described in Subsection 114.01, Paragraph 3.

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SECTION 201 -- GENERAL REQUIREMENTS

201.01 -- General

1. Work in the area of existing or relocated utilities shall be done in accordance with the requirements of Subsections 105.06 and 107.16.

2. Salvageable materials are any items that the Contractor removes and the Department designates in the contract to be salvaged. All nonsalvageable material shall become the property of the Contractor and must be promptly removed from the project.

3. The Contractor shall place right-of-way markers as one of the first orders of work.

4. The Contractor shall conduct the operations and maintain the work so that adequate drainage is in place at all times. This shall include the subsurface drainage of embankments during construction.

5. The Contractor shall employ best management practices to prevent petroleum products, chemicals, harmful materials, construction debris, and suspended solids in excess of permitted limits from entering waterways.

6. The Contractor shall be responsible for the stability of all constructed embankments and shall replace, at no additional cost to the Department, any portions which have become displaced or unstable due to construction.

7. Mandatory borrow material shall be obtained as indicated in the contract.

8. Borrow sites may be designated and described in the contract. The quality of material in such borrow sites will be acceptable in general, but the Contractor shall determine the amount of selective excavation, blending, screening, mixing, and other work required to provide a finished product meeting the contract requirements. The Engineer may order procurement of material from any portion of the designated borrow sites and may reject unacceptable portions of the borrow sites.

9. When waste or borrow locations are not designated in the contract, the Contractor shall provide waste or borrow sites.

10. The Department may acquire and make available to the Contractor the right to take soils from designated sources, together with the right to use the land for purposes such as plant sites, stockpiles, and hauling roads. Terms of the land contracts are shown in the contract.

11. If the Engineer directs the Contractor to change from a designated borrow site to another not designated in the contract, the work of moving from one site to another, any additional stripping or hauling of the material, and any other additional costs occasioned by such change shall be considered "extra work".

12. Only materials authorized by the Engineer shall be permanently piled or buried within the right-of-way of any public road.

13. When pre-watering is required, proposed pre-watering methods will be explained by the Contractor at the preconstruction conference.

14. Surplus excavated material shall be disposed in waste areas provided by the Contractor and in compliance with any applicable state,

federal, or local rules and regulations. Surplus excavated material may be disposed of in the toes of embankments if approved by the Engineer.

15. At the preconstruction conference, the Contractor shall submit for acceptance specific plans for accomplishing temporary erosion control, in accordance with Section 800.

16. The use of a borrow site shall be restricted to one contract or one pay item until the appropriate payment measurements are taken. The Department will do the initial and final cross section survey.

17. The Contractor shall furnish copies of the water distributor and supply tank calibrations to the Engineer.

18. All equipment shall be adequate for its intended use and shall be maintained in satisfactory working condition.

19. The Contractor shall be responsible for all equipment calibrations.

20. The Contractor shall protect all structures and roadway appurtenances like signs, guardrails, and curbs. If the Contractor damages items, the Contractor shall repair or replace the items at no additional cost to the Department.

21. The finish grading operations shall be started in accordance with Section 800.

SECTION 202 -- CLEARING AND GRUBBING

202.01 -- Description

1. This work shall be described as either "General Clearing and Grubbing" or "Large Tree Removal" in the contract and the bid proposal Schedule of Items.

2. Clearing and Grubbing:

a. Clearing and Grubbing is a lump sum bid item that includes:

(1) "Clearing" -- removing and properly disposing of all material from the surface, such as trees, vegetation, boulders, and trash unless designated by the Engineer.

(2) "Grubbing" -- removing and properly disposing of all material from underground, such as sod, boulders, stumps, roots, buried logs, or other debris unless designated by the Engineer.

b. "General Clearing and Grubbing" requires the Contractor to remove all living or dead vegetation, including trees, and trash from within the limits of construction, including borrow pits and channel changes unless designated to remain.

c. If "Large Tree Removal" is not included in the Contract, then no payment will be made for the removal of large trees above and beyond the payment for "Clearing and Grubbing".

3. Large Tree Removal:

a. If Large Tree Removal is included in the contract, then Large Tree Removal is an Each bid item that includes trees whose circumference exceeds 80 inches (2 m) at 40 inches (1 m) above ground level or stumps whose circumference exceeds 80 inches (2 meters) at (or near) ground level.

b. Large tree removal does not include "General Clearing and Grubbing."

4. Live trees, hedges, shrubs, or grass designated to remain shall be protected as shown in the contract.

5. Live trees outside the limits of construction shall not be injured or damaged.

202.02 -- Construction Methods

1. The Contractor shall remove and properly dispose of all unwanted material from the clearing and grubbing operations unless designated by the Engineer.

2. Grubbing:

a. All stumps, including large roots, shall be removed to a depth of at least 6 inches (150 mm) below the preconstruction ground level or the finished grade elevation in cut sections.

b. When authorized by the Engineer, the Contractor may leave stumps, roots, and nonperishable solid objects in place provided that such objects will be a minimum of 36 inches (900 mm) below subgrade or embankment slopes. These stumps will be cut to within 1 foot (300 mm) of the original ground surface.

3. When no other grading is required, the Contractor's clearing and grubbing responsibilities also include filling holes; smoothing and contouring the ground where items have been removed.

4. The following restrictions shall apply to material disposal:

a. Disposal shall be in accordance with all local, State, and Federal regulations.

b. The Contractor shall not leave material within the floodplain of any channel.

c. The Contractor shall not leave material within 1,000 feet (300 m) of the right-of-way of the project or any public road unless it is not visible from the traveled way.

d. The Contractor may enter into agreements with adjacent landowners or other persons for the disposal of trees after they have been cleared. Any such agreement must be in full compliance with all conditions established in the contract.

202.03 -- Method of Measurement

1. "General Clearing and Grubbing" will be a lump sum pay item. General Clearing and Grubbing includes removing all trees.

202.04 -- Basis of Payment

1. Pay Item	Pay Unit
General Clearing and Grubbing	Lump Sum (LS)
Large Tree Removal	Each (ea)

2. No direct payment will be made for tree protection, but shall be considered the duty of the Contractor as described in Subsection 107.09.

3. All tree removal is subsidiary to the pay item "General Clearing and Grubbing".

4. The pay item "Large Tree Removal" does not include clearing and grubbing.

5. Payment is full compensation for all work described in this Section.

SECTION 203 -- REMOVAL OF STRUCTURES AND OBSTRUCTIONS

203.01 -- Description

1. General:

a. This work consists of clearing all tracts, the removal and disposal of all buildings, lighting, traffic signals, fences, manholes, gutters, curbs, structures, headwalls, culverts, bridges, pavements, abandoned pipelines or utilities, and other obstructions not designated to remain. It includes salvaging the designated materials and backfilling the resulting cavities.

b. Removal of existing roadway lighting, sign lighting, and traffic signals shall be accomplished as shown in the contract.

2. Unless structures interfere with the work, they shall not be removed until the new structures replacing them are complete.

3. Lead Plate Recycling:

a. If there are lead plates under existing bearings, the lead plates are considered to be "recyclable materials" and "scrap material" in accordance with Title 128, Rules and Regulations Governing Hazardous Waste Management in Nebraska. Lead plates must be recycled in accordance with the requirements of the above noted rules and regulations and as follows.

(1) The lead plates must be recycled at a legitimate recycling facility of scrap metal. Disposal of these lead plates by any other means is not allowed. The Contractor shall provide documentation to the Engineer that these lead plates have been delivered to a recycling facility. This documentation shall include the following:

(i) Number of lead plates delivered to the recycling facility.

(ii) Total weight of the lead plates delivered to the recycling facility.

(iii) Name and address of the recycling facility accepting the lead plates.

(iv) Date the lead plates were shipped to the recycling facility.

(v) Shipment ticket documenting receipt of the lead plates by the recycling facility.

b. The contractor shall provide for the protection, health and safety of his workers during the handling of the lead plates. This shall be done in accordance with the Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) standards, and all applicable federal, state, and local regulations.

4. Building Removal

a. It shall be the responsibility of the Contractor to determine if any of the buildings to be removed have materials containing asbestos. If it is determined that some or all of the buildings contain asbestos, the asbestos shall be removed prior to the building removal. All asbestos shall be removed in accordance with State of Nebraska Health and Human

Services Department, Environmental Protection Agency, and the Nebraska Department of Environmental Quality regulations. A Contractor trained and certified in asbestos handling shall perform all asbestos removal and handling operations.

b. The work of determining if any of the buildings contain asbestos shall be considered subsidiary to the item "Remove Building at _____."

c. The work of asbestos abatement will be paid for as "Extra Work" as described in Subsection 104.04.

203.02 -- Construction Methods

1. The Contractor shall excavate as necessary to perform any removal.

2. a. All nonsalvageable material shall become the property of the Contractor and must be promptly removed from the project.

b. When a portion of the existing structure is to be retained, the Contractor shall not damage the retained portion during construction operations.

c. The Contractor shall first complete all removal operations which might endanger any new construction.

3. Preparation of Existing Structure:

a. "Preparation of Structure at Station _____" includes removing any part of the existing structure and using it in the new structure as indicated in the contract and the work described in the contract as preparatory to adapt a structure to an extension or reconstructed structure.

b. The connecting edges of the existing structure shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging that part of the structure to be retained. All existing reinforcing steel which is encountered shall be cleaned, straightened, and extended into the new work as shown in the contract.

c. If the Contractor elects not to cut, chip and trim to the required lines and grades, the Contractor shall drill and grout tie bars using approved methods.

4. Pavement Removal:

a. The Contractor shall remove all pavement identified for removal in the contract.

b. Materials designated for Department salvage shall be stockpiled at designated locations without contaminating the material with dirt or foreign materials.

c. Concrete pavement, sidewalks, curbs, gutters, and similar structures to be left in place shall be sawed to a true vertical line or removed to an existing joint.

5. Brick surfacing removal requires the Contractor to remove the brick surface, all foundation structures, base courses, and sand beds.

6. Building tracts:

a. The Contractor shall clear all building tracts. This shall include all work required to remove all foundations, basement walls, driveways, walks, and other miscellaneous items encountered within the specified tract and disposing of all materials.

b. Basement walls shall be removed to an elevation at least 2 feet (600 mm) below finished ground elevation, the concrete floors broken into pieces of approximately 4 square feet (0.4 m²) and left in place, and the cavity backfilled with approved material.

c. Building removal responsibilities shall include disconnecting all sewers and other utilities encountered and plugging the sewer lines with concrete.

7. The Contractor shall remove all other miscellaneous structures encountered to at least 2 feet (600 mm) below finished ground elevation.

8. Contractor Removal of Bridges, Culverts, and Other Drainage Structures:

a. The Contractor shall remove abutments, piers, bents, and walls entirely or dismantle them to an elevation at least 2 feet (600 mm) below the subgrade, slope face, or original ground level, whichever is lowest. Structures in stream beds shall be removed as designated in the contract or 2 feet below the stream bed.

b. Bridges and culverts designated in the contract or otherwise ordered to be salvaged shall be dismantled without damage, match-marked if appropriate, cleaned, and transported for storage at designated locations.

c. The Contractor shall burn apart at the joints or otherwise demolish bridge trusses that the Engineer determines are unfit for reuse on a public road.

d. When an unforeseen structure is encountered within the LOC, the Contractor shall:

(i) notify the Engineer.

(ii) remove the unforeseen structure.

e. The Contractor shall remove and dispose lead-based paint according to current regulations.

9. Concrete designated for use as riprap shall be broken into pieces not to exceed 330 lb. (150 kg) with no dimension that shall be more than 4 times the least dimension. The material shall be stockpiled or placed at designated locations.

10. Sewers:

a. When salvaging or removing sewers, manholes, catch basins, and inlets, the Contractor shall rebuild and reconnect any live sewers associated with the removal.

b. Sanitary sewer service shall be maintained during construction operations. If necessary, the Contractor shall install and maintain a bypass service during construction.

c. When manholes, catch basins, or inlets are to be abandoned, the Contractor shall plug pipe connections with concrete of the same class as that being used in the construction of new structures.

11. The Contractor's removal of discharge structures shall include the concrete and metal flumes, concrete and metal slope drains, and the concrete discharge basin.

12. Retaining Walls:

a. Retaining walls shall be removed as indicated in the contract.

b. When only a portion of a wall is removed, the ends of those portions remaining will be modified, trimmed, and dressed to provide a finished appearance.

13. The Contractor shall cut off or drive abandoned piles as designated in the contract or 2 feet below the finished grade or stream bed.

14. Roadway Lighting, Sign Lighting, And Traffic Signals:

a. Removal of existing roadway lighting, sign lighting, and traffic signals shall include the following:

(1) Disassembling the luminaires or signals from the mast arms.

(2) Disassembling the mast arms from the poles.

(3) Disassembling and removing the poles and their foundations.

(4) Removing controllers.

(5) Removing all associated and connecting wires, cables, pull boxes, and conduits. Underground conduit and cable may be abandoned in place.

b. Unless indicated otherwise, foundations, pull boxes, control centers, and all lighting, sign lighting, and traffic components indicated for removal in the contract shall become the property of the Contractor. These items must be removed from the project. Concrete foundations must be removed to at least 2 feet (600 mm) below finished grade. Anchor bolts and reinforcing steel are considered part of the foundation. The Contractor may remove the foundation as an entire unit.

c. The contract will indicate whether existing items are to remain in place, be salvaged, or be disposed of. Salvaged items are to be transported to the location shown in the contract.

d. After the removal has been completed, the Contractor shall backfill the excavation to the condition of the surrounding area.

e. Salvaged Material Preparation. The material the Contractor is to salvage for the State shall be carefully disassembled and prepared as indicated below:

(1) Poles shall be clean, free from internal wiring, and have hand-hole covers and pole caps in place. Mast arm bolts shall be attached to the pole shafts.

(2) Luminaires shall be clean and have their openings covered with duct tape. Photo controls shall not be salvaged.

(3) Transformer bases shall have covers in place and all associated bolts, nuts, and washers attached.

(4) Power foundations shall be thoroughly cleaned before delivery and shall have the attachment bolts in place.

f. Salvaged Material Disposition:

(1) All components shall be delivered to the Department's storage area identified in the contract.

(2) The Contractor shall contact the Department storage area two work days prior to delivery and request delivery instructions.

(3) The Contractor will not be allowed to "off load" any materials that are not properly prepared for storage.

(4) It shall be the Contractor's responsibility to protect the salvaged materials until delivery to the State storage area or other approved destination. If the Engineer determines that the Contractor damaged salvaged materials, the Contractor shall dispose of the materials and replace the damaged materials with new materials at no cost to the Department.

15. Signs, Sign Support Structures, and Foundations:

a. The Contractor shall remove signs, sign support structures, and their foundations.

b. This work shall include the removal and disposal of the existing signs, luminaires, support structures, and foundations.

c. The signs and sign luminaires shall be removed from the structure and delivered to the Department storage area indicated in the contract or as directed by the Engineer.

d. All overhead structures scheduled for removal shall become the property of the Contractor, and the Contractor shall dispose of the items.

e. Foundations:

(1) The exposed portion of the foundations shall be removed to a minimum depth of 2 feet (600 mm) below finished ground elevation.

(2) All debris from the foundation removal shall be disposed of as directed by the Engineer.

(3) After the removal has been completed, the excavation shall be filled and the entire surface shall be restored to the condition of the surrounding area.

16. Ground Mounted Signs and Posts:

a. The Contractor shall remove signs and posts.

b. This work shall include the removal of the ground-mounted signs and their posts as indicated in the contract and delivering both the posts and signs to the indicated Department storage area.

c. Footings:

(1) The footing shall be removed to a minimum depth of 2 feet (600 mm) below finished ground elevation.

(2) All debris from the footing removal shall be disposed of by the Contractor.

(3) After the removal has been completed, the area shall be restored to the condition of the surrounding area.

17. Overhead Signs:

a. The Contractor shall remove signs as indicated in the contract.

b. This work involves the removal of existing signs and luminaires on the overhead structures as indicated in the contract. The existing signs and luminaires shall be removed and delivered to the Department storage area as directed by the Engineer.

c. Conduits and wires shall remain in place to accommodate the new luminaires, where applicable, or be tied off at the power source.

18. All structural backfilling which forms any portion of the roadbed embankment or subgrade shall be done as described in Sections 205 and 702.

19. The Contractor shall backfill basements or cavities left by any structure removal to the surrounding ground level, and the cavities shall be backfilled and compacted, as described in Subsection 205.03, to a stiffness as defined by a deflection target value established by the Engineer and at optimal moisture as determined by NDOT T 99.

20. The Contractor may use existing structures during construction, but material which is to be salvaged shall not be damaged.

21. Disposal of Materials:

a. The price bid for the removal of structures will include all right and title to any structure removed and not salvaged.

b. Disposal Methods:

(1) The Contractor shall remove from the project all disposed materials that will not be salvaged.

(2) Removed materials shall not be stored within 1,000 feet (300 m) of the project right-of-way unless they are not visible from the traveled way.

(3) Materials shall not be burned, buried, or wasted in a stream channel.

c. Uncontaminated broken concrete, bituminous rubble, and masonry rubble may be placed in the toe of slopes and berms; above the ordinary high water mark and away from wetlands; and at least one foot (300 mm) below finish grade as directed by the Engineer.

22. The Contractor shall clean all salvaged materials to the Engineer's satisfaction.

203.03 -- Method of Measurement

1. a. All removal work will be measured based on the original position of the items.

b. The excavation cost shall be included in the removal bid item.

c. The excavation volume necessary for any removal shall be deducted from the appropriate excavation bid item.

d. The excavation required for "Removal of Driveway Culvert Pipe" that is to be salvaged shall not be included in the removal bid item. "Removal of Driveway Culvert Pipe" is the only bid item where the required excavation is included in the appropriate roadway excavation bid item.

2. Pavement Removal:

a. The removal of all pavement structure, including base courses, gutters, intersections, and driveways will be surface measured. The unit of payment will be square yards (square meters). Driveway, intersection, and pavement removal shall include the underlying base course regardless of thickness or number of layers as shown in the contract.

b. Where the curb is integral with the pavement, surface course, or base course, the removal of curbs will be surface measured in square yards (square meters) as part of the pavement, surface course, or base course.

c. The length of curb and combination curb and gutter which is separate from concrete pavement, surface course, or base course will be measured for payment in linear feet (meter).

3. Measurements for curbs or combination curb and gutter will be made along the front face of the curbs.

4. Removing sidewalk will be surface measured for payment. The unit of payment will be the area in square yards (square meters).

5. Building removals, regardless of size, are measured by the each.

6. Removal of concrete and masonry structures, including retaining walls, steps, discharge structures, and concrete headers are measured by the each.

7. The length of fence removed will be measured for payment in linear feet (meter).

8. Manhole, catch basin, and inlet removal is measured by the each, including all attached parts and connections.

9. Guardrail post removal, when the posts are not to be reset, will be measured by the each.

10. Delineator removal is measured by the each. The delineator includes the post, the reflector, and the delineator base/anchor.

11. The length of electrical cable or conduit removed will be measured for payment in linear feet (meter).

12. Removal of traffic signal heads, traffic control signs, controllers, lighting control centers, poles, signs, structures and foundations, sign posts, and lighting structures will be measured as single units by the each.

13. "Remove Traffic Signal at Station_____" is measured as a lump sum.

14. "Remove Lighting System at Station_____" is measured as a lump sum.

15. "Remove Sign Lighting at Station_____" is measured as a lump sum.

16. Both wooden and metal pole removal is measured by the each.

17. Bridges and other structures are removed under the pay item "Remove Structure at Station _____", and the unit of measurement is by the each.

18. "Preparation of Structure at Station _____" is measured by the each.

19. Pipe culvert removal will be measured as follows:

a. When shown in the contract and the Engineer determines the pipe culvert to be salvageable:

(1) Payment will be made for the length of pipe removed, regardless of pipe diameter. Transportation of the removed pipe to the storage location shown in the proposal will be subsidiary to the pipe removal.

(2) Payment will be made for any required pipe removal excavation in accordance with Section 701 and Subsections 702.04 and 702.05. No deduction will be made for the culvert or existing headwall.

b. When the Engineer determines the existing pipe culvert to be nonsalvageable in the contract or prior to commencement of work:

(1) Payment will be made for the excavation volume as "Excavation for Pipe Culverts and Headwalls". See Subsections 702.04 and 702.05.

(2) No additional payment will be made for the length of pipe removed.

(3) Removed, nonsalvageable pipe becomes the property of the Contractor.

c. (1) "Remove Driveway Culvert Pipe" is only measured when the contract indicates the Contractor is to salvage the pipe.

(2) "Remove Driveway Culvert Pipe" is measured by the linear feet (meter).

(3) Excavation for removing driveway culvert pipe is not measured.

20. The overlap of a pipe removal excavation volume with an excavation volume required to construct new work will be deducted by subtracting the overlapping pipe removal excavation volume from the new work excavation volume.

21. "Clearing Tracts _____" will be measured for payment by the each for the removal of all items within the tract except vegetation. Vegetation removal is considered to be part of "Clearing and Grubbing".

22. "Break Concrete Pavement" will be surface measured for payment by the square yard (square meter).

23. Both removal and salvage of sewer pipe will be measured by its length in linear feet (meter), regardless of diameter.

24. Underground tank removal is measured by the each.

25. Bridge removal is measured as a lump sum or by the each as identified in the bid Schedule of Items.

26. Removal of retaining walls is measured by the linear foot (meter).

27. Removing miscellaneous items which are included in the contract, but not specifically covered in this Subsection, will be paid for by the each.

28. "Sawing Pavements" is measured by the length of the cut in linear feet (meter). It includes cuts through pavements, driveways, sidewalks, and other similar flatwork.

203.04 -- Basis of Payment

1. Pay Item	Pay Unit
Break Concrete Pavement	Square Yard (SY) [Square Meter (m ²)]
Clear Tract _____	Lump Sum (LS)
Excavation for Pipe, Pipe-Arch Culverts, and Headwalls	Cubic Yard (CY) [Cubic Meter (m ³)]
Preparation of Structure at Station _____	Each (ea)
Remove _____	Each (ea), Linear Foot (LF) [Meter (m)], Square Yard (SY), [Square Meter (m ²)] Cubic Yard (CY), [Cubic Meter (m ³)] or Lump Sum (LS)
Remove _____ Cable	Linear Foot (LF) [Meter (m)]
Remove _____ Pole	Each (ea)
Remove Asphalt Surface	Square Yard (SY) [Square Meter (m ²)]
Remove Base Course	Square Yard (SY) [Square Meter (m ²)]
Remove Brick Surface	Square Yard (SY) [Square Meter (m ²)]
Remove Building _____	Each (ea)
Remove Combination Curb and Gutter	Linear Foot (LF) [Meter (m)]
Remove Concrete Ditch Liner	Square Yard (SY) [Square Meter (m ²)]
Remove Concrete Foundation	Square Yard (SY) [Square Meter (m ²)]
Remove Concrete Median Surfacing	Square Yard (SY) [Square Meter (m ²)]
Remove _____ Conduit	Linear Foot (LF) [Meter (m)]
Remove _____ Controller	Each (ea)
Remove Culvert Pipe	Linear Foot (LF) [Meter (m)]

Remove Curb	Linear Foot (LF) [Meter (m)]
Remove Delineator Units	Each (ea)
Remove Driveway	Square Yard (SY) [Square Meter (m2)]
Remove Driveway Culvert Pipe	Linear Foot (LF) [Meter (m)]
Remove Fence	Linear Foot (LF) [Meter (m)]
Remove _____ Foundation	Each (ea)
Remove Gutter	Square Yard (SY) [Square Meter (m2)]
Remove Headwalls from Culverts	Each (ea)
Remove Inlets	Each (ea)
Remove Lighting Control Center	Each (ea)
Remove Lighting System at _____	Each (ea)
Remove Lighting Unit	Each (ea)
Remove Manhole	Each (ea)
Remove Pavement	Square Yard (SY) [Square Meter (m2)]
Remove Pull Box	Each (ea)
Remove Retaining Wall	Linear Foot (LF) [Meter (m)]
Remove Sewer Pipe	Linear Foot (LF) [Meter (m)]
Remove Sign	Each (ea)
Remove Sign and Post	Each (ea)
Remove Sign Lighting at _____	Each (ea)
Remove Sign, Structure, and Foundation	Each (ea)
Remove Structure at Station _____	Each (ea)
Remove Traffic Signal at _____	Each (ea)
Remove Traffic Signal Head	Each (ea)
Remove Underground Tank	Each (ea)
Remove Walk	Square Yard (SY) [Square Meter (m2)]
Salvage Sewer Pipe	Linear Foot (LF) [Meter (m)]
Sawing Pavement	Linear Foot (LF) [Meter (m)]

2. The pay quantities for removal of structures and obstructions will be based on the quantities shown in the contract unless changes are authorized.

3. The State may sell or remove buildings prior to the start of construction. If buildings are sold or removed before this date, the item "Remove Building" will be deleted from the final pay quantities. The Contractor shall still perform the work of clearing the tract.

4. The State may "strip salvage" buildings by removing doors, windows, and fixtures before the construction start date. When this occurs, the Contractor will be paid the full bid price for the building removal.

5. Sawing pavement is paid for as an "established" contract unit price which is shown in the bid proposal "Schedule of Items."

6. Excavation for removing driveway culvert pipe is subsidiary to Remove Driveway Culvert Pipe.

7. Payment is full compensation for all work described in this Section. Separate payment for excavating, backfilling, compacting cavities resulting from the removal of structures or obstructions, and transporting salvaged materials to designated storage locations will not be made.

SECTION 204 -- TEMPORARY WATER POLLUTION CONTROL

204.01 -- Description

1. This Section defines some temporary measures and construction practices the Contractor shall use to prevent soil erosion and avoid water pollution.

2. The Contractor shall exercise every reasonable precaution throughout the life of the contract to prevent silting of rivers, streams, impoundments (lakes, reservoirs, etc.), the project site, and adjacent property. Construction of drainage facilities, as well as performance of other contract work which will contribute to the control of siltation, shall be carried out in conjunction with earthwork operations or as soon thereafter as is practicable.

3. a. The Contractor shall take sufficient precautions to prevent pollution of streams, lakes, reservoirs, the project site, and adjacent property with petroleum products, chemicals, or other harmful materials.

b. The Contractor shall conduct and schedule the operations so as to avoid interference with movement of migratory fish.

c. The Contractor shall comply with all applicable statutes relating to pollution of streams and fish and game regulations.

4. All construction debris shall be disposed in a manner that it cannot enter any waterway. Waste excavation from the roadway, channel changes, cofferdams, etc., shall not be deposited in or so near to rivers, streams, or impoundments that it will be washed away by high water or runoff.

5. The Contractor's erosion control measures shall be continued until the permanent drainage facilities have been constructed and the grass on seeded slopes is sufficiently established to be an effective erosion deterrent or until tentative acceptance of the work.

6. All erosion control measures shall be properly maintained by the Contractor.

7. All erosion resulting from the Contractor's operations and the elements must be corrected by the Contractor at no additional cost to the Department.

8. The Contractor shall explain his/her erosion control plans at the preconstruction conference.

204.02 -- Limitation of Operations

1. The maximum exposed surface area for the Contractor's operations in excavation, borrow, and embankment is 18 acres (72,800 m²) plus an equal area of clearing and grubbing/large tree removal. A written request for an increase in the maximum exposed surface area may be approved by the Engineer. This approval will be based on the soil, moisture, seasonal conditions, the Contractor's operation, or other conditions.

2. a. The Engineer shall have the authority to reduce the maximum exposed surface area when any of the following conditions warrant:

(1) Soil and moisture conditions are such that erosion is probable.

(2) Seasonal conditions may force extended delays.

(3) Proximity to lakes, streams, ponds, or other watercourses require more stringent controls.

(4) Equipment available on the job is not sufficient to properly handle areas that are opened.

(5) Any other environmental condition in the area exists which would be affected by erosion from the project.

b. The Contractor shall immediately provide permanent or temporary erosion control measures as outlined when any of these above conditions exist.

3. Construction operations in rivers, streams, and impoundments shall be restricted to those areas where channel changes are shown in the contract and to those areas which must be entered for the construction of temporary or permanent structures or embankments, unless the Engineer issues a written approval of deviation. Rivers, streams, and impoundments shall be promptly cleared of all falsework, piling, debris, or other obstructions placed therein or caused by the construction operations.

4. Frequent fording of live streams with construction equipment will not be allowed; therefore, temporary bridges or other structures shall be used wherever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams except as may be required to construct channel changes and temporary or permanent structures.

204.03 -- Construction Methods

1. a. The Contractor shall conduct all construction activities so as to avoid soil erosion.

b. Each day, slopes shall be graded so that storm runoff will not erode soil.

c. Diversion ditches shall be cut to direct the runoff flow.

2. The Contractor shall incorporate all permanent erosion control features, including cover crop seeding, into the project at the earliest practicable time as outlined in his/her schedule. "Temporary Water Pollution Control" will be used to correct the following:

a. Conditions that develop during construction that were not foreseen during the design stage.

b. Conditions that exist before installation of permanent pollution control features.

c. Temporary erosion control problems that develop during construction but are not associated with permanent control features on the project.

3. "Temporary Water Pollution Control" may include but is not limited to berms, dikes, dams, sediment basins and other erosion control structures necessary to control erosion until such time as the grading is complete and permanent erosion control can be placed as shown in the contract. It excludes berms, dikes, dams, sediment basins, temporary slope drains, mulching, cover crop seeding, silt fences, lined hay-bale diversion ditches, slope stabilization mats, and other erosion control structures shown in the contract which shall be separate pay items.

4. Necessary construction work outside the right-of-way, such as borrow pit operations, haul roads, plant sites, and equipment storage sites, shall include temporary pollution control. All pollution control requirements outside the right-of-way are subsidiary to the item being constructed.

5. a. The temporary pollution control procedures contained herein shall be coordinated with any permanent erosion control structure or direct payment item specified elsewhere in the contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

b. The Contractor shall be responsible for evaluating the construction site and determining the need for and installing additional permanent erosion control structures not shown in the contract (such as sediment traps, silt fence, ditch checks, etc.)

6. The Contractor shall also provide such measures, including dikes and berms, to limit erosion and siltation into streams, rivers, or other impoundments during the construction period, as well as during the times that work may be suspended.

204.04 -- Method of Measurement

1. Measurements will not be made for "Temporary Water Pollution Control".

204.05 -- Basis of Payment

1. "Temporary Water Pollution Control" is subsidiary to the item being constructed.

2. The work identified in Subsection 204.03, Paragraph 5.b., shall be paid for either at contract unit prices or as "extra work", provided that the Engineer is notified and approves each item in writing prior to the work being performed.

SECTION 205 -- EXCAVATION AND EMBANKMENT

205.01 -- Description

1. Excavation and embankment work is usually enacted by four different pay items, "Excavation", "Excavation (Established Quantity)", "Excavation Borrow", and "Earthwork Measured in Embankment". The requirements for each pay item are described in Tables 205.01A and B.

Table 205.01A

Excavation/Embankment Pay Item Requirements				
Work Description Code	Pay Items (See Notes 1, 2)			
	Measured Quantity		Established Quantity	
	Excavation	Excavation Borrow	Excavation (EQ)	Earthwork Measured in Embankment
A	X		X	
B	X		X	
C	X	X	X	X
D	X	X	X	X
E	X	X	X	X
F	X	X	X	X
G	X	X	X	X
H	X	X	X	X
I	X	X	X	X
J		X		X
K	X	X		
L			X	X
M	X	X	X	
N				X

¹ Excavation borrow is only used when part or all of the embankment material must be obtained off-site.

² Earthwork-Measured-in-Embankment may be used when the project requires off-site borrow; it is also used on projects where all embankment soil is available on-site.

Table 205.01B

Work Description Code	Work Description
A	Excavated and compacted soils are within the right-of-way limits.
B	Removing and disposing of excess material.
C	Excavation and embankment for inlet and outlet ditches needed for roadway drainage.
D	Excavation and embankment for changing and completing all channels.
E	Excavation and backfill at retaining walls, bridge abutments, and other structures.
F	Building, shaping, and sloping all embankments, roadbeds, cuts, fills, subgrades, shoulders, slopes, ditches, intersections, approaches, and private entrances in conformity with the alignment, grades, and typical cross sections shown in the contract.
G	Removal and disposal of unforeseen minor obstructions, (see Subsection 104.06), driveway culverts, foundations, structures, other protruding obstructions, and all materials encountered, including rock, boulders, earth and muck, except the removal of items for which direct payment is otherwise provided.
H	Stripping of all unsuitable materials that may overlie the acceptable materials and all excavating, stockpiling, loading, hauling, placing, compacting, and shaping necessary to construct the roadbed and embankments in reasonable conformity with the lines, grades, and typical cross sections shown in the contract.
I	The excavation or embankment necessary for the relaying and/or installation of driveway culvert pipes.
J	Obtaining soils from off-site borrow site, hauling soil to the location(s) designated in the contract, placing, compacting, and finish grading the soil to form the roadbed, embankments, and cuts shown in the contract.
K	Pay item is measured in the field for final payment.
L	Pay item is not field measured for final payment.
M	Quantities shown in the contract represent the volume of soil to be excavated. The Department applies a balance factor if embankments are constructed from this excavation. The embankment quantities will reflect this increase.
N	The contract quantities represent the volumes of the embankments and excavations as contract drawings. The Contractor must estimate and add to the contract quantities allowance for settlement, shrinkage, consolidation, waste, and other conditions to determine the actual excavation volume.

205.02 -- Material Requirements

1. Suitable Material:

a. The Contractor shall construct the roadbed and embankments of approved suitable material, and they shall not contain any logs, stumps, roots, sod, weeds, or other unsuitable matter except as allowed in Subsection 202.02, see Paragraph 2.b.

b. Thoroughly disced and pulverized light sod may be deposited in the outer slope of embankments.

c. Sod, weeds, or other perishable unsuitable matter cannot be used in the embankment and shall be hauled to a waste site.

2. Stones or rocks larger than 3 inches (75 mm) in diameter may be used in the embankment if:

a. No stone pockets are formed.

b. Voids are filled with small stones or earth.

c. They are below the top 2 feet (600 mm) of the finished embankment surface.

3. The maximum size of rocks allowed in embankments is shown in Table 205.02.

Table 205.02

Maximum Rock Diameters in Embankments Below the Top 2 Feet [600 mm] (By Class)			
	Class I	Class II	Class III
	<u>General*</u>	<u>All Areas</u>	<u>All Areas</u>
Diameter of	12 Inches	8 Inches	8 Inches
Rock	(300 mm)	(200 mm)	(200 mm)
* Maximum diameter of rock within 10' of the structure shall be no larger than 6".			

4. Shales and other materials that break down during compaction shall be wasted.

5. Frozen lumps of soil, snow, or ice shall not be placed in the embankment.

6. Frozen Layers:

a. Thin Frozen Layer. A thin soil layer that freezes during the construction of an embankment may remain provided that the layer:

(i) had proper stiffness and moisture prior to freezing,

(ii) can be readily broke up by a single pass of a tamping (sheepsfoot) roller or track mounted excavator,

(iii) is thoroughly scarified into pieces having a single dimension of 3 inches or less, and a second dimension of 1/2 inch or less, and

(iv) is not within 10 inches (measured vertically) of any thin frozen layer that was previously scarified and left in place.

b. Thick Frozen layer. A soil layer that freezes during the construction of an embankment, but does not meet the Thin Frozen Layer requirements:

(i) may remain in the embankment provided that the layer is thawed and has proper stiffness and moisture after thawing, or

(ii) shall be completely removed from the embankment prior to placing any additional embankment material.

7. Borrow Site Approval:

a. When borrow is obtained from sites or waste excavation is placed at sites which are not shown in the contract, the Contractor shall submit details of his/her sites and the details and locations of the haul roads, including photocopies of either a USDA, Natural Resources Conservation Services (NRCS) aerial photograph or topographical map of the area, to the Department Construction Division for routing to the appropriate agencies for their approval.

b. It is anticipated that it may require 60 calendar days or more for the Contractor to obtain the necessary Nebraska State Historical Society and Nebraska Game and Parks Commission approvals. The Contractor will not be allowed to begin work at borrow or waste sites until the necessary approvals are obtained from those agencies. No extension of completion time will be granted due to any delays in securing approval of a borrow or disposal site.

c. Army Corps of Engineers' Approval:

(1) The Contractor shall be responsible for obtaining Army Corps of Engineers' approval for proposed borrow and waste sites which are within the Army Corps of Engineers' areas of jurisdiction. If the site is not in the Corps' jurisdiction, the Contractor must obtain a letter from the Corps stating the site is not in their jurisdiction.

(2) An aerial photo or a topographical map showing the precise location of the proposed borrow and waste sites shall be submitted to the Army Corps of Engineers at the time their approval is requested.

(3) The Contractor shall mail or FAX the request for borrow and/or waste site approval to one of the following locations:

(i) Main Office (will forward to either Kearney or Wehrspan as appropriate):

U.S. Army Corps of Engineers
Regulatory Branch
P.O. Box 5
Omaha, NE 68101-0005
FAX: (402) 221-4939
Phone: (402) 221-4211

(ii) For work in Lancaster County and all counties along the Missouri River:

U.S. Army Corps of Engineers
Wehrspan Regulatory Office
8901 South 154th Street
Omaha, NE 68138
FAX: (402) 896-0997
Phone: (402) 896-0723

(iii) All other counties:
U.S. Army Corps of Engineers
Regulatory Office
1430 Central Ave.
Suite 4
Kearney, NE 68847
FAX: (308) 234-3342
Phone: (308) 234-1403

d. Material shall not be removed from borrow sites until preliminary cross sections and representative soil samples have been taken by the Engineer. The Contractor shall notify the Engineer a sufficient time in advance of the opening of any borrow site so that cross sections may be taken.

e. Material shall be removed in a manner that will allow accurate final cross sections to be taken for determining the quantity of excavation. The surfaces of the borrow sites shall be bladed and shaped to drain as shown in the contract or as directed by the Engineer.

205.03 -- Construction Methods

1. The Contractor shall excavate, build, and shape the roadbed, embankments, and cuts as shown in the contract. Embankments shall be constructed so they are stable at all times.

2. Prewatering. When the moisture content of the embankment material is too low and the Contractor elects to add water to the material before it is excavated, this work shall be performed in accordance with the following requirements:

a. The Contractor shall make sufficient borings, at no additional cost to the Department, in the excavation areas for the purpose of sampling the material for moisture determinations to be made by the Engineer. Estimates of the quantities of water necessary to provide the optimum moisture content in the soil layers to be excavated shall be made using these moisture determinations.

b. The Contractor may apply water by sprinkler irrigation or ponding methods. The natural vegetation growth on the excavation area shall be preserved until all water has been applied. The Contractor may be required to rip the excavation areas in the same direction as the ground contours to facilitate penetration of the water and to minimize run-off. Excavation areas shall be stripped of vegetation as soon as practicable after watering of the areas has been completed.

c. The watering operation shall be controlled and adjusted to avoid the application of more water than is required and to avoid any run-off or wasting of water.

d. The Contractor shall make sufficient additional borings as required to check and control the penetration of the water to the full depth of the excavation or to the depth of excavation to be pre-watered.

e. Removal of material from pre-watered excavation areas should not be started until the water has penetrated to the desired depth and the material has a uniform moisture content.

f. Prewatered soils that are unsuitably wet shall not be excavated for final incorporation in the project.

3. The Contractor shall place all materials removed from the roadway, borrow sites, or channels, including inlet, outlet, and intercepting ditches, in embankment, subgrade, shoulders, and other locations as shown in the contract.

4. Slope Maintenance:

a. During construction of the roadway, the Contractor shall maintain the roadbed in such condition that:

(1) It will be adequately drained at all times.

(2) Side ditches emptying from cuts to embankments shall be constructed so as to avoid damage to embankments by erosion.

b. All slopes shall be trimmed accurately to the slope as staked.

c. The Contractor shall avoid loosening material below or outside of the required slopes. If slopes are damaged in any way, the Contractor shall restore the slope to the original condition at no cost to the Department, regardless of whether or not the excavation is carried beyond the specified side slopes. All breakage and slides shall be removed by the Contractor.

d. The Contractor shall excavate side ditches as shown in the contract. The finished roadway shall be a continuous surface that matches the lines, grades, and cross sections shown in the contract.

5. Channel Excavation:

a. The Contractor shall accomplish all channel excavation before any bridge or culvert work unless specified otherwise. The channel excavation shall be accomplished as indicated in the contract.

b. Upon written authority of the Engineer, channel excavation work may be temporarily suspended after the area to be occupied by a bridge or a culvert has been excavated to the typical cross sections shown in the contract, provided that a temporary ditch is constructed for drainage.

c. The Contractor shall maintain completed channels free from debris and protected from erosion until all work is accepted.

6. Borrow and Excavation Borrow:

a. Material shall not be obtained from any borrow site that is not shown in the contract unless approved by the Engineer.

b. Borrow obtained from sites shown in the contract shall be excavated to the cross sections and grades shown in the contract.

c. The Contractor shall remove the available topsoil at State-furnished borrow sites and waste sites to a minimum depth of 6 inches and stockpile this material in approved areas.

d. If the Contractor elects to furnish granular materials (less than 50% passing through a No. 200 sieve [75 μ m]) as borrow, subgrade stabilization may be required. When subgrade stabilization is required to stabilize Contractor-furnished granular material to support any subsequent construction, subgrade stabilization will be accomplished in accordance with Section 303 at no additional cost to the Department.

e. If the Contractor elects to furnish granular materials (less than 50% passing through a No. 200 sieve [75 μ m]) as borrow, the Contractor shall, at no additional cost to the Department, provide cohesive material (50% or more passing through a No. 200 sieve [75 μ m]) that is able to support vegetation for the upper 6 inches (150 mm) of the foreslopes and earth shoulders or in the absence of such material in the haul area "native soil" that will support vegetation may be used with the approval of the Engineer.

(1) The cohesive material may be obtained from the right-of-way, if available, by stripping the area that will be covered by the embankment or, at the Contractor's option, obtained from sources other than State right-of-way.

(2) If there is not enough cohesive material available within the right-of-way, the Contractor will be required to furnish the cohesive material from other sources.

f. Borrow and waste areas will be restored as described in Section 208.

7. Benching:

a. When the embankment is to be constructed on sidehill slopes steeper than 1 vertical to 4 horizontal; the area of the original slope on which embankment is to be placed shall be continuously stepped (benched). Each step's vertical depth shall be 3 foot (1 m) minimum in order to integrate the placed embankment with the slope.

b. The Contractor shall bench the slope as the embankment is placed and compacted.

c. Each bench shall be cut horizontally into the existing slope a sufficient width for construction operations and equipment. The next bench will begin at the intersection of original ground with the previous bench. An existing embankment less than 4 feet (1.2 m) in height may require only one bench.

d. Except for unsuitable materials, all material excavated for the benches will be used in the embankment construction.

8. Rock Fills:

a. When the excavated material is predominantly rock fragments larger than 1 foot (300 mm) in diameter, such material may be placed in those embankments where the lift thickness is allowed to be greater than the thickness of the approximate average size of the larger rocks. Backfill materials shall be placed around the rock fragments to eliminate air voids that are larger than those in the predominate backfill material.

b. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments or earth.

c. These layers shall not be constructed in the top 2 feet (600 mm) of the finished grade or embankment.

d. The balance of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 8 inches (200 mm) in loose thickness and compacted as specified for embankments.

9. Embankment over bituminous pavement:

a. When less than 3 feet (1 m) of embankment is to be constructed on any part of the existing bituminous surfacing, all bituminous base courses (including stabilized bituminous bases and bituminous sand), or aggregate base and no other provisions have been made, the surfacing and all base courses, regardless of depth and number of layers, shall be removed and paid for in accordance with Section 203 before placing the embankment.

b. When the depth of the embankment is greater than 3 feet (1 m) and no other provisions have been made, the bituminous surfacing, bituminous base or aggregate base may be left in place.

c. Removed bituminous surfacing and base courses may be placed in the outer slopes of the embankment 1 foot (300 mm) below the finished shoulders and foreslopes.

10. Embankment over concrete pavement:

a. When less than 3 feet (1 m) of embankment is to be constructed on any part of the existing concrete pavement or concrete base course, the existing surfacing and all base courses, regardless of depth and number of layers, shall be removed and paid for in accordance with Section 203 before placing the embankment.

b. When the depth of the embankment is greater than 3 feet (1 m), the Contractor shall break the concrete pavement or base course into pieces with surface areas of approximately 4 square feet (0.4 m²) and leave them in place.

c. The Contractor may use jackhammers, drop hammers, or any other suitable means to break the pavement.

11. Where concrete slope protection is to be placed, the Contractor shall overfill and properly compact the embankment to a depth sufficient to insure that the slope can be trimmed to the proper finished grade elevation. The Contractor shall then remove the excess embankment. The work of overfilling, compacting, and removing this embankment will not be measured and paid for directly, but will be considered subsidiary to other items of work for which direct payment is made.

12. Compaction of Subgrade:

a. The Contractor shall compact the upper 6 inches (150 mm) of the roadbed in excavation areas to conform with the compaction requirements for embankments shown in the contract.

b. The work to obtain the specified compaction in the upper 6 inches (150 mm) shall be performed at no additional cost to the Department if the soils do not require any work below 1 foot (300 mm).

c. Any compaction work required at depths greater than 1 foot (300 mm) will be performed on an "extra work" basis unless such conditions are caused by the Contractor's operations.

d. If the Engineer determines the subgrade material to be unsuitable, it will be treated as a differing site condition in accordance with Subsection 104.02 or Paragraph 17. of this Subsection.

13. Compaction of Embankments:

a. Embankments are classified into three compaction classes (I, II, and III). Each class has different compaction and moisture requirements. The compaction classification for each embankment is shown in the contract.

b. Embankment Classifications:

(1) Class I:

(i) Class I embankments will not be rolled, unless specified.

(ii) The embankment, except adjacent to structures, shall be placed in successive horizontal layers not exceeding 12 inches (300 mm) in depth (uncompacted). The layers shall be of uniform thickness and full width and shall be compacted as evenly and densely as possible by varying the haul route over the entire area.

(iii) The embankment adjacent to all structures, other than driveway culverts, shall be placed in uniform layers not exceeding 6 inches (150 mm) in depth (uncompacted) for the full width of the embankment and compacted by one pass over the entire area of each layer with the treads of a crawler tractor unit weighing at least 10 tons (9 Mg) or by two passes over the entire area of each layer with equipment conforming to the requirements of Paragraph 14.c. of this Subsection.

(2) Class II:

(i) The material shall be placed in successive horizontal layers not to exceed 8 inches (200 mm) in depth (uncompacted) before rolling, each of which shall extend the full width of the embankment. Each layer shall be leveled before compaction. Each layer shall be rolled at least twice with compacting equipment which conforms to the requirements of Paragraph 13.c. of this Subsection. In all cases, the hauling shall be distributed over the entire area to assist in compacting the material.

(ii) When embankments are to be constructed through lakes or swampy areas, the material may be placed without rolling to an elevation above water level which will allow the use of a roller. The embankment above this elevation shall be placed in 8 inch (200 mm) layers (uncompacted) and rolled as specified.

(iii) When the moisture content of earth or soil used in constructing embankments is too high to allow rolling or to obtain satisfactory compaction, each layer shall be disced, harrowed, or otherwise manipulated to facilitate drying until its moisture content is reduced to the point where satisfactory compaction can be obtained.

(iv) Multiple-wheel, pneumatic-tired rollers which conform to the requirements of Paragraphs 13.c.(2) and 13.c.(3) of this Subsection

may be used in rolling the last layer to be placed on the surface of all embankments.

(v) When less than 3 feet (1 m) of embankment is to be constructed on any part of an existing stone or gravel surfaced roadbed, the existing roadbed shall be scarified to a depth not less than 6 inches (150 mm), manipulated, and rolled as specified.

(vi) When embankments are to be constructed over cultivated or fallowed land, the entire area upon which the embankment is to be constructed shall be smoothed and rolled at least twice with a roller which conforms to the requirements of Paragraphs 13.c.(1) or 13.c.(3) of this Subsection before the placement of any embankment material.

(3) **Class III:**

(i) Class III embankments shall be compacted at the moisture content shown in the contract. The optimum moisture shall be determined in accordance with NDOT T 99 or NDOT T 2835. Embankments shall be compacted to the optimal stiffness as defined by a deflection target value established by the Engineer.

(ii) Placing and Compaction:

(a) The material shall be placed in successive horizontal layers not to exceed 8 inches (200 mm) in depth (uncompacted), each of which shall extend the full width of the embankment.

(b) Each layer shall be leveled before compaction.

(c) In all cases, the hauling shall be distributed over the entire area to assist in compacting the material.

(d) When embankments are to be constructed through lakes or swampy areas, the material may be placed without rolling to an elevation above water level which will allow the use of a roller. The embankment above this elevation shall be placed in successive horizontal 8 inch (200 mm) layers (uncompacted depth) and compacted as specified.

(iii) Moisture and Stiffness Requirements. Each successive horizontal layer of soil shall be compacted to the stiffness as defined by a deflection target value. The moisture content of the soil in each layer shall be adjusted, if necessary, so that it will conform to the moisture requirements shown in the contract.

(iv) Compacting equipment and methods which will consistently produce uniform compaction throughout the depth of the compacted lifts shall be used.

(v) When less than 3 feet (1 m) of embankment is to be constructed on any part of an existing stone or gravel surfaced roadbed, the existing roadbed shall be scarified to a depth of 6 inches (150 mm) and recompacted to the requirements for the type of compaction shown in the contract.

(vi) When embankments are to be constructed over cultivated or fallowed land, the entire area upon which the embankment is to be constructed shall be smoothed and rolled at least twice with a roller which conforms to the requirements of Paragraphs 13.c.(1) or 13.c.(3) of this Subsection prior to the placement of any embankment material.

c. Compacting Equipment:

(1) Tamping (sheepsfoot/padfoot) roller. This roller shall be designed for use in the compaction of earth fills and consist of a cylindrical metal roller, drum, or shell studded with tamping feet projecting from its surface. The weight of the roller and spacing and length of the tamping feet shall be adequate to perform the compaction required. Cleaning teeth shall be attached to the rolling unit to prevent accumulation of earth between tamping feet. The pad foot compactor shall be vibratory and shall consist of one or more drums with pads or feet projecting no less than 6.5 in. The static load on the individual pads shall be no less than 200 psi exerted on a single row of pads or feet parallel to the axle of the drum.

More than one tamping rolling unit as described above may be used. When more than one rolling unit is used, the rolling units must be pivoted to the main frame in a manner which will allow the rolling units to adapt themselves to uneven ground surfaces and to rotate independently.

(2) Multiple-wheel, pneumatic-tired roller. The tires on the front and back of this roller shall be staggered so that they will cover the entire area over which the roller travels. The roller shall be designed for use in the compaction of earth fills. The pneumatic-tired roller shall have wide, smooth treads and uniform air pressure. The tires shall be staggered to provide complete coverage of the area. Sufficient weight is required to provide a minimum of 225 lbs. per inch of tire width. The tire pressure shall be no less than 60 psi with a tire variance no more than 5 psi.

(3) Alternate equipment which will produce as good or better compaction than the equipment specified above may be used with the Engineer's approval.

14. Selective placement materials shall be excavated, hauled, and placed as specified. The embankment surface upon which the material is to be placed shall be shaped to approximately the required crown of the roadbed and compacted to optimal stiffness.

15. All embankments and excavated areas shall be shaped and finished to produce the specified smooth surfaces and slopes. All existing backslopes shall be trimmed and shaped to conform to the typical cross sections. When the moisture content is too low to shape and consolidate the surface satisfactorily, water shall be applied during finishing operations.

16. Unsuitable Material:

a. Unsuitable material which cannot be dried by discing in place shall be removed to the length, width, and depth directed by the Engineer, the unsuitable material shall be disposed as directed by the Engineer and replaced with approved material.

b. Unsuitable material in low areas where drainage is expected to be a problem shall be removed, disposed and replaced with "Granular Backfill" meeting the requirements in Tables 1033.02, 1033.03, 1033.05, 1033.06, 1033.07, 1033.08, or 1033.09.

c. Approved drainage pipe (slotted/perforated 4 inch (100 mm) minimum diameter pipe) shall be placed as directed by the Engineer.

17. At "0-0" Sections (points where cuts transition to fills), the existing ground shall be excavated a maximum of 3 feet (1 m) below finished grade

level when directed by the Engineer and the area backfilled as a Class III embankment.

18. When the borrow soil for the project is dissimilar (Plasticity Index difference of 10 units or more or if delamination is evident) from the soil on site, then the Contractor shall blend all embankment lifts in the top 3 feet (1 m) of the embankment so that the dissimilar soil types are thoroughly and uniformly mixed. The blending process shall incorporate the entire thickness of all uncompacted lifts (layers) of dissimilar soil types that are being blended.

19. Engineer Directed Discing:

a. The contract shall indicate those areas where the Engineer may require embankment lifts to be disced because different types of soil are expected. The Engineer may also direct the Contractor to disc other areas.

b. The disc shall be able to penetrate through 2 entire uncompacted lifts.

c. Only the top 3 feet (1 m) of an embankment is required to be disced.

205.04 -- Method of Measurement

1. The "Excavation" volume in cubic yards (cubic meters) is calculated using the average end area method based on preliminary and final cross sections. This volume includes authorized excavation below grade and also overbreakage or slides not caused by Contractor error. Stockpiled materials will be measured in the stockpile.

2. "Excavation (Established Quantity)" is the plan quantity in cubic yards (cubic meters). "Excavation (Established Quantity)" is not field measured.

3. The "Excavation Borrow" volume in cubic yards (cubic meters) is calculated using the average-end-area method based on preliminary and final cross sections. This volume includes authorized excavation and also overbreakage or slides not caused by Contractor error. Stockpiled materials will be measured in the stockpile.

4. Earthwork Measured in Embankment:

a. "Earthwork Measured in Embankment" is a contract quantity in cubic yards (cubic meters) computed by the method of average-end-areas from the cross sections shown in the contract.

b. No additional compensation will be made for additional material required to obtain compaction, material placed by the Contractor outside the limits of the typical cross section, or material placed to correct for settlement of the embankment.

c. "Earthwork Measured in Embankment" is not field measured.

5. Water:

a. Water is measured by the volume applied. The volume unit is 1,000 gallons (MGAL) [kiloliter (kL)]. Payment shall be made at the established contract unit price.

b. Each time a meter is used, the Contractor shall furnish the Engineer with a certified copy of the meter calibration. The meter calibration shall have been performed during the last 12 months.

c. The Engineer shall deduct water that is wasted, lost, or applied in excess of soil requirements.

6. "Discing," when directed by the Engineer in the top 3 feet (1 m) of a roadbed made from dissimilar on-site soils, shall be measured by the hour for each disc in service. Only time spent discing will be measured.

205.05 -- Basis of Payment

1. Pay Item	Pay Unit
Excavation	Cubic Yard (CY) [Cubic Meter (m ³)]
Excavation (Established Quantity)	Cubic Yard (CY) [Cubic Meter (m ³)]
Excavation Borrow	Cubic Yard (CY) [Cubic Meter (m ³)]
Earthwork Measured In Embankment	Cubic Yard (CY) [Cubic Meter (m ³)]
Water	1,000 Gallons (MGAL) [kiloliter (kL)].
Discing	Hour (h)
Removal of Unsuitably Wet Soil	Cubic Yard (CY) [Cubic Meter (m ³)]

2. When borrow and waste sites are obtained by the Department and shown in the contract and the Contractor elects to use other sites, the Contractor shall be charged with all costs incurred by the Department related to the sites shown in the contract. These charges shall be deducted from Department money due the Contractor.

3. Clearing and grubbing of borrow and waste sites shown in the contract shall be measured and paid for in accordance with Section 202. When borrow is obtained from sites which are not shown in the contract, no payment will be made for clearing and grubbing.

4. Topsoil quantities shall not be deducted from the excavation quantities.

5. Direct payment will not be made for any additional hauling of materials required for the selective placement specified in the contract.

6. Removing and disposing of the bituminous surfacing and all base courses that overlay excavated areas will not be paid for directly, but shall be subsidiary to the relevant excavation pay item.

7. "Earthwork Measured in Embankment" shall be the quantity shown in the contract unless authorized changes are made to the grade line or length of the embankment.

8. The work of constructing an "embankment" is not a pay item but is subsidiary to the relevant earthwork pay item.

9. Stock Piled Material

a. The Engineer may direct the Contractor to stockpile excavated material for use as embankment or backfill. When the Contractor is required to re-excavate and place the same material as embankment or backfill, payment will be made for the quantity of material re-excavated at one-half the contract unit price per cubic yard (cubic meter) for "Excavation".

b. Payment will not be made for the re-excavation of any materials which:

(1) The Contractor is required to stockpile in the performance of selective materials placement.

(2) Are required for other work in the contract.

(3) Are stockpiled to drain and dry before placement in the embankment.

10. a. When unsuitable soil is removed and replaced, the volume of soil removed will be paid for at 2 times the bid price for the relevant pay item when the relevant pay item for that particular section is "Excavation", "Excavation Borrow", or "Earthwork Measured in Embankment". When the relevant earthwork excavation pay item is "Excavation (Established Quantity)", then the volume removed will be paid for at 3 times the bid price for "Excavation (Established Quantity)".

b. (1) When "Granular Backfill" is not included in the Bid Proposal Schedule of Items and is the required backfill material to replace unsuitable material approved by the Engineer for removal, then the unit price for the replacement granular backfill shall be a negotiated unit price.

(2) If the bid price for "Granular Backfill" is less than the relevant excavation pay item, the "Granular Backfill" is subsidiary to the relevant excavation pay item.

c. Drainage pipe shall be paid for at the bid price for similar pipe; or, if the drainage pipe is not a bid item, the pipe will be paid for as extra work.

d. Replacement soil materials, except "Granular Backfill", are subsidiary to the relevant excavation pay item.

e. Each day, the Engineer and the Contractor shall compare their records of unsuitably wet material removed and reconcile any differences.

11. a. The volume of material identified by the Engineer for removal at a "0-0" correction area shall be paid for at the bid price for the relevant earthwork excavation pay item that is being expensed for the construction of the section of the road where the "0-0" correction is encountered.

b. The volume of material for the correction shall be in addition to the quantities shown in the bid proposal Schedule of Items.

12. The volume of unsuitable material or the "0-0" correction volume as described in Paragraphs 10. and 11. of this Subsection shall not be deducted from the final payment measurements.

13. a. When discing is required for Contractor furnished borrow and when it is done as an optional procedure, it is subsidiary to the relevant

excavation and embankment pay item, except as noted in Paragraph b. below.

b. (1) Discing is only authorized for payment as a separate pay item, "Discing", when the contract indicate an area to be disced or the Engineer directs that an area be disced and "Discing" is a bid item in the bid proposal Schedule of Items.

(2) Only the discing of the material in the top 3 feet (1 m) of the roadbed is eligible for payment as "Discing."

c. Discing done at the Contractor's option to dry soil, to help obtain specified compaction, or any other purpose except as described in Subsection 205.03, Paragraph 20, shall be subsidiary to the relevant earthwork pay item ("Excavation", "Excavation (Established Quantity)", "Excavation Borrow", and/or "Earthwork Measured in Embankment").

d. If the contract does not contain the bid item "Discing" and the Engineer directs in writing that the Contractor shall disc a designated area to blend dissimilar soil types, then the discing shall be paid for as extra work.

14. Removal and disposal of excess soil is subsidiary to the relevant excavation and embankment pay item, except when the haul distance is greater than the balance's free haul distance and the contract does not indicate any waste or excess material. When these conditions exist, the movement of the waste material shall be paid for in accordance with Section 209 of these Specifications.

15. Areas that have been final graded and have a cover crop planted may be tentatively accepted by the Engineer. After tentative acceptance, additional earthwork caused by erosion will be measured for payment. No areas shall be tentatively accepted until all erosion control requirements, which will affect or be affected by the area being tentatively accepted, are in place.

16. a. Payment will be made to the Contractor for monthly fluctuations in the cost of diesel fuel used in performing the items of work, "Excavation," "Excavation, Borrow," "Excavation, Established Quantity," and/or "Earthwork Measured in Embankment" when the fuel cost fluctuates by more than 5% from the base price defined below. Payments may be positive, negative, or nonexistent depending on the circumstances. Payments or deductions will only be calculated on that portion of the fuel cost fluctuation that exceeds the 5% specified above.

b. Payments or deductions for the fuel cost adjustment will be included in the Contractor's progress estimates; and the payment or deduction authorized for each estimate will be based upon the algebraic difference between the quantities for "Excavation," "Excavation, Borrow," "Excavation, Established Quantity," and/or "Earthwork Measured in Embankment" on the current estimate and the quantities shown on the previous estimate.

c. The fuel cost adjustment for the current estimate will be computed according to the following formula:

FCA=QFD where

- FCA = Fuel cost adjustment, in dollars;
- Q = The algebraic difference between the quantities (in cubic yards or cubic meters) for "Excavation," "Excavation, Borrow," "Excavation, Established Quantity," and/or "Earthwork Measured in Embankment" on the current estimate and the quantities shown on the previous estimate.
- F = English
The fuel use factor for diesel fuel, in gallons per cubic yard. For the items of work "Excavation," "Excavation, Borrow," and "Excavation, Established quantity," "F" shall be equal to 0.20. For the item of work "Earthwork Measured in Embankment," "F" shall be equal to 0.27.
Metric
The fuel use factor for diesel fuel, in liters per cubic meter. For the items of work "Excavation," "Excavation, Borrow," and "Excavation, Established Quantity," "F" shall be equal to 0.99. For the item of work "Earthwork Measured in Embankment," "F" shall be equal to 1.32.
- D = Allowable price differential.

d. The allowable price differential, "D", for the current estimate will be computed according to the following formula:

When the current price, P, is greater than the base price, P(b).

$$D = P - 1.05P(b), \text{ but not less than zero.}$$

When the current price, P, is less than the base price, P(b).

$$D = P - 0.95P(b), \text{ but not greater than zero.}$$

e. In either case, P(b) shall be the base diesel price, in dollars per gallon (liter), defined as the average of the minimum and maximum prices for Ultra Low Sulfur Diesel (ULSD) (Oklahoma) published in the first issue of "Platt's Oilgram Price Report" for the month in which bids for the work were received.

f. In either case, P, shall be the current diesel price, in dollars per gallon (liter), defined as the average of the minimum and maximum prices for Ultra Low Sulfur Diesel (ULSD) (Oklahoma) published in the first issue of "Platt's Oilgram Price Report" for the month in which the progress estimate is generated.

17. Water is paid for as an "established" contract unit price item, which is shown in the bid proposal "Schedule of Items" or at the unit price if bid by the Contractor.

18. Payment is full compensation for all work described in this Section.

SECTION 206 -- ROADWAY GRADING

206.01 -- Description

1. "Roadway Grading" shall consist of furnishing, excavating, loading, hauling, placing, compacting, and finishing all materials necessary for the completion of the roadway, including its embankments, intersections, driveways, and approaches as shown in the contract.

206.02 -- Material Requirements

1. Soils that are placed in embankments and required in the roadway grading pay item shall meet the requirements of Subsection 205.02.

206.03 -- Construction Methods

1. The Contractor shall construct the roadway as shown in the contract.

2. The Contractor shall maintain all areas during the construction operations so that they will be adequately drained at all times.

3. The Contractor shall remove all excess material.

4. The Contractor shall obtain borrow material as necessary to construct embankments.

5. The Contractor shall perform the excavation, placement, sloping, and finishing of soils as described in Section 205. The embankment shall be compacted to comply with the compaction requirements shown in the contract.

6. The Contractor shall obliterate roads and shape the constructed areas to blend naturally with the surrounding areas.

206.04 -- Method of Measurement

1. "Roadway Grading" will be measured for payment by stations of 100 feet (100 m), measured horizontally along the centerline of the project.

2. Deductions will be made for bridge floors 20 feet (6 m) or more in length.

3. Sections having roadway grading on only one side of the road shall be measured along the centerline of the project, and then the measured distance shall be divided by two to obtain the pay quantity.

4. No additional allowance will be made for the work required to complete intersection and driveway returns, tapers, curves, tangents, stubs, and other irregular areas.

206.05 -- Basis of Payment

1. **Pay Item**

Roadway Grading

Pay Unit

Station (Sta) [Sta M]

2. When borrow and waste sites are obtained by the Department and shown in the contract and the Contractor elects to use other sites, the Contractor shall be charged with all costs incurred by the Department related to the sites shown in the contract. These charges shall be deducted from Department monies due the Contractor.

3. Clearing and grubbing of borrow and waste sites shown in the contract shall be measured and paid for in accordance with Subsections 202.03 and 202.04. When borrow is obtained from sites which are not shown in the contract, no payment will be made for clearing and grubbing.

4. Water applied shall be subsidiary to "Roadway Grading."

5. Payment is full compensation for all work described in this Section.

SECTION 207 -- SALVAGING AND PLACING TOPSOIL

207.01 -- Description

1. The Contractor shall remove topsoil from cut areas and areas to be covered by embankments and place the topsoil at the locations indicated in the contract or designated by the Engineer when "Salvaging and Placing Topsoil" is shown in the bid proposal "Schedule of Items".

207.02 -- Material Requirements

1. The topsoil material shall be loam, sandy loam, silty clay loam, or clay loam humus-bearing soils.
2. The Engineer must approve all topsoils.

207.03 -- Construction Methods

1. The Contractor shall clear and grub the topsoil areas before the topsoil is removed.

2. Soils below the designated topsoil layer shall not be incorporated into the salvaged topsoil.

3. The Contractor shall remove topsoil from cut areas and areas to be covered by embankments.

4. Topsoil shall be stockpiled at locations designated by the Engineer within the right-of-way which will not impair drainage.

5. Placement:

a. Topsoil shall be placed at the locations indicated in the contract or designated by the Engineer.

b. Areas to be covered with topsoil shall be undercut or underfilled so that, when covered to the required depth with topsoil, the finished work shall conform to the lines, grades, slopes, and typical cross sections shown in the contract.

c. Areas to be covered shall be loosened by tilling, harrowing, or discing to a depth of at least 2 inches (50 mm).

d. Harrowing, discing, or both may be required to assist in breaking down clods or lumps to provide a uniform texture to the topsoil.

e. Heavier clay bearing loam topsoils used on sandy areas shall be harrowed or disced to mix the two soils.

6. Rocks, twigs, large clods which will not break down, and other foreign material shall be removed. The entire surface shall be dressed to present a uniform appearance.

7. Compaction:

a. Rolling of the topsoil will not be required except for that which is placed on the shoulders.

b. Topsoil placed on the shoulders shall be compacted with at least two complete coverages over the area with a multiple wheel, pneumatic-tired roller meeting the requirements of Subsection 205.03, Paragraph 14.c.(2).

8. It shall be the Contractor's responsibility to determine the volume of topsoil required to complete the work.

9. Topsoil material excavated in excess of the quantity required to complete the work shall be disposed of in a manner satisfactory to the Engineer.

207.04 -- Method of Measurement

1. "Salvaging and Placing Topsoil" is measured by the square yard (square meter) of surface area where the topsoil is placed as a surface treatment.

207.05 -- Basis of Payment

1. Pay Item	Pay Unit
Salvaging and Placing Topsoil	Square Yard (SY) [Square Meter (m ²)]

2. The quantity of roadway excavation to be measured for payment will not include excavation made below embankment areas to obtain topsoil or excavation made in undercutting slopes, ditches, and shoulders in preparing such areas for the placement of topsoil. This excavation is subsidiary to "Salvaging and Placing Topsoil".

3. Topsoil quantities shall not be deducted from the excavation quantities.

4. Payment is full compensation for all work described in this Section.

SECTION 208 -- BORROW AND WASTE SITE RESTORATION

208.01 -- Description

1. This work consists of the restoration of Department provided sites from which borrow is obtained or where waste soil materials are disposed.

208.02 -- Construction Methods

1. The Contractor shall begin the restoration work, including the seeding, as soon as all borrow material has been removed or all wasted soils are disposed and finish graded.

2. The Contractor shall scarify the entire area, including slopes, to a minimum depth of 6 inches (150 mm).

3. The Contractor shall remove the available topsoil at State-furnished borrow sites and waste sites to a minimum depth of 6 inches and stockpile this material in approved areas. The Contractor shall uniformly spread topsoil that was stockpiled at the start of excavation over the area. The entire area, including the stockpile areas, shall be seeded in accordance with Section 811 using the kinds and rates specified in the special provisions for borrow/waste site restoration.

4. The Contractor shall adjust seeding time as outlined in Section 811 to fit conditions prevailing on the project.

5. The Contractor shall leave borrow and waste sites in a neat and presentable condition, in accordance with any land contract requirements, and acceptable to the Department upon completion of the work.

208.03 -- Method of Measurement

1. "Restore Borrow Site" and "Restore Waste Site" will be surface measured, and the unit of payment will be the acre (hectare) of site area actually used. The area of borrow sites and waste sites restored shall be the quantity shown in the contract unless changes are authorized.

2. All temporary stockpile areas shall be considered subsidiary to the work of "Restore Borrow Site" or "Restore Waste Site".

208.04 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---------------------|-------------------------|
| Restore Borrow Site | Acre (A) [Hectare (ha)] |
| Restore Waste Site | Acre (A) [Hectare (ha)] |
2. Payment is full compensation for all work described in this Section.

SECTION 209 -- OVERHAUL

209.01 -- Description

1. All excavated materials shall be hauled as shown in the contract from the source locations to the deposit locations and, regardless of the haul distance, overhaul will not be considered.

2. Overhaul will not be considered for material hauled from sites that are not shown in the contract (i.e. contractor obtained sites due to the item of Excavation, Borrow) or from sites substituted by the Contractor for the convenience of his/her operation.

3. When field conditions differ from the contract causing an increase in the haul distance, overhaul compensation will be allowed if all six of the following conditions are met:

a. The available excavation, within the affected balance, is inadequate to construct the embankment within that balance.

b. All available excavation, within the affected balance, has been incorporated into the embankment within that balance.

c. The contract has not provided Excavation, Borrow for embankment construction in the affected balance.

d. The materials must be obtained from outside the affected balance or from Borrow Sites not shown in the contract.

e. The actual haul distance is greater than the average plan haul distance (also known as the "free haul distance") for the affected balance.

f. The actual haul distance is greater than the minimum free haul distance of 1,500 feet (457 m).

209.02 -- Method of Measurement

1. The length of overhaul shall be determined by computing the centers of volume of the overhaul material in its original position and after placement. The centers of volume shall be determined by computation. The distance between the centers of volume minus the average plan haul distance or minimum free haul distance whichever is greater shall be the overhaul distance.

2. The quantity of overhaul shall be measured in CY/Sta (m^3/Sta M) and shall be the product of the overhaul distance in stations of 100 feet (100 m) multiplied by the volume of material in cubic yards (cubic meters).

3. The average plan haul distance will be determined from the Earthwork Data Sheets contained in the contract.

209.03 -- Basis of Payment

1. Pay Item	Pay Unit
Overhaul	Cubic Yard/Station (CY/Sta) [Cubic Meter/Station (m^3/Sta M)]

2. Payment for overhaul shall be made at the rate of \$0.06/CY/Sta. (\$0.27/ m^3/Sta M).

3. Payment is full compensation for all requirements described in this Section.

**DIVISION 300 -- SUBGRADE PREPARATION, FOUNDATION
COURSES, BASE COURSES, SHOULDER CONSTRUCTION,
AND AGGREGATE SURFACING**

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SECTION 301 -- GENERAL REQUIREMENTS

301.01 -- General

1. Compaction requirements are shown in the contract.
2. The Contractor shall be responsible for the repair and restoration of any roadbed damage, loss of stability, or rutting caused by the hauling operations.
3. Maintenance of the granular fill, base course, foundation course, and subgrade for both roadway and shoulders shall be the responsibility of the Contractor until overlying pavement is complete and accepted by the Engineer. This maintenance shall be considered subsidiary to the items for which direct payment is provided.

301.02 -- Equipment

1. Operation:
 - a. All equipment shall be kept in satisfactory working condition.
 - b. Equipment shall be operated within the manufacturer's specifications.
 - c. The Contractor shall perform the tests and calibrations on all equipment. In the event problems are encountered during the tests and calibrations, the Contractor shall arrange for a trained technician or company representative to make the necessary repairs or adjustments to the equipment. Calibrations shall be made as often as is deemed necessary by the Engineer, at no additional cost to the Department.
2. The hauling equipment shall consist of trucks equipped for dumping material into spreader boxes or in a windrow. They shall be constructed and maintained to prevent loss of materials during hauling operations.
3. Water Distributors:
 - a. The distributor equipment shall provide accurate and uniform distribution of water. The control valves shall close fully to prevent leakage.
 - b. Water will be measured through a meter or with calibrated tanks in gallons (liters). The weight of the water can also be measured and converted to Megagallons (kiloliters).
4. The equipment used for profiling the subgrades, base courses, and foundation courses shall be capable of meeting Construction Methods.
5. Only compacting equipment and methods which will consistently produce the compaction specified throughout the depth of the compacted lifts shall be used. Compacting equipment which produces laminations within the compacted lifts will not be allowed.
6. Equipment used to spread the material shall be capable of distributing the material uniformly.
7. Equipment for weighing loaded trucks shall comply with requirements given in Subsection 503.03.

SECTION 302 -- SUBGRADE PREPARATION, SHOULDER SUBGRADE PREPARATION, AND PREPARATION OF INTERSECTIONS AND DRIVEWAYS

302.01 -- Description

1. The Contractor shall complete the following requirements under the "Subgrade Preparation" or "Preparation of Intersections and Driveways" bid item:

a. (1) Furnish and place subgrade materials as shown in the contract.

(2) Bring the roadbed to the plan profile when the following conditions are met:

(i) The roadbed was graded under a separate contract or an existing grade.

(ii) The grade is less than 0.20 foot (60 mm) low.

(iii) The material is available on the right-of-way within the minimum free haul distance specified in Section 209.

b. Adjust grade lines to meet intersections, pavements, bridge ends, railroad crossings, or any other physical features designated by the Engineer.

c. Lower the grade, if necessary, to provide adequate width.

d. Dispose of surplus, excavated material within the right-of-way or the free haul distance.

e. Scarify, mix, adjust the moisture content, shape, and compact the soils as necessary to conform to the contract.

2. Under the bid item "Shoulder Subgrade Preparation", the Contractor shall complete, the adjustment of the shoulder elevations and the construction of the earth portion of the shoulder outside the surfaced shoulder width to conform to the typical cross sections shown in the contract, in addition to the above requirements for "Subgrade Preparation".

302.02 -- Material Requirements

1. Soils shall meet the requirements described in Subsection 205.02.

302.03 -- Construction Methods

1. The Contractor shall shape the subgrade to the typical cross sections shown in the contract. In the event the subgrade width is less than the width shown on the typical cross sections, the widening shall be accomplished by either:

a. Lowering the grade.

b. Placing additional embankment on the shoulder slopes.

2. Embankments will be constructed in accordance with Section 205.

a. Widening by placement of additional embankment material on the shoulder slopes to provide the minimum width will be allowed only if the existing slope is 1 vertical to 4 horizontal or flatter.

b. After placing, shaping, and compacting the material, the slope shall be no steeper than the slope shown in the contract.

3. After stepping and shaping the slopes, the Contractor shall scarify the upper 6 inches (150 mm) of the subgrade in all areas to be surfaced.

a. The scarified material shall be completely mixed vertically and horizontally to ensure a uniform material throughout the area to be surfaced.

b. Immediately before placing material on the subgrade, all areas to be surfaced shall be shaped and compacted. The upper 6 inches (150 mm) of the subgrade in these sections shall conform to the cross section requirements shown in the contract.

4. If, after the upper 6 inches (150 mm) of the subgrade has been thoroughly mixed, sections of the subgrade are too sandy to provide a firm and stable foundation for the subsequent construction operations, these sections shall be stabilized, in accordance with the requirements of Section 303, using cohesive soil from sources approved by the Engineer.

5. "Preparation of Intersections and Driveways" shall also include salvaging, stockpiling, and reapplying the salvaged aggregate beyond the surfaced area.

6. Excess excavated material may be wasted, used for filling eroded shoulder slopes, flattening embankment slopes, or temporarily stored for use in shoulder construction. Material stored for shoulder construction shall be placed so that it will always be adequately drained. Ditch drainage in cut sections shall be maintained.

7. In sandy regions, the Contractor shall compact the shoulder subgrade and then place the surface material with a shoulder widener which rides on the traveled way.

8. The Contractor shall profile all subgrades after they are properly compacted.

a. Profiling for Flexible and Rigid Pavement:

(1) Subgrades shall be profiled with an automated, electronically controlled machine. The machine must provide accurate vertical and horizontal control. Profiling is done before placement of:

- (i) Flexible pavement.
- (ii) Rigid pavement.
- (iii) Foundation and base courses.

(2) The described elevation for any point shall be based on the specified line, grade, and cross section information. The Contractor shall dispose of excess material removed in profiling.

(3) When profiling the subgrade of a mainline roadway, a reference line shall be located along both outer edges of the section being profiled. The reference line shall be maintained until the specified tolerances have been attained, except when stringless profiling is used.

b. Profiling for Shoulders:

(1) A motorgrader with automatic blade control may be used for profiling shoulders and medians.

(2) The existing roadway surface may be used as a reference when profiling shoulders.

302.03 **Subgrade Preparation, Shoulder Subgrade Preparation, and Preparation of Intersections and Driveways**

(3) When the traveled way does receive an overlay or an entirely new surface, then at least one lift of the surface course shall be placed and used as the reference for profiling the shoulder.

c. Profiling for driveways, intersections and irregular areas:

(1) A motorgrader with automatic blade control may be used for profiling driveways, intersections and irregular areas.

d. Automated profiling equipment will not be required for intersections, driveways, irregular areas, narrow areas or roadway grading of 1/2 mile (0.8 km) or less.

9. The final profile shall match the plan profile with a tolerance of ± 0.05 foot (15 mm) for each point, and the distance between any two points when measured perpendicular to the plan profile shall not exceed 0.05 foot (15 mm).

302.04 -- Method of Measurement

1. When the unit for payment is the square yard (square meter):

a. The quantity for payment of Subgrade Preparation will be the number of overlying square yards (square meters) of rigid or flexible pavement, including intersections and driveways.

b. Deductions will be made for all areas not prepared.

2. When the unit of payment is the station, "Subgrade Preparation" and "Shoulder Subgrade Preparation" are measured as follows:

a. Stations shall be measured horizontally along the project centerline between the beginning and ending points.

b. Full length stations will be 100 feet (100 m).

c. Deductions will be made for all areas not prepared.

d. The areas outside the plan typical cross sections, except intersections and driveways, will not be measured for payment but shall be considered subsidiary to "Subgrade Preparation" or "Shoulder Subgrade Preparation".

e. Each shoulder will be measured separately in stations of 100 feet (100 m) without regard to width. Stations will be measured horizontally along the project centerline between the beginning and ending points. Areas where no shoulder is required are deducted from the total measured length of shoulder.

3. Preparation of Intersections and Driveways:

a. Preparation of intersections and driveways, including compacting the subgrade and adjusting grade lines for intersections and driveways, will be measured by the square yard (square meter) for the areas outside the surfaced traveled way roadbed.

b. The work of salvaging, stockpiling, and replacing the existing aggregate surfacing on intersections and driveways will not be measured for payment but will be considered subsidiary to "Preparation of Intersections and Driveways".

4. Water will be measured by the gallon (liter), applied in increments of 1,000 gallons (MGAL) [Kiloliter]. Excess or wasted water will be estimated by the Engineer and deducted from the volume applied.

302.05 -- Basis of Payment

1. Pay Item	Pay Unit
Subgrade Preparation	Station (Sta) [StaM]
Subgrade Preparation	Square Yard (SY) [Square Meter (m ²)]
Preparation of Intersections and Driveways	Square Yard (SY) [Square Meter (m ²)]
Shoulder Subgrade Preparation	Station (Sta) [StaM]
Shoulder Subgrade Preparation	Square Yard (SY) [Square Meter (m ²)]
Water	1,000 Gallons (MGAL) [Kiloliter (kL)]

2. When subgrade stabilization is necessary but not shown in the contract, furnishing cohesive soil for subgrade stabilization will be considered "extra work".

3. The work of adjusting shoulder subgrade elevations and constructing the earth portion of the shoulders will not be paid for directly but shall be considered to be subsidiary to shoulder subgrade preparation.

4. The disposal of surplus excavated material will be paid for as "extra work" when the following conditions exist:

- a. The roadbed was graded under a separate contract.
- b. The required excavation exceeds 0.20 foot (60 mm).
- c. Suitable disposal areas are not located within the minimum free haul distance specified in Section 209.

5. In all cut areas, those fill areas graded under a separate contract, and under existing approach slabs, the work of correcting faulty subgrade conditions below 6 inches (150 mm) in depth will be done as "extra work" unless such conditions are caused by the Contractor's operations.

6. Payment is full compensation for all work described in this Section.

SECTION 303 -- SUBGRADE STABILIZATION

303.01 -- Description

1. The Contractor shall complete the following requirements under the "Subgrade Stabilization" bid item:
 - a. Provide and place soil binder (cohesive soil).
 - b. Mix soil binder into non-cohesive sand in the upper subgrade.
 - c. Adjust grade lines to meet intersections, pavements, bridge ends, railroad crossings, or any other physical features.
 - d. Dispose of surplus excavated or profiled material.
 - e. Scarify, adjust the moisture, shape, and compact soils as is necessary to conform to the contract.

303.02 -- Material Requirements

1. Soil binder shall conform to the requirements of Section 1034.
2. Soil binder shall be obtained according to the requirements of Subsection 205.02.

303.03 -- Construction Methods

1. The Contractor shall number, label, tally, and prepare a report of quantities and distribution of the materials delivered. A copy of the report shall be given to the Engineer at the end of each day when hauling materials.
2. When the grading is complete, the Engineer will determine the quantity of soil binder the Contractor shall provide to stabilize subgrade sand.
3. Soil binder shall be pulverized to the extent that at least 90% will pass a 1/2 inch (12.5 mm) sieve and at least 60% will pass a No. 10 (2 mm) sieve. The binder shall be pulverized before it is mixed with the subgrade sand.
4. After the Contractor has thoroughly mixed the soil binder with the subgrade sand, the upper 6 inches (150 mm) of the subgrade shall be compacted to the optimal stiffness as defined by a deflection target value established by the Engineer. Moisture may be added as necessary to obtain proper compaction. The moisture target value for granular materials shall be established in the field by the Contractor during the compaction process and may be adjusted at the discretion of the Engineer. Once established the target moisture shall not vary by more than +2%.
5. After the Contractor attains the required stiffness, the stabilized subgrade shall be profiled in accordance with the requirements of Subsection 302.03.
6. In all cut areas and those fill areas graded under a separate contract, correcting faulty subgrade conditions below the 6 inch (150 mm) depth will be performed as "extra work" unless such conditions are caused by the Contractor's operations.

303.04 -- Method of Measurement

1. Water will be measured as described in Subsection 302.04.

2. Soil Binder will be measured for payment by the cubic yard (cubic meter) when it is delivered. The Contractor shall level the material even with the top of the truck's cargo box to allow accurate volume measurement.

3. Subgrade Stabilization will be measured in stations of 100 feet (100 m). Stations shall be measured horizontally along the project centerline between the beginning and ending points. Deductions will be made for all areas not stabilized with soil binder.

The work of stabilizing subgrade outside the width shown in the typical cross section in the contract, including intersections and driveways, will be measured for payment in equivalent stations. The number of stations for which payment will be made will be the quotient that is obtained by dividing the surface area of the work outside the typical section by the surface area of one station of the adjacent roadway.

303.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|------------------------|--|
| Soil Binder | Cubic Yard (CY)
[Cubic Meter (m ³)] |
| Subgrade Stabilization | Station (Sta) [Station (StaM)] |
| Water | 1,000 Gallons (MGAL)
[Kiloliter (kL)] |
2. Payment is full compensation for all work described in this Section.

SECTION 304 -- EARTH SHOULDER CONSTRUCTION

304.01 -- Description

The Contractor shall complete the following requirements under the "Earth Shoulder Construction" bid item:

1. Furnish and excavate the embankment material.
2. Haul, compact, blade, and shape the material to conform to the contract's typical cross sections and compaction requirements.
3. Construct embankments as necessary to adjust the grade line of intersecting roads and driveways to meet the elevation of the new shoulder surfaces.

304.02 -- Material Requirements

1. The Contractor shall be required to obtain and furnish material unless otherwise shown in the contract.
2. Soils shall meet the requirements described in Section 205.

304.03 -- Construction Methods

1. The Contractor shall construct earth shoulders in accordance with the requirements of Sections 201 and 205.

2. When the final elevation of the traveled way is different from the elevation of intersecting roads and driveways, the Contractor shall adjust the grade line of intersecting roads and driveways to meet the elevation of the new surfaces. The existing grade line will be adjusted 5 feet horizontally for each inch (2 m horizontally for each 35 mm) of vertical change in the surfacing elevation.

3. During shoulder construction, the embankments shall be adequately drained to prevent damage to the pavement structure.

4. Shoulder materials shall not be placed along the traveled way more than 15 days ahead of their intended use. The shoulder material may be placed near the edge of pavement overnight provided it is graded and compacted in a manner so that a vehicle can drive safely over it.

5. The Contractor shall construct shoulders to the typical cross sections shown in the contract.

a. The shoulder shall be tight bladed using a motorgrader to remove any vegetation. The underlying subgrade shall be scarified to a depth of 6 inches (150 mm) and then compacted with at least two complete coverages over the area with an approved roller.

b. Shoulder construction shall match the existing width and fill slope or plan section widths, whichever is widest.

6. Earth Shoulders (Asphaltic Concrete Surfacing)

a. When a beveled edge is required and installed in accordance with contract, the earth shouldering shall begin and be completed within the following time limits:

(1) The latest the Contractor shall begin "Earth Shoulder Construction" is the eighth calendar day of placement of the top layer of asphalt pavement.

(i) The Engineer will suspend the Contractor's asphalt placement operation if shoulder construction is not started within this time.

(2) Should the Contractor discontinue asphaltic concrete placement, shoulder construction shall begin by the sixth calendar day after the Contractor stopped asphalt placement. The Contractor shall complete the shoulder work in the areas paved within 10 working days.

(3) Shoulder work will not be considered to have started until soils are placed, graded, and compacted for at least 1,500 feet (500 m).

(4) After the entire top layer of asphalt is placed, the Contractor has the time shown in Table 304.01 below to complete the shoulders:

Table 304.01

Time Allowed to Complete Shoulders	
Length of Pavement miles (Kilometers) [Entire Project]	Maximum Working Days Allowed to Complete Shoulder
0 to 3.0 (0 to 4.8)	8
More than 3.0 to 4.0 (4.8 to 6.4)	9
More than 4.0 to 5.0 (6.4 to 8.0)	10
More than 5.0 to 6.0 (8.0 to 9.7)	11
More than 6.0 to 7.0 (9.7 to 11.3)	12
More than 7.0 (11.3)	13*

* 13 plus 1 day for every whole 2 miles of project length in excess of 7 miles.

b. Liquidated Damages:

(1) If shoulder construction has not been started by the end of the eighth day of placement of the top pavement lift, liquidated damages in the amount of \$500 per calendar day will be assessed beginning on the ninth day. These liquidated damages will continue to be assessed until the Contractor starts shoulder construction. The Engineer may waive these liquidated damages because of weather and soil conditions.

(2) Failure to complete earth shoulders within the described time limit shown in Paragraphs 6.a.(1) and 6.a.(4) of this Subsection, shall be cause for the assessment of liquidated damages in the amount of \$500 per calendar day until the earth shoulders are completed. "Completion of the Earth Shoulders" shall be defined as the time when all of the required material has been placed, compacted, and the top surface shaped to the finish grade along the main traveled way.

(3) The Engineer will exclude shoulder requirements for asphalt placed in urban areas, intersections and driveways, and minor isolated areas [less than 600 SY (500 m²)] in the determination of the maximum number of working days to complete the shoulders shown in Table 304.01 and the determination of the latest date the Contractor can start shoulder construction in Paragraph 6.b.(1) of this Subsection.

(4) The assessment of all liquidated damages described in Section 304 shall be in addition to any applicable liquidated damages assessed in accordance with Subsection 108.08.

(5) When asphaltic concrete and earth shoulders are being placed on a multilane, divided highway, the provisions of Paragraph 6 of this subsection shall be applied to each roadway separately.

c. If a beveled edge is not used – or is used but fails to eliminate a vertical drop off greater than 2 inches – then the earth shouldering shall begin and be completed along those portions of roadway within the time limits listed in Paragraphs 6. a. and b. except that three (3) working or calendar days will be subtracted from all of the working or calendar day time limits.

(1) The same liquidated damage values listed in Paragraph 6. b. (1) will be applied if these reduced time limits are violated.

7. Placement and Compaction:

a. The Contractor shall place embankment material in successive horizontal layers not exceeding 6 inches (150 mm) in depth before rolling. Each layer will extend the full width of the embankment and shall be leveled before compaction.

b. Each layer of embankment material shall be compacted with at least 2 complete coverages over the area with an approved multiple wheel, pneumatic-tired roller meeting the requirements of Subsection 205.03, Paragraph 14.c.(2).

c. Water may be added to the embankment material to facilitate compaction.

d. When the moisture content of the soil used in constructing shoulders is too high to allow rolling or to obtain satisfactory compaction, each layer shall be disced, harrowed, or otherwise manipulated to facilitate drying.

8. The Contractor shall correct any pavement damage that results from shoulder construction activities.

9. The Contractor shall clean the surfaced areas with mechanical brooms before opening a lane to traffic. Mechanical brooms shall conform to the requirements of Section 501.

304.04 -- Method of Measurement

1. Each shoulder will be measured separately in stations of 100 feet (100 m) without regard to width.

a. Stations shall be measured horizontally along the project centerline between the beginning and ending points.

b. Deductions will be made for all areas where shoulders are not required. Intersecting roads and driveways are not exceptions.

c. Additional length of shoulder construction due to intersection returns, tapers, curves, tangents, stubs, driveways, and other irregular areas shall be considered subsidiary to "Earth Shoulder Construction".

d. Shoulder construction will be measured without regard for the width or depth of the work.

2. Water applied at the direction of the Engineer will be measured in accordance with Subsection 302.04.

304.05 -- Basis of Payment

1. Pay Item	Pay Unit
Earth Shoulder Construction	Station (Sta) [Station (StaM)]
Water	1,000 Gallons (MGAL) [kiloliter (kL)]

2. Preparing the shoulder by blading, scarifying, compacting, and disposing of removed material shall be considered subsidiary to "Earth Shoulder Construction".

3. Shoulder construction behind newly constructed curbs is paid for, but the material that is placed on top of the shoulder to make a smooth transition from the top of the new curb to the shoulder surface is subsidiary.

4. Embankment materials necessary to construct shoulders are subsidiary to shoulder construction.

5. Payment is full compensation for all work described in this Section.

SECTION 305 -- CRUSHED ROCK BASE COURSE

305.01 -- Description

1. The Contractor shall complete the following requirements under the "Crushed Rock for Base Course" and "Crushed Rock Screenings for Base Course" bid items:

a. Furnish, place, shape, and compact a course of crushed rock or crushed rock screenings on a profiled subgrade

305.02 -- Material Requirements

1. Crushed rock and crushed rock screenings for the crushed rock base course shall conform to the requirements of Subsection 1033.02, Paragraphs 1, 2, and 8; and Table 1033.09.

305.03 -- Construction Methods

1. The Contractor shall windrow the material to maintain uniform particle distribution. The Contractor shall exercise particular care in loading, hauling, and distributing the crushed rock to avoid segregation of the coarse and fine particles. Windrowing may be waived if the rock particle distribution is uniformly maintained.

2. The Contractor shall spread crushed rock screenings for the base course uniformly over the prepared subgrade and then moisten and compact them.

3. The crushed rock for base course shall then be hauled, distributed, spread, and compacted in such a manner as to avoid displacement of the underlying layer of screenings.

4. After the crushed rock has been placed on the roadbed, the Contractor shall spread it uniformly over the width of the proposed base course. Water shall be applied as necessary to facilitate compaction and bonding of the materials.

5. The Contractor shall roll the Base Course until no further compaction can be obtained.

6. The Contractor shall spread a final light application of crushed rock screenings uniformly over the surface of the base course to close large voids and provide a smooth and uniform surface. The final finish of the base course shall be obtained by rolling with the multiple-wheeled, pneumatic-tired roller to produce a smooth, tightly-knit surface. Water shall be added as necessary to achieve the surface finish.

305.04 -- Method of Measurement

1. The weight of crushed rock will be measured on approved scales.

2. A copy of the weight ticket shall accompany each load to the placement site and be furnished to the Engineer.

3. Water applied will be measured in accordance with Subsection 302.04.

305.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|--|
| Crushed Rock for Base Course | Ton (Tn)
[Megagram (Mg)] |
| Crushed Rock Screenings for
Base Course | Ton (Tn)
[Megagram (Mg)] |
| Water | 1,000 Gallons (MGAL)
[kiloliter (kL)] |
2. Payment is full compensation for all work described in this Section.

SECTION 306 -- GRANULAR FILL

306.01 -- Description

1. The Contractor shall complete the following requirements under the "Granular Fill" bid item:

a. Furnish and place a layer of compacted granular material. The granular fill shall be constructed in accordance with these Specifications and in conformity with the lines, grades, quantity requirements, and cross sections shown in the contract.

306.02 -- Material Requirements

1. The granular material shall meet the requirements in Subsection 1033, and Table 1033.02, Class B, unless specified otherwise in the contract.

306.03 -- Construction Methods

1. The Contractor shall haul the granular fill material to the road, spread it in uniform layers, and compact it to not less than 100% of maximum density as determined by NDOT T 99.

2. Any portion of the granular fill which is to be used as aggregate in a bituminous sand base course mixture need not be compacted.

3. This work shall be performed in accordance with the requirements in Subsection 205.03.

306.04 -- Method of Measurement

1. The Contractor shall number, label, and tally the delivery tickets and then prepare a report of the quantities and distribution of the materials. A copy of the report shall be given to the Engineer at the end of each day when hauling materials.

2. Granular material shall be measured in cubic yards (cubic meters) at the point of delivery. The Contractor shall level the material even with the top of the truck's hauling box to allow accurate volume measurement.

3. Instead of leveling the material in the hauling vehicles, the Contractor may heap the loads to an agreed volume.

4. Water applied at the Engineer's direction will be measured in accordance with Subsection 302.04.

306.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---------------|---|
| Granular Fill | Cubic Yard (CY) [Cubic Meter (m ³)] |
| Water | 1,000 Gallons (MGAL) [kiloliter (kL)] |
2. Payment is full compensation for all work described in this Section.

SECTION 307 -- FOUNDATION COURSE

307.01 -- Description

1. The foundation course is a layer of compacted material conforming to the lines, grades, and dimensions shown in the contract. The foundation course shall be built on a finished subgrade. The Contractor shall complete the following requirements under the foundation course bid items including but not limited to:

a. Adjust grade lines to meet intersections, pavements, bridge ends, railroad crossings, or any other physical features designated by the Engineer.

b. Process the source material.

c. Placement of the foundation course.

d. Compaction of the foundation course.

e. Profiling the foundation course.

f. Disposal of excess material after profiling is completed.

2. The types of foundation course are:

a. Bituminous.

b. Crushed concrete.

c. Aggregate Foundation Course - D.

307.02 -- Material Requirements

1. a. All samples, including field samples, will be washed sieve. All samples will be taken from the project grade prior to the spreading operations.

b. The Contractor shall handle all material in such a manner that prevents contamination.

2. Bituminous Foundation Course:

a. Material used in constructing bituminous foundation course shall consist of salvaged bituminous material. The source of the salvaged bituminous material will be described in the contract.

b. All salvaged bituminous material must be less than 3 inches (75 mm) in maximum dimension and shall not contain more than 5% by weight of material retained on a 2 inch (50 mm) sieve just prior to its use.

(1) Contractor Production

(i) All salvaged bituminous material produced by the Contractor from pavement removal or by cold milling material from the existing pavement structure on the project, whether hauled directly to the site of use or temporarily stockpiled, shall be screened to meet the requirements of Paragraph 2.b.

(ii) If, after screening, there is insufficient material to produce the plan quantity, the Engineer may order the oversized salvaged bituminous material to be further processed at no cost to the State prior to delivery to the roadway. Processing shall mean crushing, pulverizing, re-screening, or a combination of these methods.

(iii) On projects that allow multiple foundation course materials to be used, the Engineer may direct that salvaged bituminous material continue to be placed as bituminous foundation course to the extent this material is available and can be utilized on the project.

(iv) Unless otherwise shown in the contract, all Contractor produced salvaged bituminous material, including oversized, remaining at the end of the bituminous foundation course operation shall become the property of the Contractor and removed from the project.

(v) Asphaltic concrete millings shall be free of deleterious matter as determined by the Engineer.

(2) Department Provided Stockpiles

(i) If the salvaged bituminous material is to be obtained from existing stockpiles described in the contract, the salvaged bituminous material shall be screened to meet the requirements of Paragraph 3.b. prior to delivery to the roadway. Any oversized bituminous material remaining from the screening operation shall remain the property of the Department.

(ii) If, after screening, there is insufficient material to produce the plan quantity, the Engineer may order the oversized bituminous material to be further processed prior to the delivery to the roadway. Processing shall mean crushing, pulverizing, re-screening, or a combination of these methods. This will be paid for as extra work.

3. Crushed Concrete Foundation Course:

a. Material used in constructing crushed concrete foundation course shall consist of processed and stockpiled concrete pavement. The source of the materials for the crushed concrete will be described in the contract. Crushed Concrete shall be free of deleterious matter as determined by the Engineer.

b. All samples will be taken from the project grade prior to spreading and trimming. The crushed concrete gradation shall be determined as described in NDOT T 27 (washed test). The target gradation requirement for the crushed concrete foundation course is shown in Table 307.01 Material represented by samples with 15% or more passing the No. 200 (75 μ m) sieve will be subject to removal.

c. Material gradation will be accepted by the table below on a lot basis of 2,500 cubic yards on the average of 5 consecutive tests, one for each 500 cubic yard subplot. If at the end of the project, the final lot consists of less than 2,500 cubic yards, a minimum of 3 samples, or 1 sample for each 500 cubic yards or fraction thereof, whichever is greater shall be taken and tested and acceptance based on the average of those tests.

Table 307.01

Crushed Concrete Foundation Course Gradation Requirements	
Sieve Size	(Percent Passing)
1½ inch (37.5 mm)	100 minimum
¾ inch (19.0 mm)	85 maximum
No. 4 (4.75 μ m)	20 to 50
No. 200 (75 μ m)	0 to 8

d. Moisture content shall be no higher than necessary to facilitate compaction to required stiffness.

4. Aggregate Foundation Course-D

a. Aggregate Foundation Course-D shall be a non-recycled virgin material.

b. Aggregate shall conform to the quality requirements of Section 1033.

c. At least 14 days before beginning foundation course production, the Contractor shall submit a proposed mix design along with a 50 pound (23 kg) sample of each aggregate to the Engineer for approval. The mix design will:

(1) Result in an aggregate mix that meets the gradation requirements of Table 307.02.

(2) Propose single defined values for the percentage passing each sieve on the gradations of Table 307.02.

(3) Include the average aggregate gradations used to calculate the mix design.

(4) Create a fine aggregate angularity value of 43.0 or greater. The specific gravity for calculation of the Fine Aggregate Angularity (FAA) shall be determined on a combined aggregate sample of the material passing the No. 8 (2.36 mm) sieve and retained on the No. 100 (150 µm) sieve as defined in AASHTO T 304 Method A, except the specific gravity material shall be washed over the No. 100 (150 µm) sieve.

d. The Engineer will determine the specific moisture content and rolling pattern needed for optimal stiffness for the proposed foundation course design.

Table 307.02

Aggregate Foundation Course-D Gradation Requirements		
Sieve Size	Target Value (Percent Passing)	Tolerance
1/2 in (12.5 mm)	100	0
3/8 in (9.5 mm)	100	-4
No. 4 (4.75 mm)	93	±4
No. 10 (2.0 mm)	55	±10
No. 30 (600 µm)	25	±5
No. 40 (425 µm)	20	±4
No. 200 (75 µm)	3	±3

307.03 -- Construction Methods

1. Bituminous Foundation Course:

a. The Contractor shall load the bituminous material at locations shown in the contract, haul, screen, distribute, spread, and compact the salvaged bituminous material to form a firm and stable foundation for the construction of the surface. The quantity of bituminous material placed shall be adequate to provide for consolidation and profiling of the entire surface after compaction.

b. The Contractor shall roll the bituminous foundation course until no further compaction can be obtained and roller marks are eliminated.

(1) The Department will establish a rolling pattern and set a deflection target value.

(2) The Department shall monitor the rolling pattern with a light weight deflectometer and as conditions change the rolling pattern may be adjusted by the Engineer to attain optimal stiffness. Additional testing of separately placed irregular areas shall be performed as directed by the Engineer.

(3) The Contractor shall take immediate action to adjust the rolling pattern when the Engineer determines that the foundation course stiffness variance is outside the tolerance of the deflection target value.

2. Crushed Concrete Foundation Course:

a. The Contractor shall crush, load, haul it to the project site, and distribute, place, and compact the crushed concrete to form a foundation course as shown in the contract.

(1) The Contractor shall roll the crushed concrete foundation course until no further compaction can be obtained and roller marks are eliminated.

(2) The Department will establish a rolling pattern and set a deflection target value.

(3) The Department will monitor the rolling pattern with a light weight deflectometer. Additional testing of separately placed irregular areas will be performed as directed by the Engineer.

(4) The Contractor shall take immediate action to adjust rolling pattern when the Engineer determines that the foundation course stiffness variance is outside the tolerance of the deflection target value.

(5) The accuracy of the preparation of the subgrade and the profiling of the crushed concrete foundation course will be such that the profile grade will not vary from the contract by more than 1/2 inch.

3. Aggregate Foundation Course – D:

a. The Contractor shall place, compact, and profile the foundation course as shown in the contract.

b. The foundation course shall be spread in a uniform layer and compacted to optimal moisture as determined by AASHTO T 99.

c. The Department will establish a rolling pattern and set a deflection target value.

d. The Department will monitor the rolling pattern with a light weight deflectometer and as conditions change the rolling pattern may be adjusted by the Engineer to attain optimal stiffness. Additional testing of separately placed irregular areas will be performed as directed by the Engineer.

e. The accuracy of the preparation of the subgrade and the profiling of the aggregate foundation course will be such that the profile grade will not vary from the contract by more than 1/2 inch.

4. Profiling:

a. After the foundation course has been compacted and before the surface is profiled, the thickness shall be measured.

b. If the thickness of the compacted material is insufficient to permit profiling, the deficiency shall be corrected by the placement and compaction of additional material. An adequate bond shall be established between the compacted surface and the new material. A tack coat may be required for cohesion as directed by the Engineer.

c. The profiling operation may be accomplished by milling, if necessary.

d. During the profiling operation, the control of grade and cross slope shall be maintained by the Contractor.

e. The accuracy of the preparation of the subgrade and the profiling of the bituminous foundation course will be such that the profile grade will not vary from the contract by more than 1/2 inch.

f. The grade stakes placed for controlling the profiling operation shall be protected for controlling the pavement operation.

5. Surface Protection:

a. At the Contractor's option, a fog seal may be applied in accordance with the requirements of Section 513.

b. The Contractor shall only allow necessary local traffic and essential construction equipment on the foundation course.

c. The Contractor shall repair or replace marred, distorted, or otherwise damaged foundation course at no additional cost to the Department.

6. Material from the profiling operation may be reused if it meets the material requirements. Material not meeting the material requirements shall be wasted and removed from the project.

307.04 -- Method of Measurement

1. The foundation course will be measured for payment either by weight [tons (megagrams)] or by the square yard (square meter).

2. Foundation course paid for by the square yard (square meter) is not measured directly. The overlying pavement is measured, and the pavement quantity is used as the foundation course quantity.

3. a. Screening of salvaged bituminous material will not be measured for payment.

b. Processing of Contractor produced salvaged bituminous material, ordered by the Engineer, which contains excessive oversized material due to the Contractors production methods, will not be measured for payment.

307.05 -- Basis of Payment

1. Pay Item	Pay Unit
Aggregate Foundation Course _____	Ton (Tn) [Megagram (Mg)]
Aggregate Foundation Course _____	Square Yard (SY) [Square Meter (m ²)]
Bituminous Foundation Course _____	Square Yard (SY) [Square Meter (m ²)]
Crushed Concrete Foundation Course _____	Square Yard (SY) [Square Meter (m ²)]

2. a. If a foundation course is 0.05 to 0.10 foot (15 mm to 30 mm) less than the specified thickness, it shall be removed and replaced; or, at the Contractor's option, the material may be left in place and paid for at 40% of the bid price for the deficient areas. The area of the deficient section shall be determined by the Engineer.

b. Foundation course more than 0.10 foot (30 mm) less than the specified thickness shall be removed and replaced at no additional cost to the Department. The extent of the area to be corrected will be determined by the Engineer.

3. Application of a tack coat shall be subsidiary to the item "Bituminous Foundation Course _____".

4. If the Contractor elects to apply a fog seal, it shall be at no cost to the Department.

5. All water applied to foundation course will not be measured for payment but will be considered subsidiary to the relevant foundation course bid item.

6. Screening of salvaged bituminous material shall be considered subsidiary to the bituminous foundation course item.

7. Processing of salvaged bituminous material, ordered by the Engineer, which contains excessive oversize material due to the Contractors production methods, shall be considered subsidiary to the bituminous foundation course item.

8. If the Contractor is required to reprocess the oversized bituminous material from State stockpiles, the work of reprocessing will be paid for as "extra work".

9. Payment is full compensation for all work described in this Section.

SECTION 308 -- MEDIAN CONSTRUCTION

308.01 -- Description

1. The Contractor shall complete the following requirements under the "Median Construction" bid item:

a. Furnish the embankment material as necessary to conform to the contract.

b. Haul, compact, blade, and shape the material to conform to the contract's typical cross sections and compaction requirements.

308.02 -- Material Requirements

1. The Contractor shall be required to obtain and furnish material unless otherwise shown in the contract.

2. Soil required for embankments shall meet the requirements of Subsection 205.02.

308.03 -- Construction Methods

1. The Contractor shall construct medians as indicated in the contract.

2. The work shall be performed in accordance with the requirements of Subsection 304.03.

308.04 -- Method of Measurement

1. Median Construction shall be measured in stations of 100 feet (100 meters), regardless of width or thickness. Stations shall be measured horizontally along the project centerline between the beginning and ending points.

308.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---------------------|---|
| Median Construction | Station (Sta) [Station (StaM)] |
| Water | 1,000 Gallons (MGAL)
[kiloliters (kL)] |
2. Payment is full compensation for all work described in this Section.

SECTION 309 -- CALCIUM CHLORIDE TREATMENT

309.01 -- Description

1. The Contractor shall complete the following requirements under the "Calcium Chloride Applied" bid item:

a. Furnish and spread calcium chloride for dust control on detours, haul roads, or other areas as shown in the contract.

309.02 -- Material Requirements

1. The calcium chloride shall conform to the requirements of Section 1006.

309.03 -- Construction Methods

1. The Contractor shall apply calcium chloride at the locations described in the contract.

2. The calcium chloride may be applied dry or dissolved in water.

3. The initial application of calcium chloride shall be at a rate of 2 lb/SY (1 kg/m²).

4. Additional calcium chloride shall be applied as needed. The additional applications shall be at the rate and at the time directed by the Engineer.

5. The Contractor shall distribute each application in such a manner and by such devices that uniform coverage is attained.

309.04 -- Method of Measurement

1. Calcium chloride is generally available in grades of varying purity. Calcium chloride will be measured by the ton (megagram) and converted to equivalent mass based on the analyses furnished.

2. The weight, in tons (megagrams), will be determined on approved scales.

309.05 -- Basis of Payment

1. Pay Item

Calcium Chloride Applied

Pay Unit

Ton (Tn) [Megagram (Mg)]

2. Payment will be made for the actual amount of pure calcium chloride applied.

3. Water applied at the direction of the Engineer will be paid for as "Extra Work".

4. Payment is full compensation for all work described in this Section.

SECTION 310 -- ROCK OR GRAVEL SURFACING

310.01 -- Description

1. The Contractor shall complete the following requirements under the surface course bid items:

a. Furnish, deliver, and spread aggregate for surfacing on an approved roadbed surface in accordance with these Specifications.

310.02 -- Material Requirements

1. Crushed rock and gravel shall conform to the requirements of Subsection 1033.02, Paragraphs 1., 2., and 6.

2. Gravel shall conform to the requirements in Table 1033.06.

3. Crushed rock shall conform to the requirements in Table 1033.07.

310.03 -- Construction Methods

1. The Contractor shall deliver rock or gravel to the site specified in the contract or as directed by the Engineer.

2. The Contractor shall spread rock or gravel as shown in the contract or as directed by the Engineer.

310.04 -- Method of Measurement

1. Rock and gravel surfacing material will be measured by weight or volume.

a. The volume, in cubic yard (cubic meter) measurements, will be taken by load count or truck volume measurements at the point where the material is incorporated in the roadway. Unmeasured loads that are to be counted shall be filled to a predetermined volume mark on the truck bed.

b. The weight, in tons (megagrams), shall be determined on approved scales.

310.05 -- Basis of Payment

1. Pay Item	Pay Unit
Gravel Surface Course	Cubic Yard (CY) [Cubic Meter (m ³)]
Gravel Surface Course	Ton (Tn) [Megagram (Mg)]
Crushed Rock Surface Course	Cubic Yard (CY) [Cubic Meter (m ³)]
Crushed Rock Surface Course	Ton (Tn) [Megagram (Mg)]

2. Pay Factor:

a. The Engineer shall take random samples of rock or gravel in accordance with the Materials Sampling Guide.

b. For Gravel and Crushed Rock, the percentage passing the No. 10 (2 mm) sieve for the samples shall be averaged.

c. Payment deductions shall be computed using Table 310.01 and the averaged value of the percent passing the No. 10 (2 mm) sieve.

d. If the material is less than a full lot but more than 400 cubic yards (300 m³) or 540 tons (490 Mg), then one sample for every 200 cubic yards (150 m³) or 270 tons (245 Mg) shall be taken and averaged.

e. If the material is less than 400 cubic yards (300 m³) or 540 tons (490 Mg), then 2 samples will be taken and averaged.

Table 310.01

Gravel and Crushed Rock Surfacing Deductions		
Total Average Percent Passing the No. 10 (2 mm) Sieve		
Min.	Max.	Percent Deduction
0	30	0
31	35	10
36	40	25
41	45	50
46	100	Reject

3. Payment is full compensation for all work described in this Section.

SECTION 311 -- FURNISH ROCK OR GRAVEL

311.01 -- Description

1. The Contractor shall complete the following requirements under the Furnish Gravel or Furnish Crushed Rock bid items:

a. Furnish and deliver the rock or gravel. The point of delivery is shown in the contract or will be indicated by the Engineer.

311.02 -- Material Requirements

1. Crushed rock and gravel shall conform to the requirements of Subsection 1033.02, Paragraphs 1., 2., and 6.

2. Gravel shall conform to the requirements in Table 1033.06.

3. Crushed rock shall conform to the requirements in Table 1033.07.

311.03 -- Construction Methods

1. The Contractor shall deliver the rock or gravel to the locations shown in the contract.

311.04 -- Method of Measurement

1. Rock and gravel surfacing material will be measured by weight or volume.

2. Volume, in cubic yard (cubic meter) measurements, will be taken by load count or truck volume measurements at the point where the material is delivered. Unmeasured loads that are to be counted shall be filled to a predetermined volume mark on the truck bed.

3. The weight, in tons (megagrams), shall be determined on approved scales.

311.05 -- Basis of Payment

1. Pay Item	Pay Unit
Furnish Gravel	Cubic Yard (CY) [Cubic Meter (m ³)]
Furnish Gravel	Ton (Tn) [Megagram (Mg)]
Furnish Crushed Rock	Cubic Yard (CY) [Cubic Meter (m ³)]
Furnish Crushed Rock	Ton (Tn) [Megagram (Mg)]

2. Pay Factor:

a. The Engineer shall take five random samples of rock or gravel in accordance with the Materials Sampling Guide.

b. For Gravel and Crushed Rock, the percentage passing the No. 10 (2 mm) sieve for the five samples shall be averaged.

c. Payment deductions shall be computed using Table 311.01 and the averaged value of the percent passing the No. 10 (2 mm) sieve.

d. If the material is less than a full lot but more than 400 cubic yards (300 m³) or 540 tons (490 Mg), then one sample for every 200 cubic yards (150 m³) or 270 tons (245 Mg) shall be taken and averaged.

e. If the material is less than 400 cubic yards (300 m³) or 540 tons (490 Mg), then 2 samples will be taken and averaged.

Table 311.01

Gravel and Crushed Rock Surfacing Deductions		
Total Average Percent Passing the No. 10 (2 mm) Sieve		
Min.	Max.	Percent Deduction
0	30	0
31	35	10
36	40	25
41	45	50
46	100	Reject

- 3. Payment is full compensation for all work described in this Section.

SECTION 312 -- REMOVAL AND PROCESSING OF CONCRETE PAVEMENT

312.01 -- Description

1. The Contractor shall complete the following requirements under the "Remove Concrete Pavement" bid item:

a. Breaking, removing, hauling, and stockpiling Portland cement concrete pavement.

312.02 -- Material Requirements

1. The Portland cement concrete shall be broken into pieces having a maximum dimension of 4 feet.

2. Care shall be taken during the removal, crushing, and screening operations to avoid the inclusion of dirt or other deleterious matter in the crushed product.

312.03 -- Construction Methods

1. The pavement to be broken and removed will be shown in the contract.

2. Joint Material Removal:

a. Before removing concrete pavement, the Contractor shall remove the preformed cellular flexible polyurethane and all other joint materials from all joints in all sections of the project.

b. The Contractor shall dispose of all joint materials in accordance with all applicable laws and regulations.

3. All reinforcing steel and wire mesh that is dislodged during the removal operation shall be collected and become the property of the Contractor.

4. The Contractor shall stockpile the broken concrete at the site shown in the contract. It will be shown in the contract if Department property is used for a crushing and stockpiling site. If Department property is used, the Contractor shall clean up and remove from the area all debris, reinforcing steel, and scattered pieces of concrete remaining from the operations; and the work area shall be left in a neat and presentable condition.

312.04 -- Method of Measurement

1. "Remove Concrete Pavement" will be measured by the square yard (square meter) of pavement prior to it being broken and removed.

312.05 -- Basis of Payment

1. **Pay Item**

Pay Unit

Remove Concrete Pavement

Square Yard (SY)
[Square Meter (m²)]

2. Deductions from the payment quantity will be made for any equivalent area that is not broken to the required size. The Engineer will determine the equivalent area.

3. Payment is full compensation for all work described in this Section.

SECTION 313 -- CRUSHED ROCK EMBEDMENT

313.01 -- Description

1. The work shall consist of spreading, scarifying, blending and compacting and top dressing a layer of crushed rock into the subgrade as shown in the contract.

313.02 -- Material Requirements

1. Crushed rock for embedment shall conform to the requirements of Table 1033.07.

2. Crushed rock for embedment shall have a less than a 40% loss at the end of 16 cycles of the freeze thaw test.

3. The Contractor may substitute crushed concrete for the crushed rock. Crushed concrete shall conform to the gradation requirements of Crushed Concrete Foundation Course.

313.03 -- Construction Methods

1. The Contractor shall deliver and spread the rock in a uniform layer to the site specified in the contract or as directed by the Engineer.

2. Water shall be added as necessary to facilitate compaction.

3. After the Crushed Rock Embedment is completed, the Contractor shall place and spread 1 inch of Crushed Rock Surface Course on the roadway. Additional Crushed Rock Surface Course shall be placed and spread during the life of the project as directed by the Engineer.

313.04 -- Method of Measurement

1. Crushed Rock Embedment will be measured by the Square Yard (Square Meter) of completed and accepted work.

2. Crushed rock used for Crushed Rock Embedment and Crushed Rock Surface Course will be measured by the Ton (Megagram).

3. Water will be measured by the Mgallon (kL) applied. Excess or wasted water will be estimated by the Engineer and deducted from the volume applied.

313.05 -- Basis of Payment

1. Pay Item

Pay Unit

Crushed Rock Embedment

Square Yard (SY)
[Square Meter (m²)]

Crushed Rock Surface Course

Ton (Tn) [Megagram (Mg)]

Water

1,000 Gallons (MGAL)
[kiloliter (kL)]

2. Crushed rock will be paid for in accordance with Section 310 of the Standard Specifications

3. Payment is full compensation for all work described in this Section.

**DIVISION 400 -- LIGHTING, SIGNS, AND
TRAFFIC CONTROL**

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SECTION 401-- LIGHTING, TRAFFIC SIGNAL AND INTELLIGENT TRANSPORTATION SYSTEM (ITS) DEVICE GENERAL REQUIREMENTS

401.01 -- Description

1. The requirements in this Section apply when the Contractor furnishes or installs all or part of the following systems:

- a. Sign lighting system.
- b. Traffic signal system.
- c. Permanent lighting system.
- d. Temporary lighting system.
- e. ITS Devices.

2. When the pay item listed in the Basis of Payment Subsection of each Section includes the word "Install", then the Department will furnish the item and the Contractor shall install it. If the word "Install" is not in the pay item listed in the Basis of Payment Subsection of each Section, then the Contractor shall furnish and install the item.

3. Specifications for State supplied items are available for viewing at the Nebraska Department of Transportation Construction Office, Room 104, 1500 Nebraska Highway 2, Lincoln, Nebraska.

401.02 -- Material Requirements

1. Prior to ordering any material, the Contractor shall submit to the Engineer, for review, 8 copies of a list showing all roadway lighting system, sign lighting system, traffic signal system and ITS device items to be used on the project. This list of items shall be known as the "Materials List." A separate material list shall be submitted for each system involved. Material Lists combining items from different systems will be returned without review for resubmittal as separate Material Lists. No shop drawings or certificates of compliance will be reviewed without first having received the correct Materials List.

2. All equipment and material must be reviewed before installation. Once reviewed, there shall be no substitutions for any of the items on the "Materials List" without a prior written request for a substitution and written approval by the Engineer. The Department shall not be liable for any equipment or materials ordered or purchased by the Contractor before review.

3. The Contractor shall provide 8 sets of submittals as required by Table 401.01. These submittals will be reviewed for compliance with the contract. Materials to be incorporated into the project will be checked for compliance with the reviewed submittals.

4. The Contractor shall transfer all manufacturer's warranties and guarantees to the Department. All manufacturers' warranty and guarantee documentation and all operation and parts manuals shall also be given to the Department.

5. All items shown on the "Materials List" will be reviewed for compliance with the contract. Two copies of the reviewed "List" will be returned to the Contractor. Review does not relieve the Contractor if submittals differ from the contract. If sufficient data is not available to

**Lighting, Traffic Signal and Intelligent Transportation
System (ITS) Device General Requirements**

401.02

determine compliance, additional data will be requested in the form of catalog cuts, test data, or actual samples.

6. The Contractor shall inform his/her suppliers that all items supplied to the project must be suitably stamped, stenciled, tagged, or otherwise marked to allow for easy identification with the descriptive markings, brand names, and catalog numbers shown on the "Materials List" and shop drawings.

7. The Contractor shall furnish samples, upon request, of any item or material to be furnished on the project. Unless destructive testing is required, the sample will be returned.

Table 401.01

Required Submittals					
Item	Mfr.'s Model or Cat. No.	Shop Drawings	Certificate of Compliance	Other	
a. Traffic Signal Pole		X	X		
b. Light Pole/Tower (Metal)		X	X		
c. Pole (Wood)					*
d. Anchor Bolt		X	X		
e. Pull Box	X				
f. Luminaire	X				**
g. Photo Control	X				
h. Power Foundation	X	X			
i. Traffic Signal Controller	X				
j. Street Lighting Control Cabinet	X				
k. Signal Head	X				
l. Ped. Pushbutton and Sign	X				
m. Signal Mounting	X				
n. Relay & Cabinet	X				
o. Disconnect & Cabinet	X				
p. Vehicle Detector	X				
q. Vehicle Detector Sealant	X				
r. Lamp	X				
s. Electrical Wire and Cable	X				
t. Conduit	X				
u. Ground Rod	X				
v. Mechanical Connector	X				
w. Fuse Holder	X				
x. Fuse	X				
y. Expansion Coupling	X				
z. Lightning Arrestor	X				
aa. Recessed Junction Box	X				
bb. Utility Pedestal	X				
cc. Breakaway Device	X				
dd. Grounding Connector	X				
ee. Permanent Identification Tag	X				
* Manufacturer's data describing specie, size, class, and treatment.					
** Photometric data base in standard IES format.					

8. All materials shall conform to the requirements of Table 401.02.

Table 401.02

Material Requirements	
<u>Item</u>	<u>Section</u>
Portland Cement Concrete	1002
Reinforcing Steel	1020
Gray Iron Castings	1051
Zinc Coating on Hardware	1059
Painting	1077
Light Standards	1073
Traffic Signal Standards	1073
Anchor Bolts	1073
Ground Rods	1073
High Mast Towers	1073
Control Centers	1073
Photoelectric Controls	1073
High Mast Luminaires and Lamps	1073
Wall Mounted Luminaires	1073
Electrical Wire and Cable	1073
Miscellaneous Materials	1073

9. The Contractor shall submit the following signed certification upon completion of lighting and traffic signal work.

“The lighting and traffic signal materials installed are the materials specified in the contract or identified on reviewed submittals. These lighting and traffic signal materials have been installed in accordance with the contract, National Electric Code and other appropriate electrical safety codes.”

10. All payments for lighting and traffic signal items will be deducted if the certification statement identified above is not received by the Project Manager.

401.03 -- Tests of Lighting Systems

1. The Contractor shall demonstrate to the Engineer's satisfaction that the complete system is in proper working order before final acceptance. The Contractor shall furnish all equipment and personnel necessary to perform operating circuit and resistance tests at no additional cost to the Department.

2. The Contactor shall take each circuit's voltage and current readings at the power source and in the base of the light pole furthest from the source.

3. Data from the above tests shall be furnished to the Engineer in writing.

4. Resistance to ground shall be measured at random locations for noncurrent-carrying components, and insulation resistance tests shall be conducted when required by the Engineer.

5. The system shall be placed in normal operational mode after satisfactory completion of all required tests. Final acceptance will not be made until the system has operated satisfactorily for a period of not less than 14 days.

401.04

401.04 -- Grounding

1. a. All poles, controllers, and control centers shall be properly grounded by means of a copper clad ground rod and copper grounding electrode conductor.

b. Unless indicated otherwise, grounding conductors of No. 6 (4.67 mm) gauge or larger diameter wire shall be stranded.

c. The grounding conductor shall be grounded at the service disconnect and bonded to all ground rods and all non-current carrying components within the system.

2. a. All permanent lighting and signal systems shall have a grounding conductor (equipment ground) installed throughout the system.

b. The grounding conductor shall be grounded at the signal controller cabinet or control center and bonded to all poles, ground rods, and all non-current carrying components within the system.

c. The grounding conductor shall not be used for a neutral wire in the system and shall be tied to the AC neutral wire only in the controller cabinet or lighting control center.

3. When using a transformer type breakaway base, the grounding conductor shall be attached to the breakaway base.

4. A grounding conductor is usually not required in temporary lighting systems except that in some service areas the servicing electrical utility company may require a grounding conductor be used.

5. All ITS device supports, controllers, and service disconnects shall be properly grounded by means of a copper clad ground rod and copper grounding electrode conductor.

a. All ITS device systems shall have a grounding conductor (equipment ground) installed throughout the system.

6. All pull box rings and covers shall be grounded as shown in the contract.

401.05 -- General Construction Requirements

1. When the location at which the Contractor is to obtain electrical power is pre-arranged with the local utility, this location will be shown in the contract. These locations are approximate and subject to change. The Contractor shall make final arrangements for electrical service with the utility company. The Contractor shall arrange for services not predetermined.

2. System Operation:

a. Workable segments of the installation shall be "turned on" and made to operate normally as soon as possible if the road is open to public travel.

b. The Engineer shall be notified at least 2 NDOT work days before energizing any electrical system.

c. Electrical systems shall not be put into operation until the Engineer's authorized representative is present.

d. Unenergized circuits may be tested at any time.

e. Operation of the system shall not be construed as an acceptance of the system or any part of the system or as a waiver of any contract provisions.

f. The Contractor shall be fully responsible for proper operation of the system before final acceptance and shall remedy any defects or damages which may occur at no additional cost to the Department.

3. All installations shall be in accordance with the *National Electric Code* and all governing local ordinances and regulations. Roadway lighting, traffic signal systems and signing systems are not subject to inspection by the state, county, or city electrical inspectors. Area lighting at weigh stations and rest areas are subject to this inspection.

4. All work shall be performed by competent tradespersons experienced in their craft and under the supervision of a licensed journeyman electrician or lineperson. The licensed supervisor shall be on the job site whenever work is being performed. Any portion of the installation which presents an appearance of careless or shoddy work will be rejected.

5. The Contractor shall contact the local electrical utility company at least 3 NDOT work days prior to installing any equipment on the utility's poles or requesting final service connections. The Contractor shall not attach or connect any equipment to any utility without specific permission from the owner of the facility.

6. The Contractor shall replace and restore all plant materials and roadway structures disturbed by trenching, excavating, or backfilling operations. The Contractor shall dispose of all excess excavation and trenching material.

7. The Contractor shall be responsible for any tree trimming required.

8. The Department will not require the Contractor to pay for electrical energy consumed by the permanent lighting system or traffic signal system.

9. The Contractor shall be required to pay for the connection and electrical energy consumed by a temporary lighting system or temporary traffic signal unless indicated otherwise.

10. The Contractor shall be responsible for determining the location of all underground utilities.

401.06 -- Secondary Electrical Connections

1. Roadway and Sign Lighting Systems:

Cable connections shall only be made in pull boxes, pole bases, luminaries, and junction boxes. Connections will not be allowed in earth or conduit. All connections shall be made in accordance with the cable manufacturer's recommendations and the National Electric Code. Submersible, secondary, mechanical connectors meeting ANSI C119.1 are required in all pull boxes, and at other locations susceptible to moisture.

2. Traffic Signal Systems:

a. Traffic signal cable and detector lead-in cable shall not be broken and spliced between the controller cabinet and the cables final destination without the approval of the Nebraska Department of Transportation Traffic Engineering Division. Approved splices shall only be

made in cabinets, pull boxes, junction boxes, pole bases, and signal heads. Splices will not be allowed in earth, conduit, or exposed aerially.

b. Conductors to be spliced shall be twisted together to form a mechanically and electrically secure connection, secured with a wire nut or solder, and waterproofed. The waterproofing shall extend a minimum of 1-inch (25 mm) over the conductor insulation. Splices in cabinets shall not be waterproofed. Waterproofing shall be accomplished with one of the following methods:

(1) Self vulcanizing rubber electrical tape wrapped through the crotch of the splice then half-lapped over the entire splice. Cover the rubber tape with a half-lapped layer of plastic electrical tape.

(2) Direct Bury Splice Kits as shown on the Department's Approved Products List.

c. Finished splices shall be positioned upright and shall not be left laying in the bottom of pull boxes, pole bases, or cabinets. The splice shall be within 6-inches of pull box lids and above hand holes in poles.

d. Ends of spare conductors shall be sealed with flexible electrical coating compound.

3. ITS Devices

Cable connections shall only be made in ITS device cabinets and junction boxes. No connections shall be made in pull boxes without the Engineer's approval. Connections will not be allowed in earth or in conduit. All connections shall be made in accordance with the cable manufacturer's recommendations and the National Electrical Code. Submersible, secondary, Mechanical Connectors meeting ANSI C119.1 are required for all splices outside of the controller cabinet and the sign housing.

4. Control Cabinet:

Cable connections at the control cabinet shall be made at the terminal boards provided for this purpose. All stranded wires inserted under a binder screw shall be equipped with a solderless pressure type spade connector. Only one wire shall be used with each spade connector. No more than 3 spade connectors shall be inserted under the same screw without specific approval of the Engineer. Spade connectors shall not be used on solid wire.

5. Breakaway Connectors:

a. "Breakaway Type" connectors shall be installed in each breakaway pole base as shown in the contract. Line and load sides of the connector shall be identified.

b. The phase conductors shall be fused and shall have the female part of the connector on the line side.

c. The neutral conductor, when such is employed in the circuit, shall not be fused and shall have the female part of the connector on the load side.

6. An antioxidant compound shall be used on all dissimilar metal connections.

7. Inspection of Connections:

a. The Engineer may inspect five electrical connections at random. If these connections are found acceptable, the Contractor shall remake the inspected connections at no additional cost to the Department.

b. If any of the five connections are found unacceptable, ten additional connections shall be selected by the Engineer for inspection. If any of these connections are found unacceptable, the Contractor shall remake all connections on the project at no additional cost to the Department.

SECTION 402 -- WIRE AND CABLE IN CONDUIT

402.01 -- Description

1. The Contractor shall furnish and install wire and cable of the size and type shown in the contract. This work includes the wire and cable, splices, connections, terminations, identification tags, and all labor, equipment, tools, materials, and incidentals required to complete the work.

402.02 -- Material Requirements

1. Traffic signal and roadway lighting conductors in conduit shall conform to the requirements of Section 1073. Conductors used as a neutral must be designated white or gray. Insulated equipment ground shall be green. Line conductors shall be designated red and black. Cable in duct may be used in place of wire and cable only on roadway lighting and sign lighting systems and shall conform to the requirements of Section 1073.

402.03 -- Construction Methods

1. Unless indicated otherwise, all traffic signal and lighting systems shall be installed with conductors in conduit.

2. Conduits:

a. The conduit must be continuous, reasonably dry, completely free of debris, and without any sharp projections, edges, or short bends.

b. The Engineer may require the Contractor to demonstrate that the conduit is reasonably dry and free of debris by pulling a swab and/or mandrel through the conduit.

3. Conductors:

a. Conductors shall be installed in conduit only after the conduit system is completed and in place.

b. The wire and cable manufacturer's recommended maximum pulling tensions shall not be exceeded. If necessary, the cables shall be adequately lubricated to reduce friction and minimize possible damage. Lubricants shall be one of several commercially available wire pulling compounds that are suitable for the cables. They shall consist of soap, talc, mica, or similar materials and shall be designed to have no deleterious effects on the cables.

c. The Contractor shall not pull wire or cable without the Engineer present. The Contractor shall give the Engineer 24 hour notice before wire or cable will be installed.

4. Pulling Cables:

a. All cables shall be neatly trained to their destinations in cabinets, pole bases, transformer bases, pull boxes, junction boxes, or other enclosures. The destination of all cable runs shall be clearly identified by the use of permanent, non-ferrous or plastic tags stamped or embossed with the direction of the cable run and attached to the conduit in which the cable is housed. Conductor runs shall be tagged at all intermediate points along the run such as in pull boxes, junction boxes, pole bases, and transformer bases. In instances where the conduit housing the conductor is inaccessible, such as in anchor base pole installations, the identification tag shall be attached to the conductor itself.

b. The Contractor shall adhere to the ICEA recommended minimum values for wire and cable bending radii. These limits do not apply to conduit bends, sheaves, or other curved surfaces around which these cables may be pulled under tension while being installed. Larger radius bends are required for such conditions.

5. Where the cable enters or leaves the conduit, conduit bushings or bell ends shall be installed prior to installing cable.

402.04 -- Method of Measurement

1. Wire and cable shall be measured in linear feet (meters) from center to center of the pull boxes, poles, junction boxes, and controllers for each type and size shown in the contract. Cable in duct will be measured as 2 separate items, conduit and cable.

402.05 -- Basis of Payment

1. Pay Item	Pay Unit
2/C ____ Detector Lead-in Cable	Linear Foot (LF) [Meters (m)]
____ /C ____ Traffic Signal Cable	Linear Foot (LF) [Meters (m)]
____ Grounding Conductor	Linear Foot (LF) [Meters (m)]
____ AWG Conductor	Linear Foot (LF) [Meters (m)]
____ Pair Communication Cable	Linear Foot (LF) [Meters (m)]
Service Cable	Linear Foot (LF) [Meters (m)]
Street Lighting Cable, _____	Linear Foot (LF) [Meters (m)]
Roadway Lighting Cable, _____	Linear Foot (LF) [Meters (m)]
Street Lighting Cable, _____ Bare	Linear Foot (LF) [Meters (m)]
Video Camera Cable	Linear Foot (LF) [Meters (m)]
Traffic Signal Interconnect Cable, Type _____	Linear Foot (LF) [Meters (m)]
____ Communication Cable	Linear Foot (LF) [Meters (m)]
Service Entrance Cable	Linear Foot (LF) [Meters (m)]
Optical Detector Cable	Linear Foot (LF) [Meters (m)]
Coaxial Cable	Linear Foot (LF) [Meters (m)]
2. Payment is full compensation for all work described in this Section.	

SECTION 403 -- DIRECT BURIED WIRE AND CABLE

403.01 -- Description

1. The Contractor shall furnish and install direct buried wire and cable of the size and type shown in the contract. This includes the wire, cable, splices, connections, terminations, identification tags, trenching, backfilling, compacting, and all labor, equipment, tools, materials, and incidentals required to complete the work.

2. The Contractor may be required to pick up and install utility supplied preducted cable. The size and type of cable, together with the pick-up location, will be shown in the contract. Installation of the cable shall be according to guidelines issued by the utility.

403.02 -- Material Requirements

1. Direct buried cable and conductors for traffic signal and roadway lighting shall conform to the requirements of Section 1073. Cable used as a "neutral" shall be designated white or gray. Insulated equipment ground shall be green.

403.03 -- Construction Methods

1. The Contractor shall install the size and type of direct buried wire, cable, and preducted cable as shown in the contract.

2. The Contractor shall not trench or place cable without the Engineer present. The Contractor shall give the Engineer 24 hour notice before trenching or placing cable.

3. Trenching:

a. Direct buried wire, cable, and preducted cable shall not be plow-pulled into place.

b. Cable shall be placed a minimum of 30 inches (750 mm) below ground level.

c. The bottom of the trench shall be firm and level. Sharp objects shall not protrude from the walls or the bottom of the trench.

4. Placing Cable:

a. The Contractor shall place the cables alongside the trench by moving the reel rather than pulling the cable from the reel and dragging the cable along the ground. Cables shall not be kinked or damaged during this operation.

b. The cables shall be lifted section by section and placed in the trench in such a manner as to prevent damage to the cables.

c. Cable shall be placed in trenches without dragging or stretching.

d. All trenches shall be backfilled as soon as practicable after placing the cable. The first lift of backfill material shall be a uniform thickness of approximately 6 inches (150 mm). Care shall be exercised in compacting the backfill to prevent damage to the cable. The backfill shall be free of any material which could damage the cable. The remainder of the backfill shall be compacted to match the adjacent soil stiffness so that the trench surface will remain level with the surrounding surfaces. Six-inch wide underground

warning tape shall be installed above the cable at a depth of 12 inches below finished grade.

5. The cables shall be neatly trained to their destinations in cabinets, pole bases, pull boxes, and all other terminations.

6. The direction of each direct buried cable run shall be clearly identified with a stamped or embossed permanent plastic or non-ferrous metal tag at every point where the cable is accessible, such as in pull boxes, junction boxes, pole bases, transformer bases, and cabinets. A tag shall be attached to the conduit entrance bend whenever possible.

7. The minimum bending radii for cables or conductors less than 1 inch (25 mm) in diameter shall be 4 times the overall cable diameter. When using larger cables, the Contractor shall follow the ICEA recommended values. These limits do not apply to conduit bends.

8. Conduit bushings or bell ends shall be installed prior to installing cable whenever the conductor enters or leaves a section of conduit or conduit bend.

403.04 -- Method of Measurement

1. Direct buried wire, cable, and preducted cable shall be measured in linear feet (meter) from center to center of pull boxes, poles, junction boxes, cabinets, and controllers for each type and size shown in the contract.

403.05 -- Basis of Payment

1. Pay Item	Pay Unit
2/C _____ Detector Lead-in Cable, Direct Buried	Linear Foot (LF) [Meter (m)]
_____/C _____ Traffic Signal Cable, Direct Buried	Linear Foot (LF) [Meter (m)]
Service Cable, Direct Buried	Linear Foot (LF) [Meter (m)]
Direct Burial Cable, _____	Linear Foot (LF)
Install Preacted Cable	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for all work described in this Section. Underground warning tape shall be subsidiary to the cable.

SECTION 404 -- AERIAL CABLE

404.01 -- Description

1. The Contractor shall furnish and install aerial cable of the size and type shown in the contract. This work includes the cable, mounting devices, splices, connections, terminations, and all labor, equipment, tools, materials, and incidentals required to complete the work.

404.02 -- Material Requirements

1. Traffic signal and roadway lighting aerial cable and conductors shall conform to the requirements of Section 1073.

404.03 -- Construction Methods

1. The Contractor shall install the aerial cable in strict compliance with the latest industry standards, practices, and procedures.

404.04 -- Method of Measurement

1. Aerial cable shall be measured in linear feet (meter) horizontally from center to center of the poles for each type and size of cable shown in the contract and shall not include allowances for vertical rises, drip loops, sags, or splices.

404.05 -- Basis of Payment

1. Pay Item	Pay Unit
2/C _____ Detector Lead-in Cable, Aerial	Linear Foot (LF) [Meter (m)]
_____/C _____ Traffic Signal Cable, Aerial	Linear Foot (LF) [Meter (m)]
Service Cable, _____ Aerial	Linear Foot (LF) [Meter (m)]
Street Lighting Cable, _____ Aerial	Linear Foot (LF) [Meter (m)]
Coaxial Cable, Aerial	Linear Foot (LF) [Meter (m)]
Optical Detector Cable, Aerial	Linear Foot (LF) [Meter (m)]
Video Camera Cable, Aerial	Linear Foot (LF) [Meter (m)]
Traffic Signal Interconnect Cable, Type _____ Aerial	Linear Foot (LF) [Meter (m)]
____ Communication Cable, Aerial	Linear Foot (LF) [Meter (m)]
2. Payment is full compensation for all work described in this Section.	

SECTION 405 -- CONDUIT

405.01 -- Description

1. The Contractor shall furnish and install the size and type of conduit shown in the contract. This applies to underground conduit and conduit in or on bridges, median barriers, retaining walls, tunnels, and similar structures. This includes the conduit, fittings, excavating, backfilling, compacting, and all labor, equipment, tools, materials, and incidentals required to complete the work.

2. Special devices or fittings such as hangers, expansion fittings, deflection fittings, junction boxes, drains, grounding devices, and all other fittings required for a complete conduit system installation shall be considered subsidiary to the conduit pay item.

405.02 -- Material Requirements

1. Conduit and fittings shall conform to the requirements of Section 1073. The Contractor may use cable in duct in place of cable and conduit on lighting and sign lighting systems only, and the cable in duct shall conform to the requirements of Section 1073.

2. The Contractor may substitute a larger size conduit than specified at no additional cost to the Department if approved by the Engineer.

3. Fittings must be standard conduit fittings and designed for the specific type of conduit used. Galvanized malleable iron or steel fittings shall be used with galvanized rigid steel, intermediate metallic, or electrical metallic tubing conduit. Aluminum or zinc alloy fittings will not be allowed.

405.03 -- Construction Methods

1. The Contractor shall assemble and install conduit systems in accordance with the *NEC*, except that in those instances where the *Standard Specifications* are more stringent than the minimum requirements of the *NEC*, the *Standard Specifications* shall prevail.

2. Conduits:

a. Field bends must be properly formed with appropriate tools and shall not reduce the conduit cross section area.

b. Exposed field cut threads on metallic conduit and any area where galvanizing has been removed shall be painted with 1 coat of an approved zinc rich paint.

c. All conduit terminations shall have bells or bushings. A standard premolded PVC conduit elbow with integral belled end shall be attached to HDPE conduit to meet this requirement.

d. Spare conduits shall be capped or plugged with standard fittings.

e. Unless otherwise provided or directed by the Engineer, underground conduit shall be placed 30 inches (750 mm) below finished grade.

3. Trenching:

a. The locations of conduit runs indicated in the contract may be altered at the direction of the Engineer to accommodate field conditions. Conduit shall be routed to minimize damage to existing trees and shrubs.

b. Trenches shall be excavated to true line and grade. Trench width shall be the minimum practical dimension needed to place the conduit. Backfill material shall be free of unsuitable materials. Backfill shall be placed with care and shall be compacted and/or mounded so that, after natural settlement, the trench surface is level with the surrounding surface.

c. Six-inch wide underground warning tape shall be installed above the conduit at a depth of 12 inches below finished grade.

4. Conduit placed under surfaces which are not to be disturbed may be jacked or bored into the proposed location. Jacking pits shall be at least 2 feet (600 mm) beyond the edge of the pavement. Excessive use of water is not allowed.

5. Conduit installed in or on bridges, retaining walls, median barriers, tunnels, and similar structures shall be capped or plugged in an approved manner to prevent the entrance of water, concrete, or other foreign materials.

6. Conduit under sidewalk shall include replacement of the sidewalk from joint to joint unless the conduit is jacked under the sidewalk. Sidewalk that is damaged by the Contractor shall be removed and replaced as complete panels at no cost to the Department.

7. "Conduit Under Roadway" is conduit that is intended to be trenched in place before the roadway is paved. This conduit may be either metallic or nonmetallic. The Contractor may elect to trench through existing bituminous pavement to install conduit under the roadway before a new pavement is constructed. The Contractor may install the conduit after the paving is in place by either jacking or boring under the pavement at no increase in cost to the State.

8. "Conduit Under Median Surfacing" may be placed by jacking or boring. The Contractor may also elect to remove and replace the median surfacing and bury the conduit at no additional cost to the Department. Median surfacing shall be removed and replaced in complete panels from joint line to joint line.

9. Metallic junction boxes installed in bridges or median barriers shall be drilled and tapped to receive a grounding lug.

10. All underground conduit raceways terminating in pull boxes, light pole boxes, breakaway transformer bases, pedestal bases, lighting control center cabinets or other in-ground or ground-mounted enclosures, shall enter the enclosure vertically. All conduit ends shall be equipped with bells or bushings prior to installing cable to protect the cable they carry from chafing or abrasion.

405.04 -- Method of Measurement

1. Conduit shall be measured in linear feet (meter) for each type and size shown in the contract. The length shall be measured horizontally from center to center of poles, pull boxes, junction boxes, and control cabinets and shall not include allowances for vertical rises or bends. Cable in duct will be measured as two separate items, conduit and cable.

405.05 -- Basis of Payment

1. Pay Item	Pay Unit
_____ Conduit in Trench	Linear Foot (LF) [Meter (m)]
_____ Conduit in Bridge	Linear Foot (LF) [Meter (m)]
_____ Conduit in Median Barrier	Linear Foot (LF) [Meter (m)]
_____ Conduit Under Median Surfacing	Linear Foot (LF) [Meter (m)]
_____ Conduit on Structure	Linear Foot (LF) [Meter (m)]
_____ Conduit Under Roadway	Linear Foot (LF) [Meter (m)]
_____ Conduit Under Sidewalk	Linear Foot (LF) [Meter (m)]
_____ Conduit, Jacked	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for all work described in this Section. Underground warning tape shall be subsidiary to "Conduit in Trench".

SECTION 406 -- PULL BOXES

406.01 -- Description

1. The Contractor shall construct pull boxes of the size, type, and at the locations shown in the contract. A spare bend, if required, shall be installed in the pull box as shown in the contract. This shall include furnishing and installing the pull box, spare conduit bend, grounding connectors, clean coarse gravel, and all excavation, backfilling, compaction, labor, equipment, tools, and incidentals required to complete the work.

2. The Contractor shall relocate pull boxes as shown in the contract. A spare bend, if required, shall be installed in the relocated pull box as shown in the contract. "Relocate Pull Box, Type PB _____" shall include removing the existing pull box and spare conduit bends: installing the pull box at the new location: tapping into existing conduit and extending conduit to the relocated pull box; furnishing and installing spare conduit bends, grounding connectors, ground rods, if required, clean coarse gravel; and all excavation, backfilling, compaction, labor, equipment, tools, and incidentals required to complete the work.

406.02 -- Material Requirements

1. Pull boxes shall conform to the requirements shown in the contract.
2. Pull boxes shall be on the Department's Approved Products List.
3. Fill material shall be a Class B fine aggregate for concrete as shown in Table 1033.02A. Crushed limestone will not be acceptable.

406.03 -- Construction Methods

1. Pull boxes shall not be constructed in ditch bottoms, low areas where ponding of water may occur, or where they will be subjected to vehicular traffic.
2. Pull boxes shall not have concrete bottoms.

406.04 -- Method of Measurement

1. Pull boxes and relocated pull boxes shall be measured by the each.

406.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--------------------------------------|-----------------|
| Pull Box, Type _____ | Each (ea) |
| Adjust Pull Box to Grade, Type _____ | Each (ea) |
| Relocate Pull Box, Type _____ | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 407 -- POLE AND TOWER FOUNDATIONS

407.01 -- Description

1. Concrete Foundations (Conventional and High Mast, Traffic Signal, and ITS devices):

a. Concrete foundations for poles and towers shall be of the size and type shown in the contract. Foundations shall include a ground rods, reinforcing steel, anchor bolts, conduit entrance bends, and a spare conduit bend.

b. If the foundation details are not shown in the contract, the Contractor shall obtain the necessary soil data, design the foundation according to the soil test data, and construct the foundation. Two copies each of the soil test data and foundation design must be submitted to the Engineer two weeks before construction of the foundation will be allowed to begin.

c. The concrete foundation must be designed by a Professional Engineer registered in Nebraska. The Professional Engineer must stamp and sign all design documents.

2. Power Installed Foundations:

Power installed pole foundations may only be used when specified in the contract. Power installed foundations shall be of the size and type shown in the contract.

407.02 -- Material Requirements

1. Materials for use in concrete foundations shall conform to the requirements of Sections 1002 and 1020.

2. Anchor bolts shall conform to the requirements in Section 1073.

407.03 -- Construction Methods

1. Staking:

a. The Engineer will stake the locations of all pole and tower foundations. Before constructing a foundation, it will be the Contractor's responsibility to verify that the staked location will not place the finished pole or tower in an overhead or underground conflict situation.

b. Any locations or elevations that appear unreasonable or in conflict with specifications should be brought to the attention of the Engineer. The Engineer will review and decide any changes in location or elevation.

2. Conventional Light Poles: The Contractor shall construct the size and type of foundations shown in the contract.

3. High Mast Towers, Traffic Signal Poles, and ITS devices: The Contractor shall construct foundations according to the design details shown in the contract or to those the Contractor has been required to furnish.

4. Concrete foundations for both pole and tower installations shall be constructed according to the following:

a. All foundation excavations shall be free of loose dirt.

b. All concrete shall be Class 47B-3000 (47B-20).

c. The anchor bolt pattern shall be centered in the foundation.

d. The Contractor shall perform all excavations, backfilling, and placing of reinforcing steel and concrete in accordance with Sections 702, 704, and 707.

5. Power Installed Foundations:

a. The Contractor shall furnish and install power installed foundations in accordance with the manufacturer's instructions and details shown.

b. Foundations shall be installed before trenching for conduit or direct buried wire or cable.

6. The Contractor shall backfill and compact around the foundation to the optimal stiffness as defined by a deflection target value established by the Engineer and an optimal moisture as determined by NDOT T 99.

407.04 -- Method of Measurement

1. If the pole or tower foundation design is shown in the contract:

a. No measurements are necessary.

b. The foundation is subsidiary to the new or relocated pole or tower.

c. Ground rods, conduit entrance bends, and a spare conduit bend (if required) are subsidiary to the tower or pole.

2. If the pole or tower foundation design is not shown in the contract:

a. The pole or tower foundation design is measured by the each per structure.

b. The pole or tower foundation concrete is measured by the cubic yard (cubic meter).

c. The pole or tower foundation reinforcing steel is measured by the pound (kilogram).

d. The pole or tower foundation anchor bolts are measured by the each.

e. Ground rods, conduit entrance bends, and a spare conduit bend (if required) are subsidiary to the tower or pole.

407.05 -- Basis of Payment

1. Pay Item	Pay Unit
Foundation Design	Each (ea)
Concrete for Foundation	Cubic Yard (CY) [Cubic Meter (m ³)]
Reinforcing Steel	Pound (lb) [Kilogram (Kg)]
Anchor Bolts	Each (ea)

2. All labor, equipment, excavation, and incidentals necessary to complete the foundation according to plan are subsidiary.

3. Payment is full compensation for all work described in this Section.

SECTION 408 -- POLES AND TOWERS

408.01 -- Description

1. The word "pole," when used in this Section, shall be taken to mean a lighting standard 50 feet or less in mounting height. Units with mounting heights greater than 50 feet will be referred to as "towers." Poles and towers have many different configurations. The type to be provided shall be as shown in the contract and described in the special provisions.

2. General pole and tower requirements:

a. New Pole and Tower Installation:

(1) The Contractor shall furnish and install poles and towers of the size and type shown in the contract. Each traffic signal pole, lighting pole and tower, complete with all of its components, shall be designed according to the latest edition of the AASHTO, "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals".

(2) Light poles and traffic signal poles, unless shown or stated otherwise, shall be furnished complete with pole shaft, base plate, mast arm(s), grommets, end caps, handhole with cover and watertight gasket, anchor bolts with nuts, nut covers, ground rods and wire, luminaires, foundation, breakaway device (if required), in-line fuses and fuse holders, wire and cable in the pole and mast arms, and all excavation, backfilling, compaction, labor, tools, equipment, and incidentals necessary to complete the work.

(3) High mast towers, unless shown or stated otherwise, shall be furnished complete with tower shaft, base plate, handhole with cover and watertight gasket, anchor bolts with nuts, ground rod(s) and wire, high mast lowering system powered by an internal motor, electrical wires and cables, winch cable(s), hoisting cables, foundations, and all other items required to provide a complete and workable unit.

(4) All items associated with a lighting unit of either type must be compatible and work together to provide a reliable and efficient unit.

b. Pole and Tower Relocations:

(1) The Contractor shall relocate poles and towers as shown in the contract. Poles shall be carefully dismantled and all items stored and protected from damage until installed at their new locations. Towers shall be carefully lowered and stored on timber cribbing with the shaft in essentially straight alignment with no part of the unit in contact with the ground. The tower and its components shall be protected from damage until installed at their new location. The Engineer will designate specific areas for temporary storage of the material.

(2) Pole and tower relocations shall consist of removing the pole or tower with all associated items from its foundation and reinstalling the pole or tower on a new foundation at a new location. The Contractor shall remove the pole or tower foundation, including steel and anchor bolts, to a minimum depth of 2 ft (600 mm) below finish grade. The relocation shall include all necessary excavation, backfilling, removal of debris, compaction, labor, tools, equipment, and incidentals necessary to complete the work. Constructing a new concrete foundation, if required, is a part of this work.

408.02 -- Material Requirements

1. Pole and tower materials shall conform to the requirements of Section 1073 and to the requirements shown in the contract.

2. All poles and towers shall be designed by a Professional Engineer licensed to practice in the State of Nebraska. The Contractor shall submit 2 sets of design comps stamped by a licensed Professional Engineer. The Contractor shall submit shop drawings stamped by a licensed Professional Engineer.

3. The Contractor shall furnish all material for a complete pole or tower installation.

4. The entire assembly shall meet all applicable local, county, state, and national codes.

5. Department-Furnished Material:

a. Department-furnished material and the locations where they are to be picked up are shown in the contract.

b. The Contractor shall furnish all other items required for a complete installation.

c. The Contractor will contact the Engineer to determine when and where to pick up the State-furnished material. The Engineer will supply the Contractor with a completed "Stock Requisition." The Contractor will not be issued materials without a properly completed stock requisition.

408.03 -- Construction Methods

1. The Contractor shall assemble and install poles and towers in accordance with the manufacturer's instructions, plan details, or as directed by the Engineer.

2. Setting Poles:

a. All poles shall stand plumb under the dead load. If shimming is required, all shims shall be placed between the top of the foundation and the bottom of the transformer base (bottom of the pole base if no breakaway device is being used). Only regular "U" shaped shim stock shall be used and installed with the back edge of the shim flush with the bottom edge of transformer base or bottom edge of the pole base.

b. If concrete foundations are being used, the foundation shall be dressed to provide for proper seating and leveling. Traffic signal poles shall be placed on leveling nuts. The leveling nuts shall not be more than one bolt diameter above the foundation.

c. Each pole shall be grounded to a ground rod and to the system grounding conductor.

d. Breakaway devices shall be installed in strict compliance with the manufacturer's details and instructions.

3. Setting Towers:

a. All towers shall be plumbed and supported by anchor bolts and nuts. The tower shall not rest on the concrete.

b. The space between the top of the concrete foundation and the bottom of the tower base shall be no greater than 2 anchor bolt diameters.

c. Each tower shall be grounded to a ground rod and to the system grounding conductor.

4. Mast arm signal and combination mast arm signal/lighting poles shall be leveled by the use of nuts and anchor bolts supplied with the pole. Before the pole is loaded, it shall be raked back in excess of the calculated deflection and plumbed after the loads are applied by adjusting the leveling nuts.

5. Relocating poles and towers:

a. Poles and towers being relocated shall be installed at their new locations and connected electrically as shown in the contract.

b. Existing luminaires or traffic signals being reinstalled on relocated poles shall be cleaned and provided with new lamps or LED's.

c. Relocated towers shall have their luminaires cleaned and new lamps installed.

d. The Contractor shall install new wires with in-line fuses and fuse holders in the relocated pole shaft and new wires in the mast arm.

e. Missing or damaged components shall be replaced by the Contractor. The replacement parts will be paid for as extra work.

6. Foundation dimensions and materials shall be as indicated in the contract. Anchor bolts shall be of the correct size and spacing for the pole(s) being furnished.

7. The cables exiting the pole shaft or mast arm shall have adequate drip loops. The wiring for the luminaires shall be installed with 40 inches (1 m) of cable extending beyond the end of the mast arm.

8. Poles or other lighting items being returned to the State must be disassembled, clean and free of internal wiring. Handhole covers shall be in place, and mast arm bolts shall be attached. The Contractor will not be allowed to "off-load" any items not cleaned or prepared.

408.04 -- Method of Measurement

1. Installation and relocation of the various types and sizes of poles, towers, lighting units, traffic signal structures, and ITS device structures are measured by the each.

408.05 -- Basis of Payment

1. Pay Item	Pay Unit
Mast Arm Signal Pole, Type MP _____	Each (ea)
Combination Mast Arm Signal and Lighting Pole, Type CMP _____	Each (ea)
Span Wire Signal Pole, Type SWP _____	Each (ea)
Combination Span Wire Signal and Lighting Pole, Type SWP _____	Each (ea)
Pedestal Pole, Type PP _____	Each (ea)
Signal Structure, Type _____	Each (ea)
Street Lighting Unit, Type SL _____	Each (ea)
High Mast Lighting Unit, Type T _____	Each (ea)
Install Mast Arm Signal Pole, Type MP _____	Each (ea)
Install _____	Each (ea)
Install Combination Mast Arm Signal and Lighting Pole, Type CMP _____	Each (ea)
Install Span Wire Signal Pole, Type SWP _____	Each (ea)
Install Combination Span Wire Signal and Lighting Pole, Type SWP _____	Each (ea)
Install Pedestal Pole, Type PP _____	Each (ea)
Install Street Lighting Unit, Type SL _____	Each (ea)
Relocate High Mast Lighting Unit, Type T _____	Each (ea)
Install High Mast Lighting Unit, Type T _____	Each (ea)
Relocate _____	Each (ea)
Relocate Street Lighting Unit, Type _____	Each (ea)
Install Temporary Lighting Unit, Type _____	Each (ea)

2. Separate payment for pole and tower foundations, if provided, is as described in Section 407.

3. Foundation anchor bolts are subsidiary to the pole and/or tower except for relocated pole and tower foundations.

4. Payment is full compensation for all work described in this Section.

SECTION 409 -- SIGNAL HEADS

409.01 -- Description

1. Traffic Signals and Pedestrian Signals:

a. The Contractor shall furnish and install signal heads of the type and size shown in the contract. This work shall include furnishing and installing the signal head, lamps, mounting bracket, and backplate (if required). Pole mounted signals do not require backplates.

2. LED Traffic Signal Modules:

a. The contractor shall furnish and install LED traffic signal modules of the type and size shown in the contract. This work shall include removing the incandescent lamp, lamp socket, reflector, and lens from an existing signal head and then retrofitting the signal head with a LED module.

409.02 -- Material Requirements

1. Traffic and pedestrian signal heads shall be in conformance with Section 1073.

2. Optically programmed signal heads shall be on the Department's Approved Products List.

3. LED traffic signal modules shall be on the Department's Approved Products List.

409.03 -- Construction Methods

1. The Contractor shall install signals plumb, level, and securely attached with all fittings, so they present a neat appearance.

2. If required, the Contractor shall furnish pipe nipples in appropriate lengths so that all signals on one span will hang at the same elevation.

3. If, after the signal assemblies are erected and the road is open to public travel, the signal system is not put immediately into operation, the signal faces shall be covered with burlap or other opaque material subject to the approval of the Engineer. Inoperative signals on roads open to the public shall always be covered. Tilting the signals upward is not an acceptable alternative to covering the heads.

409.04 -- Method of Measurement

1. Signal heads shall be measured by the each.

409.05 -- Basis of Payment

1. **Pay Item**

Pay Unit

Traffic Signal, Type TS _____ Each (ea)

Pedestrian Signal, Type PS _____ Each (ea)

Install Traffic Signal, Type TS _____ Each (ea)

Install Pedestrian Signal, Type PS _____ Each (ea)

LED Traffic Signal Module, Type _____ Each (ea)

LED Pedestrian Signal Module, Type _____ Each (ea)

Install LED Traffic Signal Module, Type _____ Each (ea)

2. Payment is full compensation for all work described in this Section.

SECTION 410 -- DETECTORS

410.01 -- Description

1. The Contractor shall furnish and install pedestrian pushbuttons and vehicle detectors of the type and size shown in the contract.

410.02 -- Material Requirements

1. Vehicle and pedestrian detectors shall be in conformance with requirements in Section 1073.

410.03 -- Construction Methods

1. The Contractor shall install all detectors shown in the contract, including any identified as Department-furnished detectors.

2. The Contractor shall install preformed loop vehicle detectors under new pavement. Saw cut loop detectors shall be installed in existing pavement and shall not be substituted for preformed detectors.

3. The Contractor shall install magnetic detectors for 2-lane approaches under the lane line between lanes. Magnetic detectors installed under 1-lane approaches shall be installed under the outside edge of the lane.

4. Preformed Loops:

a. The Contractor shall place preformed loops 1 inch to 2 inches (25 mm to 50 mm) below the surface of the subgrade or base course before paving. Care shall be taken to prevent damage to the loop during the paving operation.

5. Saw Cut Loops

a. The Contractor shall exercise care to prevent damage to the wires when installing the loops in the sawed slots in pavement.

b. The slots shall be blown clean of all stones and dirt.

c. The wire shall be tamped as deeply as possible into the slot using a blunt stick. The use of sharp instruments such as screwdrivers, etc., is not allowed.

d. Caution shall be exercised at all corners and sharp bends so as not to damage the insulation or introduce undue stresses in the wire.

e. Testing of the loops during and after installation shall be performed in the manner described by the Engineer.

6. A splice between the detector and the lead-in cable shall be made in the pull box nearest the detector. No other splice shall be made in the detector leads.

7. Pedestrian pushbuttons shall be installed as shown in the contract.

410.04 -- Method of Measurement

1. Vehicle detectors and pedestrian pushbuttons shall be measured by the each.

410.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|-----------------|
| Vehicle Detector, Type TD _____ | Each (ea) |
| Vehicle Detector, Type ____ Preformed | Each (ea) |
| Install Vehicle Detector, Type TD _____ | Each (ea) |
| Install Vehicle Detector,
Type ____ Preformed | Each (ea) |
| Pedestrian Pushbutton, Type PPB | Each (ea) |
| Install Pedestrian Pushbutton | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 411 -- TRAFFIC SIGNAL CONTROLLER

411.01 -- Description

1. The Contractor shall furnish and install traffic signal controllers of the type and at the locations shown in the contract.
2. All equipment required to be installed for the power service, including but not limited to, meter sockets and breaker boxes is considered subsidiary to the traffic signal controller installation.

411.02 -- Material Requirements

1. Traffic signal controllers shall meet the requirements in Section 1073.
2. Concrete shall meet the requirements in Section 1002.

411.03 -- Construction Methods

1. The controller shall be placed on a concrete pad as shown in the contract. The controller shall not be placed in a ditch or depression that is subject to water ponding or flooding. Pole mounted controllers shall have a pad constructed below the controller as shown in the contract.
2. All conduits within the cabinet shall be clear of any braces or equipment which would interfere with cable runs. One spare 2 inch (50 mm) conduit bend shall be installed in each pad mounted controller foundation. The ends of the bend shall be capped. This work shall include furnishing and installing the controller, concrete, spare bend, and all excavation, backfilling, labor, equipment, tools, and incidentals required to complete the work.

411.04 -- Method of Measurement

1. Traffic signal controllers shall be measured by the each.

411.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|-----------------|
| Traffic Signal Controller,
Type TC _____ | Each (ea) |
| Install Traffic Signal Controller,
Type TC _____ | Each (ea) |
2. Concrete Pad is subsidiary to controller.
 3. Payment is full compensation for all work described in this Section.

SECTION 412 -- LUMINAIRES

412.01 -- Description

1. The Contractor shall furnish and install luminaires of the size and type indicated in the contract.

412.02 -- Material Requirements

1. Luminaires shall conform to the requirements in Section 1073.

412.03 -- Construction Methods

1. The Contractor shall install luminaires in conformance with the manufacturer's recommendations.

2. Conventional Luminaires:

a. Unless indicated otherwise, luminaires shall be installed perpendicular to the centerline of the roadway being lighted.

b. The position of the lamp socket in each luminaire must be adjusted in accordance with the manufacturer's specifications to meet the photometric requirements shown in the contract.

c. Unless otherwise indicated in the contract or directed by the Engineer, luminaires will be installed level in both horizontal axes.

d. Each luminaire shall be fused. Fuses shall be installed in each hot leg using approved disconnect type in-line fuseholders. Fuseholders shall be located in the transformer base or the base of the pole.

e. The month and year of installation shall be permanently indicated on the base of each lamp at the location provided by the manufacturer.

3. High Mast Luminaires:

a. Luminaires shall be adjusted to proper alignment and orientation with respect to the roadway as shown in the contract.

b. All connections from the portable cable to the individual ballasts shall be made in the junction box located on the luminaire support assembly. When an electrical cable passes through any metal or pulley, a bushing shall be provided.

c. Each luminaire shall be fused by installing an in-line fuseholder in each hot leg. Fuseholders shall be located inside the luminaire.

d. Night inspection by the Engineer will determine the need for adjustments to the luminaires.

e. When shielding is required, shielding methods proposed must be approved by the Engineer before any materials are installed. Unless indicated otherwise, external shields will not be allowed.

4. Wall Mounted/Underdeck/Overhead Luminaires:

a. Wall mounted/underdeck/overhead luminaires shall be installed as shown in the contract. Each luminaire shall be grounded.

b. Fuses shall be installed in each hot leg using approved in-line fuseholders located inside the units or in a junction box when so indicated in the contract.

c. Wall mounted/underdeck/overhead luminaires shall be adjusted for optimum light distribution as directed by the Engineer.

5. Sign Lighting Luminaires:

a. The sign lighting luminaires shall be mounted as shown in the contract and in accordance with the manufacturer's instructions.

b. The lamps shall be 150 watt high pressure sodium or as shown in the contract.

c. All conductors shall be copper and shall be installed in conduit.

d. The feeder cable shall be a minimum No. 8 gauge (3.25 mm) diameter THWN with a 30 ampere circuit breaker at the service entrance.

e. Each sign structure shall be controlled by a 15 ampere, 2 pole NEMA 3R breaker at a location convenient for luminaire maintenance.

f. Each sign structure shall have a photoelectric control mounted near the sign unless the sign luminaires are tied into the roadway lighting photocells.

g. The relays for switching the line current to the lighting fixtures shall be mounted near the circuit breaker or as directed by the Engineer.

6. Luminaire Conversion:

a. The Contractor shall install new luminaires with lamps on existing poles as indicated in the contract. The Contractor shall provide new internal pole and mast arm wiring with in-line fuseholders and fuses.

b. The existing luminaires will become the property of the Contractor and shall be removed from the project site.

c. The position of the lamp socket in each luminaire must be adjusted in accordance with the manufacturer's specifications to meet the photometric requirements shown in the contract.

d. Unless otherwise indicated in the contract or directed by the Engineer, luminaires will be installed level in both horizontal axes.

e. The month and year of installation shall be permanently indicated on the base of each lamp.

412.04 -- Method of Measurement

1. Luminaires, luminaire conversions, and wall mounted/underdeck/overhead luminaires shall be measured by the each.

412.05 -- Basis of Payment

1. Pay Item	Pay Unit
Luminaire, Type _____	Each (ea)
Underdeck Luminaire, Type _____	Each (ea)
Luminaire Conversion, Type _____	Each (ea)
High Mast Luminaire, Type _____	Each (ea)
2. Payment is full compensation for all work described in this Section.	

SECTION 413 -- LIGHTING CONTROL CENTERS

413.01 -- Description

1. New Lighting Control Center: The Contractor shall furnish and install a new lighting control center of the size and type shown in the contract. This work includes the relay, disconnect, contactor, pole, control cabinets, grounding devices, photo control, conduit, concrete, fittings, excavating, backfilling, compacting, and all other items required for a complete installation.

2. Relocate Existing Control Center: The Contractor shall relocate the lighting control center as shown in the contract. The lighting control center shall be carefully dismantled, stored, and protected from damage. The Engineer may designate specific areas for temporary storage of the materials. The lighting control center shall be installed at the described new location and connected electrically as shown in the contract. Missing or damaged components shall be replaced by the Contractor before final payment will be made.

3. Temporary Lighting Control Center: The Contractor shall install the temporary lighting control center as described in the contract.

4. Department Furnished Material:

a. If the Department is furnishing the lighting control center, the items and the location where they are to be picked up will be shown in the contract. The Contractor shall provide all other materials required for a complete installation and shall install all materials as shown in the contract.

b. The Contractor shall contact the Engineer for additional details associated with obtaining the Department-furnished material. The Engineer will supply the Contractor with a completed "Stock Requisition." The Contractor will not be issued materials without a properly completed "Stock Requisition."

413.02 -- Material Requirements

1. Lighting control centers shall conform to the requirements shown in the contract and Section 1073.

413.03 -- Construction Methods

1. Control Center Location:

a. The location at which the Contractor is to install the lighting control center has been prearranged with the local utility and this location will be shown in the contract. Lighting control center locations are approximate and subject to change.

b. The Contractor shall be required to contact the Utility Company and the Department prior to installing the conduit, cable, and lighting control center to determine if the location for the electrical service remains as shown in the contract. If the location for the service has changed, the Contractor shall advise the Engineer of this change and shall not install the lighting control center, conduit and cable until he has received the Engineer's approval of a new location.

c. The Contractor shall be fully responsible for installing the lighting control center at its correct location. If installed at an incorrect

location, the Contractor will be required to move the control center to its correct location at no additional cost to the State.

2. The Contractor shall assemble the lighting control center in accordance with the manufacturer's instructions and the details shown in the contract or as directed by the Engineer.

3. The Contractor shall take appropriate action to insure that all conduits within cabinets are clear of any braces or equipment which would interfere with cable runs. Unless indicated otherwise, one extra 1 1/2 inch (38 mm) conduit bend, with the ends capped, shall be installed in each pad mounted lighting control center cabinet foundation.

413.04 -- Method of Measurement

- 1. Lighting control centers shall be measured by the each.

413.05 -- Basis of Payment

1. Pay Item	Pay Unit
Lighting Control Center, Type _____	Each (ea)
Install Lighting Control Center, Type _____	Each (ea)
Relocate Lighting Control Center, Type _____	Each (ea)

2. Replacement of missing or damaged components will be paid for as extra work according to Section 109. Any damage or lost components by the Contractor shall be replaced at no cost to the Department.

- 3. Payment is full compensation for all work described in this Section.

SECTION 414 -- HIGH MAST LOWERING SYSTEMS

414.01 -- Description

1. The Contractor shall furnish and install a new high mast lowering system on a new or existing tower as indicated in the contract. This work shall include a headframe, headframe cover, luminaire support ring, bracket arms, hoist winch and winch cables, hoist cables, internal power unit, and all labor, equipment, tools, and incidentals necessary to complete the work.

2. The Contractor shall be responsible for any damage to any portion of the lighting system caused by the Contractor.

414.02 -- Material Requirements

1. High mast lowering systems shall be on the Department's Approved Products List.

414.03 -- Construction Methods

1. The Contractor shall be responsible for any modifications necessary to the tower to accommodate the high mast lowering system.

2. The Contractor shall install the new high mast lowering system on a new or existing tower in accordance with the manufacturer's instructions and recommendations.

3. Installation of a new high mast tower lowering system may require some modification to the tower. Modifications shall be made as detailed by the Manufacturer and reviewed by the Engineer.

4. The manufacturer's representative shall be present, on site, to advise the Contractor during the installation and testing of the first complete lowering system. Duties of the manufacturer's representative shall include, but not be limited to, the following:

a. Directing all adjustment to the lowering system to ensure positive latching and unlatching. This will consist of a minimum of 3 complete raising and lowering cycles.

b. Training the maintaining utility company and/or Department personnel in the methods of proper maintenance to avoid lowering system malfunctions along with the proper procedures to follow in the event of a hoist malfunction.

414.04 -- Method of Measurement

1. High mast lowering systems, furnished and installed on existing high mast towers, will be measured by the each.

414.05 -- Basis of Payment

1. Pay Item	Pay Unit
High Mast Lowering System, Type _____	Each (ea)

2. A high mast lowering system furnished by the Contractor and installed on a new tower will not be paid for directly, but will be considered subsidiary to the new high mast tower.

3. Payment is full compensation for all work described in this Section.

SECTION 415 -- MAINTENANCE OF PROJECT LIGHTING SYSTEM

415.01 -- Description

1. "Project Lighting System," when used in the contract, shall be taken to mean all lighting units and their associated circuitry (conduit, cable, and controls) located within the limits of the project. A lighting unit is a pole, luminaire, a mast arm and anchor base unit or breakaway device.

2. The Contractor shall be responsible for the proper operation and maintenance of all lighting units on the project (existing, relocated, temporary, and/or new) from the time the project begins until construction is complete and the project is accepted.

a. Damage caused by the Contractor's forces to any equipment, including but not limited to lighting units, pull boxes, controls, or conduit and cable, shall be repaired or replaced at no cost to the Department.

b. The Contractor shall supply all needed materials. If any disruption to circuits or other components causes the lighting to fail, the Contractor shall install temporary conductors as required and make the necessary repairs to return the system to operation at no additional cost to the Department.

c. Any damage shall be repaired within 48 hours.

3. Any existing lighting units within the project limits, not working at the time construction is started will not be the Contractor's responsibility. The Engineer may negotiate the repair and maintenance of the non-working lighting units with the Contractor.

415.02 -- Material Requirements

1. Replacement parts, except as noted in Subsection 415.03, shall be furnished by the Contractor and must be compatible with the lighting system.

2. Lamps provided shall be as shown in the contract.

415.03 -- Construction Methods

1. The Contractor will be responsible for locating and flagging all underground circuits to all lighting systems on the project. The Contractor will be responsible for the proper repair or replacement of any part of any lighting system on the project that is damaged as the result of the Contractor's operations.

2. Replacement parts:

a. Replacement parts for new lighting units (units being installed under the present contract) shall be furnished by the Contractor.

b. Replacement parts (poles, mast arms, breakaway bases, power foundations, and luminaires) for existing, relocated, and temporary lighting systems will be available at the Department's storage area in Lincoln.

3. Lamps for all units shall be supplied by the Contractor.

4. If for any reason a lighting unit fails or is damaged, it shall be repaired or replaced and put back in working order within 48 hours from the time of failure or damage.

415.04 -- Method of Measurement

1. Project lighting system maintenance is measured by the each per day the entire system is in operation.

415.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|-------------------------------------|-----------------|
| Project Lighting System Maintenance | Day (d) |
2. Payment is full compensation for all work described in this Section.

SECTION 416 -- TEMPORARY LIGHTING SYSTEMS

416.01 -- Description

1. The Contractor shall furnish and install the temporary lighting systems as described in the contract. The contract will indicate whether poles, luminaires, lamps, photo controls, power foundations, and breakaway bases are to be Department furnished.

2. The Contractor shall operate and maintain the lights daily from dusk to dawn throughout the life of the contract. The Contractor shall be responsible for the proper operation and maintenance of the temporary lighting system including replacement parts. Any failure or malfunction of the system shall be promptly corrected by dusk of the following day.

416.02 -- Material Requirements

1. All Contractor-furnished lighting units and all other items required for a complete system shall conform to the requirements in the contract.

2. The Contractor shall obtain the Department-furnished materials from the Department's storage area. The Contractor will be responsible for transporting the material from the Department storage area to the job site.

416.03 -- Construction Methods

1. Replacement lighting units:

a. On Contractor-furnished systems, additional poles, luminaires, and breakaway devices shall be retained in the Contractor's stock for replacement purposes. Upon completion of the project, the Department will, if the Contractor desires, accept the surplus lighting units (up to 3 each poles, luminaires, and breakaway devices) as described in Subsection 109.06.

b. In the event of failure of a lighting unit on a Department-furnished system, the Department will provide additional lighting units for replacement by the Contractor.

c. In the event of damage to a lighting unit on a Department-furnished system, the Contractor shall be responsible in accordance with Section 107.

2. The power source shall be a dependable, well-regulated source of power adequate for the requirements of the lighting system. The contract will indicate whether the Contractor or the Department arranges and pays for electrical power.

a. If the Contractor is required to arrange and pay for the electrical power to the temporary lighting system, the source of power may be an electric utility serving the area, if such a source is available, or it may be an engine-generator furnished, operated, and maintained by the Contractor.

b. The Contractor will not be responsible for the cost of the electrical energy, which has been arranged by the Department, required for the operation of the temporary lighting.

3. The Contractor shall install, test, and operate the temporary lighting system before traffic is routed through the construction zone. The Contractor shall also maintain and operate the system until the project is complete.

4. Department Furnished Equipment:

a. It will be the Contractor's responsibility to protect the Department's poles, luminaires, and the foundations from damage during installation, removal, salvage, storage, and transportation to and from the storage area. All items must be accounted for and in good working condition. Missing or damaged components must be replaced by the Contractor at no additional cost to the Department.

b. When the temporary lighting units are no longer required, the Contractor shall carefully dismantle, clean, and return the salvaged material to the Department's storage area indicated in the contract. All components not ordered salvaged shall become the property of the Contractor and removed from the project.

c. The Contractor shall notify the Engineer 2 days before delivery of the materials to the storage area. Upon delivery, the materials shall be placed in the storage area at the locations designated by the Engineer.

d. When the units are returned:

(i) All luminaires shall have the photo control removed and the photo control receptacle and the luminaire mounting hole covered with duct tape. Photo controls shall become the property of the Contractor.

(ii) All poles shall have handhold covers fastened securely in place.

(iii) Power foundations and transformer bases shall have all associated bolts, nuts, and washers attached. Breakaway support couplings shall be bundled in sets of 4 held together with duct tape with all bolts, nuts, and washers fastened in place on the couplings.

416.04 -- Method of Measurement

1. Installation of Contractor and Department-furnished temporary lighting systems shall be measured by the each.

a. When the bid proposal's Schedule of Items contains the pay item "Temporary Lighting System, Type _____", then the Contractor is required to furnish the temporary lighting system.

2. "Operation and Maintenance of Temporary Lighting Systems, Type____" shall be measured by the number of calendar days each temporary lighting system is in operation.

416.05 -- Basis of Payment

1. Pay Item	Pay Unit
Temporary Lighting System, Type _____	Each (ea)
Operation and Maintenance of Temporary Lighting System, Type _____	Day (d)

2. Payment shall be made according to the following schedule: Two-thirds of the contract unit price will be paid when the system is installed, in place, and approved by the Engineer; one-third of the contract unit price will be paid when the system is removed, delivered to the Department, and accepted by the Engineer.

3. Payment is full compensation for all work described in this Section.

SECTION 417 -- HIGHWAY SIGNS

417.01 -- Description

1. This work shall consist of all materials and labor necessary to provide, fabricate, and install highway signs at the locations shown in the contract.

417.02 -- Material Requirements

1. Materials for highway signs shall conform to the requirements of Section 1070 and the current adopted version of the *Manual on Uniform Traffic Control Devices for Streets and Highways*.

a. "Type A Signs" are regulatory, warning, guide, and information signs composed of a flat aluminum sheet background surfaced with retroreflective sheeting and the message either directly applied or reverse screened on the sign face, all in the colors specified in the contract. Bridge and hazard markers shall be classified as a Type A sign.

b. "Type B Signs" are large guide and information signs mounted along the roadside or on overhead structures and constructed of molded extruded panels or reinforced aluminum, horizontally joined panels with retroreflective sign sheeting and direct applied letters, numerals, symbols, and borders.

c. "Type C Signs" are large guide and information signs mounted on overhead structures and constructed of molded extruded panels or reinforced aluminum, horizontally joined panels sheeted with retroreflective sign sheeting and direct applied letters, numerals, symbols, and borders.

2. Mounting:

a. "Type A Signs" shall be mounted on breakaway posts made from aluminum, steel, or wood as indicated in the contract.

b. Type B ground mounted signs shall be mounted along the roadside as shown in the contract and supported by structural steel beam breakaway posts with the post stub extending into round, reinforced concrete footings.

c. Type B and C overhead signs shall be mounted over the roadway on sign structures, including cantilever structures, with vertical supports installed on reinforced concrete foundations or on sign brackets attached to existing roadway bridges.

3. Retroreflective sheeting for Type A and B signs shall meet the requirements of ASTM D 4956 Type IV.

4. Retroreflective sheeting for Type C signs shall meet the requirements of ASTM D 4956 Type XI.

5. All concrete shall be Class 47B-3000 conforming to the requirements of Section 1002.

6. Before fabrication, the Contractor shall prepare and submit complete design drawings for Type B and C signs for approval. These shall include 6 sets of prints and drawings on half size plan sheets (11 x 17 inches [297 x 420 mm]) prepared and signed by a registered Professional Engineer licensed in Nebraska.

417.03 -- Construction Methods

1. The Contractor shall prepare the sheet aluminum for retroreflective sheeting on both Type A, B, and C signs as follows:

a. Paint shall be removed with lacquer thinner or a controlled alkaline cleaning system.

b. The aluminum sheet and extrusheet panels shall be degreased by one of the following methods:

(1) Vapor Degreasing--Total immersion of the sign in a saturated vapor of trichlorethylene or perchlorethylene.

(2) Alkaline Degreasing--Signs shall be immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications. Immersion time shall depend upon the amount of soil present. Metal shall be rinsed thoroughly with running water.

c. Acid Etching:

(1) The aluminum sheet and extrusheet panels shall be acid etched in a 6 to 8% phosphoric acid etching solution at 100°F (38°C).

(2) After etching, the metal shall be thoroughly rinsed with running cold water.

(3) The cold rinse shall be followed by a hot water rinse. A forced hot air drier shall be used to dry the panels.

d. Metal shall not be handled directly, but shall be moved with a mechanical device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

There shall be no opportunity for metal to contact greases, oils, or other contaminants before the application of reflective sheeting.

2. Reflective Sheeting Application:

a. Reflective sheeting shall be mechanically applied to properly treated base panels using the sheeting manufacturer's recommended procedures and equipment.

b. Seams:

(1) The Contractor shall apply the reflective sheeting without visible seams or joints.

(2) If seams are required, they must be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance, both day and night.

(3) Signs on which the background color of adjacent sheets or panels is not properly matched will be rejected.

c. After aging 48 hours at 75°F (24°C), adhesion of retroreflective sheeting to the sign surface shall be strong enough to resist stripping from the panel when tested with a stiff putty knife.

3. The message, legend, and border of Type A signs shall be applied by one of two processes, depending on the kind of sign.

a. Direct Screen:

(1) Direct screened processing shall consist of processing the message, legend, and border color on the face of the sign by the silk screen process.

(2) The color material to be used and the dry film thickness to be obtained shall be as recommended by the manufacturer of the reflective sheeting.

(3) The color of the sign face, message, legend, and border shall be as shown in the contract.

b. Reverse Screen Process:

(1) Reverse screen processing shall consist of processing an opaque or transparent color over the sign face to form the legend and border.

(2) The opaque or transparent process color material to be used and the dry film thickness to be obtained shall be as recommended by the manufacturer of the reflective sheeting.

(3) The color of the sign face, legend, and border shall be as shown in the contract.

4. Extrusheet Panels:

a. The extrusheet panels for each sign shall be of the length and width specified in the contract.

b. The width of the top, intermediate, and bottom panels shall be in the sequence shown in the contract for each sign.

c. There shall be no longitudinal gap between panel joints on the sign face, and the face of the panels shall be in the same plane on the sign face.

d. The ends of all panels in any one sign shall be perpendicular and in line. The ends shall be free from burrs.

e. The surface of all sign panels shall be flat and free of flaws.

f. The sign shall be attached to vertical supports as shown in the contract.

g. The vertical supports shall be flush with the top of the sign.

5. Type B Sign Legends:

a. Letters, numerals, symbols, and border for Type B signs shall be directly applied.

b. Large letters, numerals, and symbols may be fastened to the panel face with self-plugging type rivets, 1/8 inch (3 mm) in diameter and of all aluminum construction, when they cannot be directly applied.

(1) Rivet length shall be as recommended by the manufacturer for the combined thickness of each legend material and the structural panels to which they are applied.

(2) After a rivet is set, the stem, if remaining, shall be trimmed flush with the rivet head in a manner recommended by the rivet manufacturer.

6. Height of all signs shall be as shown in the contract.

7. The Engineer will upon request establish by stake (or mark on the pavement) the location of each sign and will also establish the elevation of the edge of the roadway if it does not exist.

b. Sign Offsets:

(1) In urban areas signs shall be mounted so that any edge of the sign which is adjacent to a roadway will be 2 feet (600 mm) outside of the curb where there is a barrier type curb.

(2) On rural freeways (interstate), the edge of any sign shall be at least 35 feet (10.7 m) from the edge of the roadway, excluding exit gore signs.

(3) On rural expressways, the edge of any sign shall be at least 30 feet (9.1 m) from the edge of the roadway, excluding exit gore signs.

(4) On urban freeways or expressways, the edge of any sign shall be at least 30 feet (9.1 m) from the edge of the roadway, excluding exit gore signs.

8. Type B and C signs shall be erected so that the sign face is vertical and positioned as shown in the contract. On curved alignments, the angle of placement should be determined by the course of approaching traffic rather than by the roadway edge at the point where the sign is located.

9. Sign Fasteners:

a. Type A signs shall be fastened to sign posts with threaded bolts as described in Section 1071.

b. Type B and C signs shall be fastened to the supports in accordance with the recommendations of the extrusheet panel manufacturer. All supports shall be cut off flush with the top of the sign.

10. Breakaway Posts:

a. The Contractor shall drill wood posts as shown in the contract to provide a breakaway feature.

b. Steel Posts:

(1) The Contractor shall fabricate steel beam breakaway posts in accordance with Section 708.

(2) Mill test reports shall be submitted to the Engineer before fabrication.

(3) The saw cut for the breakaway hinge should be made on the job site to avoid deformation of the pre-cut post in shipping.

(4) The saw cut shall be free of galvanizing material.

(5) The saw cut and any damage to galvanizing shall be repaired in accordance with Method 2 of Section 1061.

(6) Any deformation of the post shall be cause for rejecting the post.

(7) The fuse plate bolt shall be tightened by the turn-of-the-nut method described in Subsection 708.03. The base connection assembly shall follow the procedure outlined in the contract which shall include rechecking the torques until all bolts in the base have the described torque. This procedure shall be repeated immediately preceding the final inspection of the project.

(8) Footings for roadside mounted signs on steel beam breakaway posts shall be concrete.

(i) The footing shall be circular in shape and of the diameter and depth shown in the contract.

(ii) Before placing concrete footings, stub posts shall be placed so the posts are plumb and correctly spaced.

(iii) Footings shall be no higher than 4 inches (100 mm) above the ground to prevent snagging.

(iv) Footing construction shall be in accordance with the applicable requirements of Sections 702, 704, and 707.

11. When 2 or more signs are required on an overhead sign support, the bottom of all signs shall have the same elevation so they will be horizontally aligned with each other. All signs shall be hung at a minimum of 2 feet (600 mm) above the sign support walkway. Sign posts and vertical supports used as sign stiffeners shall be cut off flush with the top of the sign.

417.04 -- Method of Measurement

1. Providing, fabricating, and installing Types A, B, and C signs shall be measured by the square foot (m²).

2. Providing and installing breakaway steel supports for Type A and Type B signs shall be measured by the pound (Kg) of unplated, unwelded, and undrilled steel. The pounds (Kg) of steel shall be the weight per foot (m) multiplied by the length of sign support above the stub post required at each location. Connection shall be subsidiary to this item.

3. Providing, fabricating, and installing wood supports for Type A and Type B signs shall be measured for payment by the linear foot (meter). The quantity to be paid for shall be the actual support length used or as ordered by the Engineer.

4. Providing and constructing concrete footings for a steel beam breakaway post for Type A and B signs will be measured by the each for each post.

417.05 -- Basis of Payment

1. Pay Item	Pay Unit
Type A Sign	Square Foot (SF) [Square Meter (m ²)]
Type B Sign	Square Foot (SF) [Square Meter (m ²)]
Type C Sign	Square Foot (SF) [Square Meter (m ²)]
Install Type A Sign	Square Foot (SF) [Square Meter (m ²)]
Install Type B Sign	Square Foot (SF) [Square Meter (m ²)]
Install Type C Sign	Square Foot (SF) [Square Meter (m ²)]
Structural Steel for Sign Supports	Pound (lb) [Kilogram (kg)]
4 x 4 Inch Wood Sign Support	Linear Foot (LF) [Meter (m)]
4 x 6 Inch Wood Sign Support	Linear Foot (LF) [Meter (m)]
_____ Sign Support Footing	Each (ea)

2. Furnishing and installing 40 inch (1 m) long stub posts and the required reinforcing steel shall be subsidiary to the "_____ Sign Support Footing".

3. Connecting and mounting hardware shall be subsidiary to the relevant pay item.

4. Payment is full compensation for all work described in this Section.

SECTION 418 -- OVERHEAD SIGN SUPPORTS

418.01 -- Description

1. a. "Overhead Sign Support, Location _____" shall consist of:

(1) Providing all materials to construct overhead sign supports.

(2) Transporting all sign support materials to the project site.

(3) Constructing all trusses and other sign support structures as shown in the contract (including attachment of sign brackets to the structure).

(4) Providing the Department copies of the manufacturer's designs of the overhead sign support structure. Steel cantilever and steel truss or aluminum box truss structures shall be manufacturer-designed. Bridge brackets shall comply with the design provided in the contract.

(5) (i) Providing the design for the concrete foundation for the sign support.

(ii) The foundation shall be continuous between the vertical end supports of the sign structure when the foundation is located in the median and will require impact attenuators.

(iii) Foundation design shall be based on test results of soil borings taken from the location of each overhead sign support. Soil borings, soil analysis, and foundation design must be performed by individuals proficient in that line of work.

(iv) The Contractor shall submit two (2) complete Geotechnical Engineering Reports showing the soil analysis of the borings taken at each of the sign support locations, eight (8) complete 1/2 size sets of plans of the foundation design drawings, and eight (8) complete sets of reports on the foundation design computations to the Engineer for review.

(v) The foundation design drawings and computations must be signed and stamped by a registered Professional Engineer licensed in Nebraska. Acceptance of the foundation design(s) by the Department will be based upon this seal and signature.

b. Aluminum or steel trusses that span multi-lane roadways and when shown in the contract, shall be provided with a sign lighting system in accordance with Sections 401 through 412.

c. Steel cantilevers shall be installed at the side of the roadway with the horizontal member overhanging the roadway and shoulder.

d. Steel sign brackets shall be attached to existing roadway bridges spanning the roadway and when shown in the contract, shall be provided with a sign lighting system in accordance with Sections 401 through 412.

e. Plans shall be augmented by Contractor-furnished working drawings submitted in accordance with Subsection 105.02.

2. Full Span and Cantilever Sign Structures:

a. The overhead sign supports shall be steel or aluminum box or single panel truss structures.

b. The work shall consist of designing, furnishing, and erecting a structure, complete with vertical end supports, span members, walkways, sign brackets, foundations, and all necessary material and fasteners for assembling the structures. All material fabrications shall be in accordance with the applicable requirements of Sections 401 through 412, 417, 708, and 1040.

c. All overhead sign support structures shall be fabricated in a plant owned and operated by a fabricator sufficiently experienced to manufacture the structures in accordance with these Specifications. The Contractor shall furnish the name and address of the fabricator, if requested by the Engineer, and evidence of the fabricator's qualifications and experience.

418.02 -- Material Requirements

1. Aluminum cantilevers, trusses, and other sign supports shall be made from the alloys in Table 418.01 and shall conform to the indicated ASTM requirements.

2. Steel sign supports for Type B and C (See Section 417 for type definitions) signs shall be fabricated from structural steel conforming to the requirements of ASTM A 36/A 36M with a maximum working stress of 20,000 psi (140 MPa). After fabrication, the cantilever members shall be galvanized in accordance with ASTM A 123.

Table 418.01
Alloy Requirements

Member or Shape	Aluminum Alloy	ASTM Requirements
Extruded tubes for chord and column members	6061-T6	B211/B 211M; B 429
Bracing Members	6063-T6	B221/B 221M; B 429
Extruded Shapes	6061-T6	B211/B 221M; B 308/B 308M
Plates	6061-T6	B209/B 209M
Post Base and Chord Flange	356.0-T6	
Aluminum Alloy Sand Castings	356.0-T6	B26/B26M
Aluminum Alloy Permanent Mold Castings	356.0-T6	B 108
Grates	6061-T6	B211/B 211M; B221/B221M
Bearing Bars	6061-T6	B211/B 211M; B221/B221M
Cross or Crimp Bars	6063-T5	B211/B 211M; B221/B221M
Pipe Handrail	6061-T6/6063-T6	B 221M; B 241/B 241M
Post and Chord Caps	356.0-F	B 26/B 26M
Anchor Bolts & Nuts	---	A 325
Galvanizing	---	A 153

3. Steel sign brackets to be attached to existing bridges shall be fabricated from structural steel conforming to ASTM A 36/A 36M with a maximum working stress of 20,000 psi (140 MPa).

4. Concrete Foundations:

a. The reinforced concrete foundations shall be constructed to the dimensions shown in the shop plans.

b. The materials and construction methods shall be in accordance with the applicable requirements of Sections 702, 704, and 707 and as required in the shop plans.

5. Anchor Bolts for Sign Supports:

a. The structure manufacturer shall design and furnish all required anchor bolts (as specified below). Each anchor bolt shall be provided with seven (7) heavy hex nuts and two hardened steel flat washers.

(1) The Contractor shall furnish an extra bolt sample (including nuts and washers) from each heat of steel used on the project (or multiple projects) to the Materials and Research Division for destructive testing.

(2) Anchor bolts shall be straight rods threaded a minimum of 24 inches on the top end and a minimum of 24 inches on the bottom end. The threads of all anchor bolts must be rolled in accordance with standard industry practice.

(3) The use of cut threads will not be permitted. Galvanizing the anchor bolts and heavy hex nuts will not be allowed. Prior to shipment, the top 24 inches of the anchor bolt together with its heavy hex nuts and hardened flat washers shall be cleaned and painted with zinc rich paint to a minimum dry film thickness of 4 mils. The type of zinc rich paint and its method of application will be approved by the Department.

(4) The minimum foundation design acceptable for cantilever sign structures will be one detailing six (6) – 2 inch (50 mm) diameter anchor bolts (designed for fatigue) of AASHTO M-314, Grade 55 or equivalent steel.

(5) The minimum foundation design acceptable for overhead sign support structures will be one detailing four (4) – 2 inch (50 mm) diameter anchor bolts (4 for each support, designed for fatigue) of AASHTO M-314, Grade 55 or equivalent steel.

(6) Regarding Overhead Span and Cantilever Sign Structures, the Contractor's actual design may require a greater number of anchor bolts, anchor bolts of larger diameter or both. In all cases, however, anchor bolts must meet AASHTO M-314, Grade 55 or equivalent steel.

(7) The design shall allow sufficient space between the shaft supports and the anchor bolts (and/or between the hand hole opening flange and the anchor bolts), to allow the use of deep well sockets which are required when performing proper tensioning of the anchor bolt nuts in accordance with NDOT Specifications.

b. The heavy hex nuts shall meet the requirements of ASTM A-563 Grade C3 or DH3.

c. The plain hardened steel washers shall conform to the requirements of ASTM F 436 Type 3 or ASTM F 436M Type 3. If Type 3

plain hardened steel washers are not available for the specified bolt diameter, mechanically deposited zinc coated hardened steel washers conforming to the requirements of ASTM F 436 or ASTM F 436M shall be used. Only flat washers shall be used. The use of lock washers will not be permitted.

d. Anchor bolts of the specified size for each support shall be supplied in an assembly retained with steel templates (conforming to the requirements of ASTM A 36/A 36M) and nuts (see plan detail) to prevent their movement while the concrete footing is being poured to ensure proper bolt spacings and alignment. Welding on anchor bolts will not be permitted. This assembly shall be detailed on the shop plans. The anchor assembly cage shall be placed at the depth shown in the shop plans, properly aligned and secured in place before placing concrete. Once the concrete has set, no adjustments or realignments shall be made to the anchor bolts. Field straightening of anchor bolts will not be allowed. The anchor bolts shall be truly vertical, with no more than a 1/8 inch deviation in 12 inches (3 mm in 300 mm) of length permitted. Anchor bolt projection above the base plate shall allow for the thickness of a hardened flat washer, for the capture of two heavy hex nuts plus 1/2 inch, while allowing no more than two anchor bolt diameters between the top of the concrete foundation and the bottom of the base plate.

e. The manufacturer of the anchor bolts shall furnish certification and test reports covering the steel used. The test report shall show the following:

- (1) Chemical analysis of the steel used.
- (2) Yield strength in pounds per square inch (MPa).
- (3) Tensile strength in pounds per square inch (MPa).
- (4) Percent elongation in 2 inches (50 mm).
- (5) Percent reduction in area.

6. Overhead Span and Cantilever Sign Design Requirements:

a. (1) The overhead span and cantilever sign structures shall be box or single panel trusses designed in accordance with the latest edition of the *Specifications for the Design and Construction of Structural Supports for Highway Signs*, published by the American Association of State Highway Transportation Officials.

(2) All overhead structures shall be designed to be supported by single poles or end frames having no more than 2 vertical main members of a closed cross section.

(3) The sign spans, sign locations, and sign mounting heights used for structure calculations shall be as shown in the contract.

(4) The design areas used for calculations shall be the sign areas shown plus 30% or as noted on the contract.

b. Overhead Span Materials:

(1) Designs, materials, and basic member shape, once selected, shall be used throughout the project.

(2) Overhead Truss Structures shall be aluminum or steel galvanized after fabrication. Cantilever Structures shall be of galvanized steel.

c. Footings shall be reinforced concrete with the overhead portion of the structure attached by means of base plates and anchor bolts. The top of each footing shall extend 12 inches (300 mm) above ground level and shall have a 1 inch (25 mm) chamfer on its edges. Footings shall be constructed so that the top surface shall be level [less than 1/4 inch in 3 feet] (6 mm in 900 mm).

d. Footing Design:

(1) The contractor shall design a concrete foundation showing foundation dimensions, reinforcement and anchor bolts for each of the sign structure locations requiring a new foundation. Foundation design shall be based on test results of soil borings taken from the areas of each of the new sign structure locations. Soil borings, soil analysis and foundation design shall be performed by individuals proficient in that line of work.

(2) The contractor shall submit two complete Geotechnical Engineering Reports showing the soil analysis of the borings taken at each of the sign structure locations: six complete half-size sets of foundation design drawings together with two complete sets of foundation design computations to the traffic engineer for review.

(3) The foundation design drawings and computation shall be signed and stamped by a registered professional engineer, licensed in Nebraska. Acceptance by the State of the foundation design(s) will be based upon this seal and signature. By applying his/her seal and signature to the design drawing and calculations, the engineer affirms that the foundations are of proper design and material to meet the structural requirements of the specifications.

(4) The minimum foundations design acceptable will be as specified in Paragraph 6 of Subsection 418.02.

(5) Each structure sign footing shall be neatly excavated to its design dimensions; only the top two feet (600 mm) may be formed. The excavation shall be dry with all loose material removed before concrete can be placed.

e. The bottom of aluminum supporting shafts and all anchor bolts shall receive a heavy coating of aluminum filled, resilient sealing compound completely covering all areas which may contact the concrete. The sealing compound shall be on the Department's *Approved Products List*.

f. Corrosion of aluminum caused by contact with dissimilar metals shall be prevented by proper design considerations and installation procedures.

g. Full Span structures shall be lighted with walkways provided in front of and in back of the entire length of the structure.

(1) Sign lighting and electrical equipment for the structure shall be in accordance with the applicable requirements of Sections 401 to 413 and 1073.

(2) The walkways shall be continuous to the vertical access point/support and shall be a minimum of 3 feet in width.

(3) Walkways shall have a railing along the front side which can be folded when not in use. The fold-down handrails shall be limited to sections that are 12 feet (4 m) or less in length.

(4) No part of a walkway or railing in the folded position shall obstruct normal viewing of the sign.

h. Cantilever structures shall be lighted and have front and back walkways, continuous over the width of the sign and shoulder and extending to the vertical end support. These walkways shall be at the same level +/- 6 inches (150 mm).

(1) Both front and back walkways (closest to cantilever arm) shall extend a minimum of 2 feet (600 mm) beyond the sign's vertical edge.

(2) Vertical deflection of the cantilever arm shall be limited to $L/120$.

i. Vertical sign supports for overhead signs shall be constructed independently of the overhead sign structure and/or walkways to allow for future signing changes on the overhead sign structure.

j. For access to the walkway, a ladder or other type of foot support shall be constructed on the end support beginning 9 feet (3 m) above the ground.

k. Connecting bolts on structures will be ASTM A 325 Type I, galvanized.

l. Before fabrication, the Contractor shall prepare and submit complete design drawings, calculations, and other supporting data for approval. These shall include 6 sets of prints and drawings on half size plan sheets (11 x 17 inches [297 x 420 mm]) and 2 sets of design computations prepared and signed by a registered Professional Engineer licensed in Nebraska.

418.03 -- Construction Methods

1. General:

a. The Contractor shall take precautions to avoid scarring or marring aluminum or galvanized surfaces. Any such damage which, in the judgment of the Engineer, gives an objectionable appearance or contributes to weakening of the structure will be cause for rejection.

b. The Contractor shall remove all casting irregularities from cast parts.

c. Tubing shall be seamless; and exterior and interior surfaces shall be clean, smooth, and free from slivers, lamination, grooves, cracks, or other defects.

d. Poor welding skill, as noted by visual inspection, will be sufficient cause for rejection.

2. Fabrication of Sign Structures:

a. Aluminum alloy fabrication shall conform to AWS procedures and the following:

(1) Thermal cutting will not be allowed.

(2) Material 1/2 inch (12.5 mm) or less in thickness may be sheared, sawed, or milled. Material over 1/2 inch (12.5 mm) in thickness shall be sawed or milled. Cut edges shall be true and free from excessive burrs or ragged breaks.

(3) Material to be bent may be heated to a temperature not exceeding 400°F (205°C) for a period not exceeding 15 minutes to facilitate bending.

(4) Bolt holes shall be drilled full size or subpunched 1/8 inch (3 mm) smaller than the nominal diameter of the fastener and reamed to size. Unless otherwise indicated in the contract, the finished diameter of the holes shall be not more than 7% greater than the nominal diameter of the fastener.

(5) The length of the vertical end frames for structures shall be field checked before fabrication.

b. Fabrication of steel materials (center mounts, cantilevers, and sign brackets) shall be in accordance with the applicable requirements of Section 708. Center mount and cantilever structures shall be galvanized as required by the contract. Sign brackets shall be painted in accordance with the applicable requirements of Section 709 and as required by the contract.

3. Aluminum Welding Requirements:

a. (1) The aluminum alloys shall be welded in accordance with the ASTM requirements listed below:

<p>Wrought heat-treatable alloys Alloy 6061 Alloy 6063</p> <p>Cast heat-treatable alloy Alloy 356.0</p>
--

(2) Material used for permanent backing shall be at least equivalent in weldability to the base metal being welded.

(3) These Specifications include provisions for welding by the gas metal-arc process and the gas tungsten-arc process.

(4) Bare wire electrodes for use with the gas metal-arc process and welding rods for use with the gas tungsten-arc process shall conform to the requirements of *Specifications for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes, AWS A5.10*.

(5) Tungsten for the gas tungsten-arc process shall conform to the requirements of *Specifications for Tungsten-Arc Welding Electrodes, AWS A5.12*. Filler metals to be used with particular base metals shall be as shown in Table 418.02. Other filler metals may be used as approved by the Engineer.

**Table 418.02
Filler Metal Requirements**

AWS Base Metal	Use Filler Metal
6061 welded to 6063	ER5356
6063 welded to 6063	ER5356
356.0 welded to 6061	ER4043
356.0 welded to 6063	ER4043

(6) (i) Filler metals shall be kept covered and stored in a dry place at relatively uniform temperatures.

(ii) Original rod or wire containers shall not be opened until time to be used.

(iii) Rod and wire shall be free of moisture, lubricant, or other contaminants.

(iv) Spools of wire temporarily left unused on the welding machine shall be kept covered to avoid dirt and grease contamination.

(v) If a spool of wire is to be unused for more than a short length of time, it shall be returned to the carton and the carton tightly resealed.

(7) (i) Shielding gases shall be welding grade or better. Shielding gas for gas metal-arc shall be argon, helium, or a mixture of the two (approximately 75% helium and 25% argon).

(ii) Shielding gas for gas tungsten-arc welding done with alternating current shall be argon.

(iii) Shielding gas for gas tungsten-arc welding done with direct current, straight polarity, shall be helium.

(iv) Hose used for shielding gases shall be made of synthetic rubber or plastic.

(v) Natural rubber hose shall not be used. Hose which has been previously used for acetylene or other gases shall not be used.

b. (1) (i) Joint details shall be in accordance with design requirements and detail drawings.

(ii) The location of joints shall not be changed without the approval of the Engineer.

(iii) Edge preparation shall be by sawing, machining, clipping, or shearing. Gas tungsten-arc or gas metal-arc cutting may also be used.

(iv) Cut surfaces shall meet the American Standards Association surface roughness rating value of 1,000.

(v) Oxygen fins, tears, and other defects which would adversely affect the quality of the weld will not be allowed.

(vi) Dirt, grease, lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing.

(vii) On all edges and surfaces to be welded, the oxide shall be removed just before welding by wire brushing or by other mechanical methods such as rubbing with steel wool or abrasive cloth scraping, filing, rotary planing, or sanding. If a wire brush is used, the brush shall be made of stainless steel.

(2) Hand or power driven wire brushes which have been used on other materials shall not be used on aluminum.

(3) (i) Where mechanical methods of oxide removal are found to be inadequate, a standard chemical method shall be used.

(ii) Chemical removal of aluminum oxide shall be accomplished by one of the chemical treatments recommended in the AWS or the Aluminum Association *Welding Aluminum* pamphlet.

(iii) Welding shall be done within 24 hours after chemical treatment.

(iv) When gas tungsten-arc welding with direct current, straight polarity, is being used, all edges and surfaces to be welded shall have the oxide removed by a standard chemical method.

(v) Welding shall not be done on anodically treated aluminum unless the condition is removed from the joint area to be welded.

(4) (i) All butt welds requiring 100% penetration, except those produced with the aid of backing, shall have the root of the initial weld chipped or machined out to sound metal before welding is started from the second side.

(ii) Butt welds made with the use of backing shall have the weld metal thoroughly fused with the backing.

(iii) Where accessible, backing for welds that are subject to computed stress or which are exposed to view on the completed structure and which are not otherwise parts of the structure shall be removed and the joints ground or machined smooth.

(iv) In tubular members, butt welds subjected to computed stresses shall be made with the aid of permanent backing rings or strips.

(5) The procedure used for production welding of any particular joint shall be the same as that used in the procedure qualification for that joint.

(6) Undercut shall not be more than 0.01 inch (0.25 mm) deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall not be more than 1/32 inch (0.8 mm) deep when its direction is parallel to the primary stress in the part that is undercut.

(7) No overlap shall be allowed.

(8) All craters shall be filled to the full cross section of the welds.

(9) Welds having defects greater than the levels of acceptance specified above shall be considered as rejected unless corrected as indicated below.

(10) All welding operations, either shop or field, shall be protected from air currents or drafts to prevent any loss of gas shielding during welding. Adequate gas shielding shall be provided to protect the molten metal during solidification.

(11) The work shall be positioned for flat position welding whenever practicable.

(12) In both the shop and field, all weld joints shall be dry at the time of welding.

(13) The size of the electrode, voltage, amperage, welding speed, gas or gas mixture, and gas flow rate shall be suitable for the thickness of the material, design of joint, welding position, and other circumstances attending the work.

(14) Gas metal-arc welding shall be done with direct current, reverse polarity.

(15) Gas tungsten-arc welding shall be done with alternating current or with direct current, straight polarity.

(16) (i) When the joint to be welded requires specific root penetration, the Contractor shall make a sample joint and a macroetched cross section of the weld to demonstrate that the joint welding procedure used will attain the required root penetration.

(ii) The sample joint shall have a length of at least 1 foot (300 mm) and shall be welded with the electrode, polarity, amperage, voltage, speed, gas mixture, and gas flow rate that are proposed to be used in production welding.

(iii) Tolerance for variation of amperage and voltage shall be plus or minus 10% for amperage and plus or minus 7% for voltage during fabrication.

(iv) The Engineer, at his/her discretion, may accept evidence on record in lieu of the preceding test.

(17) Where preheating is needed, the preheating temperature shall not exceed 350°F (177°C) for heat-treated alloys and 600°F (315°C) for non-heat-treated alloys. The temperature shall be measured by temperature indicating crayons or by pyrometric equipment. Heat treated alloys shall not be held at the maximum preheat temperature or at temperatures near the maximum for more than 30 minutes.

c. Weld Quality:

(1) Regardless of the method of inspection, the acceptance or rejection of welds shall be determined by the following conditions:

(i) Cracks in welds or adjacent base metal are not acceptable.

(ii) Copper inclusion is not acceptable.

(iii) Porosity in excess of that allowed by Appendix IV, Section VIII of the ASME Boiler and Pressure Vessel Code will not be acceptable.

(iv) Lack of fusion, incomplete penetration, or tungsten or oxide inclusions are acceptable only if small and well dispersed.

(2) For highway sign structures, the dye penetrant method shall be used on butt welds in columns, main chord members, and on fillet welds connecting columns to bases and main chord members, including the associated flanges, gussets, or main load carrying brackets or members. This method shall also be used on fillet welds connecting flanges to the main truss chord members.

(3) The dye penetrant tests shall be performed in accordance with the requirements of ASTM E 165, Standard Methods for Liquid Penetrant Inspection, Method B.

(4) Dye penetrant inspection may be omitted if the Inspector examines each layer of weld metal with a magnifier (3X power minimum) before the next successive layer is deposited.

(5) Dye penetrant inspection will be required and performed at the Contractor's expense. Personnel performing liquid penetrant inspections shall be qualified as required in AWS. In all cases where the dye penetrant method is done by the Contractor, the inspector must be present when the inspection is made.

d. (1) The Contractor may make the corrections shown in Table 418.03 when a weld is defective. These corrective measures shall be approved by the Engineer before work begins.

**Table 418.03
Welding Defects**

Problem	Corrective Action
Defective weld	Remove and replace the entire weld.
Cracks in weld or base metal	Determine full extent of crack by dye penetrant method or other positive means. Remove crack throughout its length and depth and reweld.
Excessive porosity, lack of fusion	Remove defective portions and reweld.
Copper or tungsten inclusion	Remove defective portions and reweld.
Excessive concavity of crater, undercut, undersize weld	Clean and deposit additional weld metal.
Overlap	Reduce by removal of excess weld metal.

(2) The Contractor shall remove the defective areas by chipping or machining. Oxygen cutting shall not be used. Before rewelding, the joint shall be inspected to assure that all of the defective weld has been removed. If dye penetrant has been used to inspect the weld, all traces of penetrant solutions shall be removed with solvent, water, heat, or other suitable means before rewelding.

e. Qualification of Procedures, Welders, and Welding Operators:

(1) Joint welding procedures which are to be employed in executing contract work under these Specifications shall be previously

qualified by tests described in Part B, Section IV, of the ASME Boiler and Pressure Vessel Code. The qualifications shall be at no additional cost to the Department. The Engineer, at his/her discretion, may accept evidence of previous qualifications of the joint welding procedures to be employed.

(2) All welders and welding operators to be employed under these Specifications shall be previously qualified by tests as described in Part V, Section IX, of the ASME Boiler and Pressure Vessel Code. The Engineer, at his/her discretion, may accept evidence of previous qualification of the welders and welding operators to be employed. The same process and type of equipment that is required for execution of the construction work shall be used in qualifying welders and welding operators.

f. Steel welding shall be in accordance with Section 708.

4. Inspection of Single Panel or Box Truss Sign Structures:

a. The Contractor shall inspect single panel and box trusses in accordance with Section 708. All mill test reports and certifications shall be furnished to the Engineer before any requests for shop inspection are made.

b. To determine compliance with these welding procedures, all welds shall be visually inspected and a random sample of welds shall be chosen by the inspector to be investigated using dye penetrants.

5. Fastening to Supports:

a. In fastening a sign to the supports, the Contractor shall follow the recommendations of the manufacturer of the extrusheet panels as to frequency of post clamps and torque on nuts.

b. The Contractor shall exercise care in handling and erecting signs so damage is prevented. The Contractor shall replace at no additional cost to the Department any sign which is damaged before final project acceptance.

6. Field Installation of Sign Structures:

a. The Engineer or his designated representative shall be present at all times during pole installation. The Contractor shall notify the Materials and Research Division and Traffic Engineering Division to arrange for inspection no less than 3 days prior to pole installation. No poles installed without proper inspection will be accepted by the state for final payment.

b. Proper Tensioning of Sign Structure Anchor Bolts and Connecting Bolts

In order to provide the correct tension to anchor bolts, the Contractor will be required to have on hand the following items:

(1) A standard combination wrench (box end/open end) 24 inches in length for snug tightening of bolts less than 1 3/4" diameter and a Standard Combination wrench 36 inches in length for bolts equal to or greater than 1 3/4" diameter.

(2) A deep well impact socket for final tightening, for each size nut being installed.

(3) A torque multiplier (plate reaction style) with the following minimum requirements:

Gear Ratio: 60:1
Torque Ratio: 52:1
Output Capacity: 8000 ft.-lb.

Anchor bolt hold-down nuts and connecting bolt nuts shall be tightened by the turn-of-the-nut method as described below, but only after determining that the leveling nut/flat hardened washers for the anchor bolt are in full contact with the underside of a level base plate.

Turn-of-the-Nut Method

(a) Snug tighten and final tighten all nuts in a “star” pattern.

(b) Using the appropriate combination wrench, apply full effort of a workman to the end of the wrench to “snug tighten” the nut.

(c) Mark the location of one corner of the nut on the base plate.

(d) Using the torque multiplier and the mark placed on the base plate; for nuts that are equal to or greater than 1 ¼”, tighten the nut onto the anchor bolt by giving the nut 1/6th of a turn (this is equal to turning the nut onto the anchor bolt a distance equal to the length of one flat or until the next corner of the nut is even with the mark on the base plate). For nuts less than 1 ¼” diameter, use a 1/3rd of a turn.

(e) Install a “lock nut” or “jam nut” on each of the anchor bolts by repeating steps (a) through (c).

(f) After the top nuts are fully tightened, all leveling nuts should be retightened to assure that full contact has been maintained with the bottom of the base plate.

Connecting bolt nuts shall be tightened by the same turn-of-the-nut method as described for anchor bolts with the exception that the bolt head must be held stationary while applying the torque multiplier.

Nuts shall be rechecked for tightness by the Contractor no less than 14 days, nor more than 30 days following installation in the presence of the Engineer. After the structure has been checked, lock nuts shall be installed to keep the nuts from working loose.

c. The Contractor shall dress, as necessary to provide a proper seating of the bases, the areas of the foundation concrete upon which the shafts are to be set before the erection of the aluminum vertical end supports. The bottoms of the supporting shafts and all anchor bolts shall receive a heavy coating of aluminum filled, resilient sealing compound, completely covering all areas of aluminum which may contact the concrete. The compound used shall be on the Department’s *Approved Products List*.

d. The Contractor shall assemble the truss sections in the field on the ground and adjust them with shims to provide the camber called for in the contract. While assembled, the truss shall be erected on the end frames in one piece.

e. The end supports shall be erected on the leveling nuts to a truly vertical position and then the top nuts securely tightened to the plate.

The grout shall not be placed until the truss has been erected, adjusted, and bolted to final position. The final projection of the base plate above the concrete foundation shall be no greater than the thickness of two leveling nuts.

f. After the structure has been erected and completed and all signs mounted, the area between the top of the foundation and the bottom of the anchor base plates of the vertical end supports shall be filled using a high strength, non-shrink, grout from the Approved Products List. The grouting shall be placed the same day that the uprights are installed on the foundation.

7. Overhead Sign Electrical Requirements:

a. Signs requiring electricity will be identified in the contract.

b. The luminaires shall be on the Department's *Approved Products List*.

c. The sign lighting luminaires shall be mounted as shown in the contract and in accordance with the manufacturer's instructions.

d. The lamps shall be 150 watt high pressure sodium unless shown otherwise in the contract.

e. All conductors shall be copper and shall be installed in conduit. The feeder cable shall be a minimum No. 8 gauge diameter THWN with a 30 ampere circuit breaker at the service entrance. Each sign structure shall be controlled by a 15 ampere 2 pole NEMA 3R breaker at a location convenient for maintenance of the luminaires.

f. Each sign structure shall have a photoelectric control mounted near the sign. The relays for switching the line current to the lighting fixtures shall be mounted near the circuit breaker or as directed by the Engineer. Separate photocells are not required when sign lighting is tied into the roadway lighting.

g. Structure electrical equipment and material, when required, shall be in accordance with the applicable requirements of Section 1073.

8. a. The Contractor shall provide manufacturer-designed steel or aluminum box-truss overhead sign supports or steel brackets attached to a roadway bridge for Type B and C signs.

b. The structures that will support the Type B and C signs shall be constructed in conformance with Sections 417, 702, 704, 707, and 708 and as described in the contract.

9. When two or more signs are required on an overhead sign support, the bottom of all signs shall have the same elevation so they will be horizontally aligned with each other. All signs shall be hung at a minimum of 2 feet (600 mm) above the walkway. Sign posts and vertical supports used as sign stiffeners shall be cut off flush with the top of the sign.

418.04 -- Method of Measurement

1. Overhead Sign Supports are measured by the Each.

2. The foundation design and geotechnical work, including but not limited to borings, analysis, designs, and submittals of the required drawings

and reports, will not be measured for payment, but shall be considered subsidiary to the item "Overhead Sign Support, Location _____".

3. Concrete for overhead sign support foundations is measured by the cubic yard (CY).

4. Reinforcing steel for overhead sign support foundations is measured by the pound (lb).

418.05 -- Basis of Payment

1. Pay Item	Pay Unit
Overhead Sign Support, Location _____	Each (ea)
Sign Structure Foundation Design, Location _____	Each (ea)
Class _____ Concrete for Sign Support Foundations	Cubic Yard (CY) [Cubic Meter (m3)]
Reinforcing Steel for Sign Support Foundations	Pound (lb) [Kilograms (kg)]
Concrete for Foundation	Cubic Yard (CY) [Cubic Meter (m ³)]
Reinforcing Steel	Pounds (lbs) [Kilograms (kg)]

2. The anchor bolt and/or anchor bolt assemblies required for the overhead sign support shall not be paid for directly, but shall be considered subsidiary to "Overhead Sign Support, Location _____".

3. The sign structure grounding system is subsidiary to the item "Reinforcing Steel".

4. Excavation for foundations is subsidiary to the item "Sign Structure Foundation Design, Location _____".

5. Soil borings and soil analysis for the sign structure foundation is subsidiary to "Sign Structure Foundation Design, Location _____".

6. Payment is full compensation for all work described in this Section.

SECTION 419 -- TRAFFIC CONTROL MANAGEMENT AND SURVEILLANCE

419.01 -- Description

1. When the pay item "Traffic Control Management" is shown in the contract, the Contractor shall accomplish the requirements in Section 419.02, Paragraph 1 and 2. This pay item will only be utilized when directed by the Engineer.

2. When the pay item "Surveillance of Temporary Traffic Control Devices" is shown in the contract, then the Contractor shall accomplish the requirements in Section 419.02, Paragraph 1 and 3. This pay item will only be utilized when directed by the Engineer.

3. The Contractor shall be alert at all times to any and all deficiencies in the placement and maintenance of any traffic control devices and shall take immediate action to correct any deficiencies.

419.02 -- Construction Methods

1. Traffic Control Personnel

a. The Traffic Control Manager shall be qualified by having attended and having satisfactorily passed the examination which accompanies the training course for Traffic Control Supervisor or Traffic Control Technician offered by the American Traffic Safety Services Association (ATSSA) or the Basic Traffic Control or Advanced Traffic Control courses offered by Nebraska LTAP. The training shall have been completed no more than 4 years prior to working on the project. Other certifications may be accepted if approved by the Engineer. The Traffic Control Manager shall also possess a current valid Flagger Certification Card. Documentation of the Traffic Control Manager's training or certifications shall be provided to the Engineer prior to the installation of any traffic control devices on the project.

b. The Assistant Traffic Control Managers shall be qualified by certification according to the Department's certification program for Assistant Traffic Control Managers, the training shall have been completed no more than 2 years prior to working on the project. The Assistant Traffic Control Managers may be qualified by having attended and having satisfactorily passed the examination which accompanies the training course for Traffic Control Technician or Traffic Control Supervisor offered by ATSSA or the Basic Traffic Control or Advanced Traffic Control courses offered by Nebraska LTAP. The training shall have been completed no more than 4 years prior to working on the project. Documentation of the Assistant Traffic Control Manager's training or certifications shall be provided to the Engineer. The Assistant Traffic Control Manager shall also possess a current valid Flagger Certification Card.

c. Department Certification Program:

(1) In order to be qualified according to the Department's Certification Program, the prospective Assistant Traffic Control Manager must:

(i) View the video "Training and Certification of Assistant Traffic Control Managers."

(ii) Correctly answer 80% of the questions on an examination that accompanies the video.

(2) Upon satisfactory completion of the training and examination procedure, the prospective Assistant Traffic Control Manager shall be issued an Assistant Traffic Control Manager Certification Card by the examining Contractor. The Assistant Traffic Control Manager's name, last four digits of their social security number, and test score shall be reported to the Engineer on DR Form 90a, "Certification Report for Assistant Traffic Control Managers."

(3) The video examination forms, Assistant Traffic Control Manager Cards, and Certification Reports for Assistant Traffic Control Managers will be furnished by the Department.

2. Traffic Control Management

a. This work shall consist of providing Traffic Control Management by furnishing one or more qualified individuals who shall be specifically responsible for performing or supervising the installation, inspection, maintenance, and removal of all traffic control devices.

b. The qualified personnel shall insure that all traffic control devices are functioning properly, are clean, and are correctly located as shown on the Traffic Control Plan or as directed by the Engineer.

c. The qualified personnel shall inspect all traffic control devices on every calendar day that traffic control devices are in place, whether in use or covered. Inspections shall take place a minimum of twice daily, and at least two inspections shall be eight hours apart. However, during or following periods of inclement weather or when the situation warrants for other reasons, inspections shall be done more frequently. At least one inspection each week shall occur during hours of darkness. Additionally, when flagger controls are being utilized, at least one inspection each week shall be performed during flagging operations for monitoring purposes. The qualified personnel shall perform the inspections. The qualified personnel shall complete a Traffic Control Inspection form provided by the Engineer at the completion of each inspection. These forms shall be submitted daily to the Engineer, either in person or other method agreed to by the Engineer.

d. The qualified personnel shall monitor the cleaning and maintenance of all traffic control devices and the placement of temporary pavement markings.

e. The qualified personnel shall coordinate all traffic control operations, including those of subcontractors and suppliers.

f. The qualified personnel shall coordinate traffic-related activities with the appropriate law enforcement, fire, and emergency medical agencies.

g. When project conditions warrant, the Engineer may suspend the need for Traffic Control Management and will notify the Contractor accordingly. The Engineer will give the Contractor at least three days' notice of the suspension, but the work may be suspended in a lesser time if mutually acceptable to the Department and the Contractor. During periods when no payment is being made for Traffic Control Management, this section will not apply.

h. The Contractor shall designate an individual, other than the Project Superintendent, to be the Traffic Control Manager for the project.

i. The Contractor may also designate one or more Assistant Traffic Control Managers for the project.

j. The qualified personnel's activities on the project shall be dedicated to the purpose of monitoring and maintaining the traffic control devices. The performance of other crafts or trades will be permitted, but shall be secondary to the performance of duties associated with traffic control. The qualified personnel shall not act as a flagger, except in an emergency or when providing relief for short periods of time.

k. The qualified personnel shall be available and reasonably accessible (within 30 minutes) to the project during normal working hours on every day that work is being performed on the project and always on call at other times. During other than normal working hours, these individuals shall respond and be on the project within 60 minutes of notice being given that traffic control items on the project are in need of attention. The Contractor may elect to have an employee or employees perform this function simultaneously on more than one project, but shall not be relieved from the sanctions or disincentives that may be imposed for failure to meet the deadlines specified herein.

l. The Traffic Control Manager shall be required to attend weekly Partnering meetings as requested by the Engineer. The Traffic Control Manager shall also conduct a Traffic Control Partnering Meeting prior to any changes in traffic control.

m. The Contractor shall provide, prior to the installation of any traffic control devices on the project, at least two but no more than four telephone numbers where the Traffic Control Manager or an Assistant Traffic Control Manager may be reached 24 hours a day, 7 days a week.

n. The qualified personnel shall have available at all times an approved, current version of the Traffic Control Plan.

o. If corrective action is not taken by the Contractor within the times specified in Paragraph g, the Engineer may suspend all work on the project until the problem is corrected. The Engineer may make reasonable allowance for existing weather conditions in the case of materials whose installation is governed by temperature or other atmospheric conditions.

p. With regard to inspection, maintenance, and repair of temporary traffic control devices, an assessment in the amount of \$500 per occurrence per day shall be charged to the Contractor when any of the following occur (these assessments shall be in addition to any other liquidated damages which may be assessed):

(1) The Contractor fails to respond within the timeframe specified in Paragraph g. Response time shall begin when:

(i) The Engineer notifies the Contractor of deficiencies in person;

(ii) The Engineer makes notification of deficiencies via the 24 hour phone numbers provided by the Contractor; or

(iii) The Engineer leaves a message or receives no answer at the numbers provided;

(2) The Contractor fails to begin corrective actions to repair, replace, remove, relocate, or clean any traffic control devices or pavement markings within two hours of the completion of an inspection that uncovers deficiencies or within two hours of notification of deficiencies by the Engineer.

(3) The Contractor fails to begin corrective actions to repair, replace, remove, relocate, or clean any traffic control devices or pavement markings within two hours of documented notification by an official law enforcement agency.

(4) The Contractor fails to make or report the inspections described in this Specification.

(5) The Engineer observes and documents any occurrence of the Contractor or his or her subcontractors flagrantly disregarding the necessary maintenance of traffic control devices that are in obvious need of attention.

3. Surveillance of Temporary Traffic Control Devices.

a. The Contractor shall provide continuous surveillance of temporary traffic control devices on a 24 hour per day basis. Continuous shall be defined as having one or more persons on the project at all times. The qualified personnel's activities on the project shall solely be for 24 hour surveillance of temporary traffic control devices.

b. The Contractor shall provide the Engineer with at least two but no more than four telephone numbers of the 24 hour surveillance personnel on the project and shall also provide the Engineer with the names and telephone numbers of personnel to contact if the 24 hour surveillance personnel cannot be located on the project.

c. The qualified personnel assigned to provide the continuous 24-hour surveillance shall insure that all traffic control devices are functioning properly, are clean, and are correctly located as shown on the Traffic Control Plan or as directed by the Engineer. The qualified personnel shall be responsible for identifying deficiencies, and effecting the immediate repair, correction or replacement of the traffic control devices.

d. The qualified personnel assigned to surveillance shall be responsible for completing a Traffic Control Inspection form, provided by the Engineer, at the completion of each 24-hour period. These forms shall be submitted daily to the Engineer, either in person or other method agreed to by the Engineer.

e. Deficiencies should be corrected upon detection, but in no case shall the time limit for correction exceed 60 minutes. Failure to (1) correct deficiencies or (2) respond to notifications from the Department or law enforcement officials within the sixty-minute time period will result in the assessment of a \$1,000 liquidated damage assessment. This liquidated damage assessment will be assessed per occurrence and per calendar day that the deficiency is not corrected. This assessment will be in addition to other liquidated assessment described elsewhere in the proposal.

f. The Engineer may proceed to correct deficiencies in a manner that he or she deems appropriate and assess the Contractor for the costs incurred as a result of the unsatisfactory performance of the corrective action.

419.03 -- Method of Measurement

1. Traffic Control Management and Surveillance:

a. "Traffic Control Management" and "Surveillance of Temporary Traffic Control Devices" will be measured by the day for the actual number of days management and inspection are required and provided. Payment will only be made for one day during each midnight-to-midnight period regardless of the number of Traffic Control Managers or assistants required to adequately perform the work.

b. No measurement will be made when the Engineer has suspended the need for Traffic Control Management and notified the Contractor accordingly.

419.04 -- Basis of Payment

1. Pay Item	Pay Unit
Traffic Control Management	Day (d)
Surveillance of Temp Traffic Control Devices	Day (d)

2. Payment for "Traffic Control Management" or "Surveillance of Temporary Traffic Control Devices" will not be made for any day 24-hour the item is not provided and will not extend beyond the last working day or calendar day allowed by the contract, except for any approved extension of contract time allowance.

3. This price will be considered full compensation for all labor, materials, equipment, tools and incidentals necessary to complete the work described in this Section.

SECTION 420 -- DELINEATORS

420.01 -- Description

1. The Contractor shall furnish and install roadside delineator units in accordance with the details shown in the contract. A delineator unit shall consist of round, acrylic plastic, prismatic reflector(s) mounted on a post. The delineator unit shall be installed at the locations shown in the contract or designated by the Engineer.

2. The prismatic reflectors to be installed on the delineator shall be as follows:

a. Delineators, Type I -- One circular prismatic reflector and post.

b. Delineators, Type II -- Two circular prismatic reflectors mounted vertically on the same side of the post.

c. Delineators, Type III -- Two circular prismatic reflector units mounted back-to-back on a single post.

3. Flexible post delineators shall be installed with one or two 3-inch (75 mm) wide by 9-inch (225 mm) long micro-prismatic reflecting sheeting plates as shown in the contract.

4. Reflectors on the left side of divided streets and highways and one-way roadways shall be yellow in the direction of travel. All other reflectors shall be white.

5. The Contractor shall furnish and install the delineator post, mounting hardware and mount the Department supplied Chevrons as shown in the contract. Chevrons (W1-8) are a Type A sign [18" X 24" (450 mm x 600 mm)] or as indicated in the contract.

420.02 -- Material Requirements

1. All reflectors for delineators and all flexible delineator posts shall be on the Department's Approved Products List.

2. Before ordering any materials, the Contractor shall submit, for approval, the manufacturer's name and identifying information on the proposed delineator unit. There shall be no substitution subsequent to approval without the prior written permission of the Engineer.

3. Flexible Delineator Posts

a. The post material shall be rubber, plastic, or any other material which meets physical test requirements and meets NCHRP 350 or MASH crashworthiness criteria.

b. The post shall be black or dark green.

c. The top 11 inches (275 mm) of the post shall be flattened to approximately a 3-inch (75 mm) width to provide surfaces to mount reflectors.

d. A piece of white or yellow (as required by the contract) reflective sheeting, no smaller than 3 inches x 9 inches (75 mm x 225 mm) shall be placed no more than 2 inches (50 mm) from the top of the post.

e. The reflective sheeting shall be ASTM D 4956 Type IV or V reflective sheeting.

4. The materials used shall conform to the requirements of Sections 1070 and 1072.

5. Steel posts shall conform to the requirements of Subsection 1071.02 for light duty posts.

6. The highway signs and reflectors shall also conform to the requirements of Sections 1070 and 1072.

7. The Department will provide the chevrons which are to be mounted on delineator posts.

420.03 -- Construction Methods

1. a. The normal mounting height is shown in the Standard Plans or the contract plans. However, the Engineer may require other mounting heights.

b. All posts on which chevrons are mounted shall be metal posts.

c. When required, the chevron will include the delineator reflector.

2. Flexible posts shall be anchored using a galvanized anchor that is recommended by the manufacturer for the soil type at the installation location.

420.04 -- Method of Measurement

1. "Delineator, Type _____" will be measured by the each.

2. Flexible post delineators are measured by the each.

3. Chevrons are measured by the each per post regardless of their size. If a post requires two chevrons, it will be treated as one for payment.

420.05 -- Basis of Payment

1. Pay Item	Pay Unit
Delineator, Type _____	Each (ea)
Flexible Post Delineator	Each (ea)
Install Chevron	Each (ea)
2. Payment is full compensation for all work described in this Section.	

SECTION 421 -- REMOVING AND RESETTING DELINEATORS

421.01 -- Description

1. The Contractor shall remove and reset flexible post and standard delineators at the locations shown in the contract.

421.02 -- Construction Methods

1. The Contractor shall remove the delineators, intact, and stockpile them at designated locations for future resetting.

2. Any material lost or damaged shall be replaced by the Contractor at no additional cost to the Department.

3. The delineators shall be set plumb and anchored as described in the contract.

421.03 -- Method of Measurement

1. Removing and resetting delineators will be measured by the each.

421.04 -- Basis of Payment

- | Pay Item | Pay Unit |
|--|-----------------|
| Remove & Reset Delineators | Each (ea) |
| Remove & Reset Flexible Post Delineators | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 422 -- TEMPORARY TRAFFIC CONTROL SIGNS AND DEVICES

422.01 -- Description

1. The Contractor shall furnish, install, operate, and maintain temporary traffic control signs and devices at the locations shown in the contract. When the work is complete, the Contractor shall remove the temporary traffic control signs and devices described in this Section.

2. Permanent Signs

a. Permanent Signs (Sign Day) are signs furnished by the Department and installed and maintained by the Contractor on posts and hardware supplied by the Contractor which are subsidiary to the "Sign Day" pay item.

3. Temporary Signs

a. Temporary Signs (Temporary Sign Day) are signs furnished by the Contractor and mounted on temporary sign supports supplied by the Contractor which are subsidiary to the "Temporary Sign Day" pay item.

b. Barricade Signs (Barricade Sign Day) are signs furnished by the Contractor that are mounted on barricades that are paid for separately by the Department.

4. General Requirements:

a. All signs and devices shall be constructed and erected in accordance with the contract and MUTCD.

b. Sign legends and symbols shall be of professional quality workmanship and in uniformity with the Standard Highway Signs and Markings Manual. All signs shall meet the requirements of the American Traffic Safety Services Association (ATSSA) "Quality Guidelines for Work Zone Traffic Control Devices". Hand printing or poor workmanship shall not be allowed.

c. The initial placement, replacement, and removal of the traffic control signs and devices shall be done with extreme care and consideration for the traveling public.

d. Permanent and temporary signs and devices shall not be removed without the Engineer's approval.

e. The temporary traffic control signs and devices, except materials furnished by the Department, shall remain the property of the Contractor.

422.02 -- Material Requirements

1. Permanent Signs:

a. The Department will furnish the permanent signs on an appropriately sized panel at one of the maintenance headquarters located throughout the State. These are as follows:

Table 422.01

Maintenance Headquarters			
Ainsworth	Geneva	McCook	St. Paul
Alliance	Gering	Mullen	Sidney
Bridgeport	Grand Island	Neligh	South Sioux City
Broken Bow	Hastings	Norfolk	Tecumseh
Chadron	Holdrege	North Platte	Valentine
Columbus	Imperial	Omaha	Wayne
Fairbury	Kearney	O'Neill	York
Fremont	Lincoln		

2. Temporary Signs

a. "Temporary Signs" shall consist of approved retroreflective fluorescent orange or white signs mounted on temporary sign supports. The color and design of the signs shall be as required by the MUTCD and the contract. Retroreflective fluorescent orange sheeting used for temporary signs shall be on the Department's Approved Products List.

b. Rigid sign substrates that have been approved to NCHRP 350 or MASH (TL-3) may be used. When used, the rigid sign substrate with sign sheeting and temporary sign support shall, all together as a single tested unit, be NCHRP 350 or MASH (TL-3) approved.

c. The temporary sign supports shall have enough vertical rigidity to support the sign in an upright position and provide continuous legibility of the sign legend in gusty conditions (wind or vehicle gusts). The Engineer shall determine the adequacy of visibility. Temporary sign supports that fail to provide adequate visibility of the sign shall not be allowed.

d. Signs required for flagging shall meet the "Temporary Sign" requirements of this Section.

3. The following items shall meet the requirements described in the contract:

- a. Barricades (Type II & III)
 - (1) Reflectorized Plastic Drums
 - (2) 42 inch Cones
- b. Temporary Traffic Signals
- c. Concrete Protection Barriers
- d. Vertical Panels

4. The following items shall be on the Department's Approved Products List to be used on a Department project:

- a. Inertial Barrier Systems

- b. Flashing Arrow Panels
- c. Tubular Posts
- d. Opposing Lane Dividers
- e. Temporary Glare Screen
- f. Portable Dynamic Message Signs
- g. Tubular Post and Curb Systems
- h. Fluorescent Orange Sheeting. The fluorescent orange sheeting shall meet the luminance requirements of Table 422.02.

Table 422.02

FHWA Luminance Factor			
	Luminance Factor Y_T		
Sheeting Type	Min	Max	Fluorescence Luminance Factor Limit, Y_F
Fluorescent Orange	25	None	15

5. Sign Covers:

- a. The Contractor shall provide hard covers for signs left in place and currently not in use.
- b. The covers shall be the same size as the sign and completely cover the sign when installed.
- c. Bolting the cover to the sign by drilling holes through the sign will not be allowed.
- d. The cover shall be constructed so there will be at least a 1/8 inch (3 mm) space between the sign and the cover when installed.
- e. Spacer blocks are only allowed in the border area of the sign.
- f. The cover will be fastened so that it will not come loose or damage the sign during normal or windy conditions.

6. National Cooperative Highway Research Program (NCHRP) Report 350 and Manual for Assessing Safety Hardware (MASH) Requirements.

a. Traffic control devices shall be crashworthy and qualify as such according to the testing and acceptance guidelines of the National Cooperative Highway Research Program (NCHRP) Report 350 or Manual for Assessing Safety Hardware (MASH). Traffic control devices have been classified into four (4) categories. The following is a list of categories and compliance requirements.

(1) Category 1: Includes traffic cones, tubular posts, vertical panels, flexible delineator posts, and reflectorized plastic drums with no attachments. The Contractor shall provide the Engineer a copy of the developer's self-certification of the devices used.

(2) Category 2: Includes Type II and III barricades, portable sign supports, intrusion alarms and cones, vertical panels and plastic drums with a light or sign attached. The following compliance requirement for Category 2 devices shall be used:

(i) The Contractor shall provide the Engineer a copy of the FHWA acceptance letter for all NCHRP 350 or MASH (TL-3) compliant Category 2 devices when used.

(3) Category 3: Includes concrete protection barriers, fixed sign supports, truck mounted attenuators (TMA), and work zone crash cushions (WZCC) and other work zone devices not meeting Category 1 or 2.

(i) The Contractor shall provide the Engineer a copy of the FHWA acceptance letter for all NCHRP 350 or MASH (TL-3) Category 3 devices when supplied by the Contractor.

(ii) Fixed breakaway sign supports for work zones shall be tested under the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and accepted by the FHWA.

(4) Category 4: Includes portable or trailer-mounted devices, such as flashing arrow panels, temporary traffic signals, area lighting supports and portable changeable message signs. Crash testing is currently not required for Category 4 work zone devices.

7. Type A, B, and C barricade lights shall be on the Department's Approved Products List. Type A, B, and C barricade warning lights shall comply with the requirements for warning lights in the MUTCD.

8. Posts for mounting Permanent Signs or Temporary Signs shall be wooden 4x4 or 4x6 posts, or perforated square steel tubing meeting the requirements of NCHRP 350 (TL-3) or MASH when tested all together as a single tested unit.

422.03 -- Construction Methods

1. General Requirements

a. The Contractor shall install, maintain, and remove all signs and devices in accordance with the details of and at the locations shown in the contract. The Contractor shall furnish all necessary posts, support standards, bolts, or other fasteners for signs.

b. The Contractor shall maintain a stock of spare lights, signs, devices, and repair parts at the project site for immediate emergency replacement or repairs.

c. The Contractor shall mow or trim vegetation to insure that the complete visibility of signs, barricades, and other warning devices is maintained at all times. The contractor shall maintain vegetation to a height less than 12 inches around the device.

d. The Contractor shall, at the preconstruction conference, provide the Engineer with the names and telephone numbers of personnel who will be available on a 24-hour-per-day, 7-days-per-week basis. These people shall be responsible for repair, correction, replacement, and maintenance of the traffic control devices.

e. The Contractor shall take all necessary precautions for the protection of the work and the safety of the public.

(1) The Contractor shall be alert at all times to any and all deficiencies in the placement and maintenance of any traffic control devices and shall take immediate action to correct any deficiencies.

(2) The Contractor shall inspect traffic control devices at least once every day the devices are in use, but shall provide more frequent inspections during or following periods of inclement weather or at other times when more frequent inspections are warranted.

f. The Contractor may be given notice, either written or verbal, of failure to install, replace, remove, or maintain a traffic control device.

(1) Upon notification by the Engineer, the Contractor shall respond to any site within 4 hours and take immediate steps to correct the deficiency.

(2) If corrective action is not taken by the Contractor within 4 hours of the initial notice, the Engineer shall make no payment for any traffic control devices for that day.

(3) If corrective action is not taken within 4 hours, a written notice of action to be taken shall be given to the Contractor or person designated for work zone traffic control.

(4) Failure to install, replace, remove, or maintain a device within 8-hours of the initial notice may result in no payment being made for any traffic protective devices on the project for that day and on subsequent days until the requested installation, replacement, removal, or maintenance is performed. The Engineer may also suspend all other work until the problem is corrected.

g. The Department may elect at any time to correct a traffic control deficiency and bill the Contractor for all costs necessary to correct the problem.

h. The Contractor shall immediately notify the Engineer of any hazard or changed roadway condition that is not identified in the contract.

i. When more than one Contractor is working on the project or when consecutive projects require protection and control of traffic, the Engineer shall determine and notify in writing the Contractor whose responsibility it shall be to provide the protection and control of traffic.

j. Failure of the Contractor to erect and maintain traffic protective devices shall be reason to temporarily suspend the work in accordance with Subsection 108.06.

2. Posts

a. Posts used to erect permanent and temporary signs shall be installed and maintained plumb, and the sign faces shall be positioned and maintained so that they face approaching traffic.

(1) Stub steel posts used for erecting signs shall not be installed prior to the placement of the signs or be left in place when signs are removed unless the following conditions are met:

(i) Stub steel posts may be installed prior to the placement of the signs or temporarily left in place when the signs are removed. Each stub steel post shall be immediately and clearly identified by a 42 inch Reflective Cone, 36 inch (minimum) delineator post with button reflector, or other warning device acceptable to the Engineer. No payment will be made for the items used to identify the stub steel posts.

3. Permanent signs:

a. The Contractor shall give the Engineer two week's notice prior to picking up signs at the designated maintenance yards.

b. Signs shall be returned to the maintenance yards from which they were obtained, or to a location designated by the Engineer, during normal working hours.

(1) Signs returned to the Department shall be in reusable condition.

(2) Aluminum signs shall not be marred, damaged, bent, or contain holes other than necessary bolt holes.

4. Temporary Signs shall be post mounted.

a. Signs in place no longer than 3 days may be mounted on a temporary sign support.

b. Signs on a temporary sign support shall be mounted a minimum of 1 foot (300 mm) above the roadway, unless otherwise required to be mounted at a higher height.

5. Barricades:

a. The Contractor shall provide, install, maintain, relocate, and when no longer required, remove barricades and reflectorized drums at the locations shown in the contract or designated by the Engineer.

b. In applications other than on a freeway, expressway, or an interstate roadway, reflectorized drums may be used in lieu of Type II Barricades. Reflectorized drums shall be used in lieu of Type II Barricades in applications on a freeway, expressway, or an interstate roadway.

c. When approved by the Engineer or shown in the contract, 42 inch (1070 mm) reflective cones may be used in lieu of Type II Barricades or Reflectorized Drums. 42 inch (1070 mm) reflective cones shall not be used for lane-closure tapers or shifts.

6. Temporary Traffic Signal:

a. Temporary traffic signal systems shall be furnished, installed, operated, and maintained by the Contractor at the locations shown in the contract.

b. The item "Temporary Traffic Signal" shall include signal heads for all approaches to the signal. A temporary traffic signal for a single lane roadway section or bridge shall include signal heads for both ends of the single lane section and any other approaches.

c. Temporary Power Service:

(1) The Contractor shall make arrangements with the local utility for power service for temporary signals in a timely manner.

(2) The Contractor is required to comply with the local utility's policy for temporary power service.

(3) The Contractor shall cooperate with the local utility in scheduling the installation.

(4) Any delay resulting from a Contractor's untimely request to the local utility for temporary power service shall not be justification for the suspension or adjustment of the working days or calendar days on a project.

d. When work is complete, the Contractor shall remove the traffic signal.

7. Concrete Protection Barriers:

a. "Install Concrete Protection Barrier": Concrete protection barriers will be furnished by the Department and shall be installed by the Contractor at the locations shown in the contract or designated by the Engineer. The Contractor shall obtain and return the concrete barriers to the locations indicated in the contract.

b. "Concrete Protection Barrier": The Contractor shall furnish and install concrete protection barriers at the locations shown in the contract or designated by the Engineer.

c. "Relocate Concrete Protection Barrier": The Contractor shall reposition the concrete protection barriers at the same location as directed by the Engineer or as shown in the contract after the initial installation.

d. Adjacent ends of the barrier units shall be aligned and fastened together as directed by the Engineer.

e. The Contractor shall shim the barrier units as necessary to compensate for surfaces that are not level.

f. Concrete protection barriers that become dislodged or moved out of alignment shall be placed back in alignment as soon as practical. If the dislodged barriers are considered to be a hazard to the traveling public by the Engineer, or the barriers encroach into the traveled lane, the barriers shall be realigned within 4 hours of the time the Contractor is notified. For each occurrence, failure to realign the barriers within the 4 hour time period will result in the assessment of a lump sum \$1,000 liquidated damage assessment and the Engineer may proceed to correct the adverse conditions in a manner that is deemed appropriate. The Contractor will also be assessed the cost incurred when the action is performed by others. This assessment has not been provided for elsewhere in the contract and shall be considered in addition to other liquidated damage assessments which are a part of the contract.

8. Temporary Rumble Strips:

a. The Contractor shall furnish, install, and maintain temporary rumble strips at the locations shown in the contract or directed by the Engineer.

b. The material shall be given adequate time to harden before the rumble strips are opened to traffic.

c. Upon completion of that particular phase of the work requiring rumble strips, the Contractor shall remove the rumble strips. The Contractor

shall exercise the same care and consideration for traffic control during removal operations as that required for the initial installation or replacement.

9. Vertical Panels:

The Contractor shall furnish, install, and maintain vertical panels at the locations and spacing shown in the contract or designated by the Engineer. The vertical panels shall comply with the requirements shown in the MUTCD and any pertinent modifications shown in the contract. A vertical panel unit may be single or double sided (back-to-back) as required by the contract, and the supporting post shall not cover any of the reflective area of the panels.

10. Inertial Barrier System:

a. This work shall include the furnishing and installation required for project phasing, and removal of sand-filled type inertial barrier systems, including filler material and object markers, in accordance with the contract or as required by the Engineer.

b. System Components:

(1) The Contractor shall furnish an FHWA approved inertial barrier system that is on the Department's Approved Products List.

(2) The system shall be installed in the field as required by the manufacturer.

(3) The sand or filler material for the inertial barrier system shall meet one of the material and gradation requirements of fine aggregate for concrete. The sand or filler material shall contain 5 to 15% (by volume) rock salt mixed with the filler material.

(4) A complete set of replacement modules shall be available near the project site in the event of damage to the installed system. Damaged modules shall be replaced within 24 hours.

(5) Upon completion of the work requiring the inertial barrier system, the Contractor shall remove the system and clean the site of any debris and filler material remaining from the system.

c. Inertial barrier modules shall be available in 200, 400, 700, 1,400, and 2,100 pound (90, 180, 315, 630, and 950 kg) sizes and shall consist of the following components:

(1) An outer container molded in one or two pieces. The material shall be durable, weatherproof, and formulated to resist deterioration from ultraviolet rays. The outer container shall have a minimum width of 27 inches (685 mm) at the base, 36 inches (915 mm) at the top, and a minimum height of 36 inches (915 mm). The standard color shall be yellow.

(2) A lid which locks securely to the top lip of the outer container. The material shall be durable, weatherproof, and formulated to resist deterioration from ultraviolet rays. The lid shall be capable of withstanding a 200 pound (90 kg) vertical load.

(3) A supporting insert which is varied to allow for different sizes of modules to support 200, 400, 700, and 1,400 pound (90, 180, 315, and 630 kg) sand weight. Care shall be taken to fill each module with the proper amount of sand as called for in the array design. The height and

diameter of the inserts shall be such to ensure that the center of gravity of each module is at the proper elevation to control the attitude of impacting vehicles. The insert container interface shall allow free drainage of excess water contained in the sand mass.

d. An MUTCD Type I object marker shall be placed on the first inertial barrier module facing approaching traffic. The Type I object marker shall consist of nine yellow prismatic reflectors, each with a minimum dimension of 3 inches (75 mm), mounted symmetrically on a 18 inch (450 mm) black or yellow diamond panel; or a 18 inch (450 mm) yellow diamond panel of ASTM D4956 Type IV retroreflective sheeting without buttons. The object marker shall be placed approximately 2 inches (50 mm) below the top of the first module.

11. Flashing Arrow Panel:

a. The Contractor shall furnish, install, operate, and relocate mounted flashing arrow panels for use in traffic control at the locations shown in the contract. The Contractor shall remove the panels when work is complete and the Engineer has approved their removal.

b. Panel Design:

(1) The minimum panel size shall be 8 feet by 4 feet (2.4 m by 1.2 m) and shall contain 22 lamps. The lamps shall be arranged to form 3 connected diamonds with the short axis of the diamonds lying on the horizontal centerline of the sign. Each side of the diamonds will form an arrowhead of 5 lamps per head. Each arrowhead shall have a minimum angle of 100 degrees.

(2) The panel shall be constructed in a rigid manner such that the panel face does not flex in the vertical dimension.

(3) For use on multi-lane roadways where at least one traffic lane is maintained for each direction of travel, the arrow panel shall have the capability of the following mode selections:

- (i) Left or right flashing arrow.
- (ii) Left or right sequential chevrons.
- (iii) Double flashing arrows.
- (iv) Flashing or alternating caution.

(4) For use as a hazard identification marker on 2-lane highways with 1 lane closed, the flashing arrow panel shall be wired to alternately flash the two outside diamonds or flash the 4 outside corners.

(5) Minimum "on time" shall be 50% for the flashing arrow and flashing diamonds and equal intervals of 25% for each sequential phase.

c. Visibility:

(1) Lamps for generator powered arrow panels shall maintain visibility out to a horizontal angle of 20 degrees.

(2) Solar powered arrow panels shall maintain visibility out to a horizontal angle of 13 degrees.

(3) Vertical maintained visibility shall be greater than 3 degrees.

(4) The lamp intensity shall be adjusted to prevent an unnecessary blinding effect and to compensate for daytime and nighttime light conditions so that the arrow panel message is legible for a distance of 1 mile (1.6 km). The intensity shall be controlled by an automatic dimmer capable of a 50% reduction in intensity when ambient light falls below 50 lux.

d. Positioning:

(1) The arrow panel shall be aimed to provide for recognition throughout the range from 1,600 feet to 300 feet (488 m to 91 m) upstream of the panel.

(2) For use on 2-lane highways as a hazard identification marker, the mounted arrow panel shall be located immediately in front of the hazard and behind a Type III barricade.

(3) The arrow panel shall be mounted at a minimum height of 7 feet (2.1 m) from the road surface to the bottom of the panel.

(4) The arrow panel shall be mounted such that it will remain stationary and rigid in high or gusty winds while the panel is in use.

e. Maintenance:

(1) The arrow panel shall be maintained so as to operate continuously. The Contractor shall advise the Engineer of the person to contact in case of needed repairs or maintenance.

(2) The Contractor shall always have an extra unit on the project for use as a standby unit. In the event of equipment failure resulting in an arrow panel becoming inoperative, regardless of the time of day, the Contractor shall immediately substitute the standby unit for the inoperative arrow panel. The Contractor shall then either immediately repair or replace the defective unit.

12. Flagging:

a. The Contractor shall furnish flaggers to direct traffic when construction activity occurs on or adjacent to a surface being used by the traveling public.

b. Flagging shall only be performed by certified flaggers. When necessitated by an emergency situation or for situations not reasonably expected to last for more than 15 minutes, flagging may be performed by other than certified flaggers. Flaggers must always carry a valid Flagger Certification Card.

c. The flaggers shall be properly attired with vest and head gear. They shall be provided properly installed advance warning signs, and they shall be otherwise equipped in accordance with the requirements of the contract.

d. Flaggers shall position themselves appropriately and according to accepted flagging procedures.

e. The Contractor shall be responsible for the training and certification of the flaggers employed on the project. Certification shall be according to the standards established herein and the "Guidelines for Flagger Training and Certification of Flaggers" available from the Department. Certification cards issued according to these rules by other Contractors, provided they have not expired, shall be considered valid.

f. Flaggers shall be familiar with the contents of the Department's "Flagger's Handbook" and shall carry a copy of such publication on their person while performing the flagger duties. This publication is available from the Engineer and considered part of the contract.

g. In order to be certified, the prospective flagger must:

- (1) Be in good health with normal abilities of hearing and sight.
- (2) Be able to read and speak English.
- (3) View the 45 minute video "The Flagger."
- (4) Correctly answer 80% of the questions on an examination that accompanies the video.

h. Upon satisfactory completion of the training and examination procedure, the prospective flagger shall be issued a Flagger Certification Card by the examining Contractor.

i. The video, examination forms, Flagger Certification Cards, Flagger Certification Reports, and "Guidelines for Flagger Training and Certification of Flaggers" shall be furnished by the Department.

13. Pilot Vehicle:

a. When a pilot vehicle is required by the contract, it shall be used to lead the traffic through the restricted section. The work shall be so coordinated that the pilot vehicle shall make a round trip in 15 minutes or less.

b. This work shall consist of providing a vehicle and driver to serve as a pilot vehicle to lead the traveling public and the Contractor's vehicles through the construction work area where 2-way traffic is restricted to only one lane.

c. Vehicle Requirements:

(1) The pilot vehicle shall be properly equipped and licensed for operation on public roadways in accordance with the applicable State laws.

(2) The vehicle may carry the Contractor's monogram or company insignia and shall be equipped with a rear facing, rigidly mounted sign having a fluorescent orange background (ASTM D4956 Type IV or greater sheeting) with black lettering bearing the message:

"PILOT CAR---FOLLOW ME"

(3) The sign shall be a MUTCD sign No. G20-4, sized at 36 x 18 inches (900 mm x 450 mm).

(4) The bottom of the sign shall be mounted a minimum of 1 foot (300 mm) above the vehicle's roof.

(5) The sign shall be securely covered or removed when not in use.

(6) The vehicle, while in use, shall be used exclusively to lead and assist traffic movement.

(7) During construction, a pilot vehicle shall be kept in continuous operation. Delays to traffic movement will not be allowed for refueling, driver relief, or any other foreseeable reason.

(8) The work shall be so coordinated that the pilot vehicle shall make a roundtrip in 15 minutes or less.

d. Pilot vehicle drivers shall be properly licensed and shall be familiar with and always observe the "Rules of the Road" for proper, safe, and courteous driving. Drivers will be subject to prosecution for all violations.

e. Pilot vehicle drivers shall be certified flaggers and must have their Flagger Certification Card in their possession at all times.

14. Tubular Post:

a. The Contractor shall furnish, install, maintain, and remove reflectorized tubular posts at the locations shown in the contract or as directed by the Engineer.

b. Post Design:

(1) The height of a tubular post shall be 28 inches (700 mm). The material from which the post is fabricated shall be rubber, plastic, or any other material which meets the physical test requirements and results in little or no damage to impacting vehicles. The minimum width of the post shall be 2 inches (50 mm). The predominant color of the post shall be orange, unless otherwise stated in the contract.

(2) Each complete tubular post and each replacement post shall have a minimum of two 3-inch (75 mm) wide retroreflective white bands placed a maximum of 2 inches (50 mm) from the top with a maximum of 6 inches (150 mm) between the bands.

(3) Tubular posts that are approved for use will be shown on the Department's Approved Products List. Tubular posts which have not been previously approved by the Department will not be permitted on the project until approved by the Engineer.

c. The tubular posts shall be spaced at the intervals shown in the contract or as directed by the Engineer and shall be attached to the existing surface by epoxy or other suitable adhesive or method. The adhesive shall be given adequate time to harden before the post can be attached and the area opened to traffic. The initial placement and/or replacement of the tubular posts shall be performed with extreme care and consideration for the traveling public.

d. Retroreflective sheeting which is no longer effective shall be replaced.

e. Tubular posts which have become dislodged due to traffic or other action shall be properly repositioned and reattached within 24 hours. Tubular posts which cannot be cleaned or which are broken shall be replaced.

f. Upon completion of that particular phase of the work requiring tubular post delineation, the Contractor shall remove the posts as directed by the Engineer. The Contractor shall exercise care and consideration for traffic control during initial installation, replacement and removal. The

Contractor must explain this phase of traffic control to the Engineer before installation, replacement, and removal.

15. Opposing Lane Dividers:

a. The Contractor shall furnish, install, and maintain reflectorized opposing lane dividers at the locations shown in the contract. When work is complete and the Engineer has approved their removal, the Contractor shall remove the reflectorized opposing lane dividers.

b. Design:

(1) The height of the opposing lane divider shall be 36 inches (900 mm).

(2) The divider shall be fabricated from rubber or plastic.

(3) The predominant color of the divider shall be orange.

(4) Each opposing lane divider and each replacement divider must have back-to-back, upright, orange, reflective panels approximately 12 inches (300 mm) wide by 18 inches (450 mm) high. The symbol on the divider shall be 2 opposing black arrows. The reflective panel must be ASTM D 4956 Type IV retroreflective sheeting or approved equivalent.

c. Installation:

(1) The opposing lane dividers shall be attached to the existing surface by an epoxy or other suitable adhesive or method.

(2) The adhesive shall be given adequate time to harden before the divider can be attached and the road opened to traffic.

e. Maintenance:

(1) Reflective panels which are no longer effective shall be replaced.

(2) Lane dividers which cannot be cleaned or which are broken shall be replaced.

16. Portable Dynamic Message Boards:

The Contractor shall furnish, install, operate, and maintain portable dynamic message boards as described in the contract. When their removal is approved by the Engineer, the Contractor shall remove the portable dynamic message signs. Signs shall meet the text size and phase limit requirements as described in the MUTCD.

17. Install Impact Attenuator:

a. The Contractor shall pick up the impact attenuator from the location designated in the contract and assemble the attenuator in accordance with the details shown in the contract. The Contractor shall transport, install, and maintain the units at the location shown in the contract or designated by the Engineer.

b. The Contractor shall perform all earthwork and provide the reinforced concrete pad (required for off-the-road installations) needed to place the unit.

c. The Contractor shall immediately repair or replace any damaged units. A second unit will be stored with replacement cartridge sets in the Maintenance Yard designated in the contract. It will be available in the

event of damage to the installed system or if a second system is required while the original system is still in operation.

d. Upon completion of the work, the Contractor shall disassemble the system and return it to the location designated by the Engineer.

18. Mobile Traffic Control Operations

The Contractor shall furnish and operate the mobile traffic control operation as described in the contract.

422.04 -- Method of Measurement

1. Signs:

a. (1) "Sign Day" is the pay item for permanent signs. "Sign Day" will be measured by the number of calendar days each permanent sign is in place and positioned as shown in the contract or as directed by the Engineer. Vertical Panels will be measured for payment as a permanent sign.

(2) "Temporary Sign Day" is the pay item for signs furnished by the Contractor and mounted on sign supports. "Temporary Sign Day" will be measured by the number of calendar days each temporary sign is in place and positioned as shown in the contract or as directed by the Engineer. The sign support will not be measured separately.

(3) "Barricade Sign Day" is the pay item for temporary signs furnished by the Contractor and mounted on barricades. "Barricade Sign Day" will be measured by the number of calendar days each barricade sign is in place and positioned as shown in the contract or as directed by the Engineer. The barricade on which the sign is mounted on will be measured separately.

b. The quantity of sign days will be the number of signs multiplied by the number of calendar days that the respective signs are in place.

c. A calendar day for signs is defined as the 24-hour period from midnight to midnight, or any portion of it, within which the sign is installed and maintained.

d. Each sign will be paid for separately, even if more than one sign is installed on the same post or device.

2. Barricades:

a. Type III barricades will be measured for payment by the number of calendar days each Type III barricade is in place and positioned as shown in the contract or as directed by the Engineer. The unit is barricade-day (BDay).

b. Type II Barricades, Reflectorized Drums, and 42 inch (1070 mm) Reflective Cones will be counted as "Barricades, Type II" and measured for payment by the number of calendar days each is in place and positioned as shown in the contract or as directed by the Engineer.

c. Payment for "Barricades, Type II", "Barricades, Type III", Reflectorized Drums, and 42 inch (1070 mm) Reflective Cones will not be made for any devices which are not kept clean and properly positioned.

d. Barricades used to protect pipe culvert extensions and storage areas adjacent to an open road will not be measured directly but will be subsidiary to the appropriate bid item.

e. Barricades used to protect box culvert extensions adjacent to an open road will be measured for payment during construction of the box culvert extension. After the concrete reaches the strength that the forms may be removed, barricades used to protect the box culvert extensions adjacent to an open road will not be measured directly but will be subsidiary to the appropriate bid item.

3. Flagging:

a. "Flagging" will be measured for payment for each flagger on a daily basis.

b. Operation of one flagger for 4 hours or less will be considered as one half day and operation for more than 4 hours will be considered as one full day.

c. This price shall be full compensation for furnishing properly trained, attired, and equipped flaggers; for furnishing, installing, maintaining, relocating and removing all flagging related signs and devices, and for all labor, tools, equipment, material, and incidentals necessary to complete the work. Temporary signs and stands for flaggers shall comply with the requirements of Temporary Sign.

4. Temporary Traffic Signal:

a. "Temporary Traffic Signal" will be measured by the each for every complete installation.

b. When a traffic signal is required at a bridge or other obstruction, all signals required to clear traffic through the obstruction are counted as a single unit.

5. Concrete Protection Barrier:

a. "Concrete Protection Barrier" will be measured by the length in feet (meters) based on the 12 foot 6 inch (3.8 m) nominal length of the individual units.

b. The pay item "Relocate Concrete Protection Barrier" applies to those repositionings directed by the Engineer or shown in the contract. These relocations will be measured by the length of the concrete barriers so relocated based on the 12 foot 6 inch (3.8 m) nominal length of the individual units.

6. Temporary rumble strips will be measured for payment by the each for the entire section of temporary rumble strips initially installed at a specific location. No direct payment will be made for rumble strips replaced.

7. The inertial barrier system will be measured by the each.

8. Flashing Arrow Panels:

a. Flashing arrow panels will be measured by the each per each calendar day in use.

b. A double-faced flashing arrow panel will be counted as two units when a double-faced panel is described in the contract.

9. The pilot vehicle will be measured for payment on a daily basis when actually in use. Operation for 4 hours or less shall be considered as one-half day and operation for more than 4 hours shall be considered as a full day.

10. Tubular posts will be measured by the each.

11. Opposing lane dividers will be measured by the each.

12. Temporary Glare Screen will be measured by the length in linear feet (meters) of base rail initially installed, complete with blades.

13. "Portable Dynamic Message Signs" will be measured by the each per day for the number of calendar days each sign is in place and operating.

14. "Install Impact Attenuator" will be measured by the each.

15. "Replacement Module" is the pay item for inertial barrier system replacement modules and the unit of measurement is each (EA).

16. "Relocate Inertial Barrier System" is the pay item for moving the inertial barrier system to a new location after initial installation and operation.

17. The mobile traffic control operation shall be measured for payment on a daily basis for each day that the operation is in use. Operation for 4 hours or less will be considered as one-half day and operation for more than 4 hours shall be considered as a full day.

18. Payment for any traffic control device paid for by the day (excluding "Flagging") will not extend beyond the last working day or calendar day allowed by the contract. Payment will be made for any approved extension of the contract time allowance. The traffic control devices paid by the day that are required as determined by the Engineer, shall remain in service at no cost to the Department.

19. "Install Traffic Control Taper" is the pay item for the equipment, labor and incidentals for installing and removing traffic control taper, including all Reflectorized Drums, Flagger, and Flashing Arrow Panel and other devices required for the installation and measured by the Each. This item will be measured each time the traffic control taper is relocated to a new location after initial installation.

422.05 -- Basis of Payment

1. Pay Item	Pay Unit
Sign Day	Each (ea)
Temporary Sign Day	Each (ea)
Barricade Sign Day	Each (ea)
Barricade, Type II	Barricade-Day (BDay)
Barricade, Type III	Barricade-Day (BDay)
Flagging	Day (d)
Temporary Traffic Signal	Each (ea)
Install Concrete Construction Barrier	Linear Foot (LF) [Meter (m)]
Concrete Protection Barrier	Linear Foot (LF) [Meter (m)]

Temporary Rumble Strip	Each (ea)
Inertial Barrier System	Each (ea)
Flashing Arrow Panel	Day (d)
Furnishing & Operating Pilot Vehicle	Day (d)
Opposing Lane Divider	Each (ea)
Contractor Furnished Sign Day	Each (ea)
Mobile Traffic Control Operation	Day (d)
Temporary Glare Screen	Linear Foot (LF) [Meter (m)]
Portable Dynamic Message Boards	Day (d)
Tubular Post	Each (ea)
Install Impact Attenuator	Each (ea)
Relocate Inertial Barrier System	Each (ea)
Replacement Module	Each (ea)
Relocate Concrete Protection Barrier	Linear Feet (LF) [Meter (m)]
Install Traffic Control Taper	Each (ea)

2. Signs:

a. If signs are not returned or are returned damaged, and the damage is beyond reasonable "wear and tear" and the damage was caused by the Contractor, then the Contractor shall be charged the value of the missing or damaged items. These charges shall be deducted from monies due the Contractor upon final payment.

b. Payment will not be made for those calendar days when signs are not in use, such as for folded signs, temporarily covered signs, or signs temporarily positioned so that the message is not readable by the traveling public.

c. Temporary Signs:

(1) Temporary Signs which are required for "Flagging" are subsidiary to "Flagging".

(2) The "Temporary Sign" pay item will be full compensation for furnishing the "Temporary Sign" and for "Temporary Sign" support, transportation, original installation, any required relocation and maintenance of any and all "Temporary Signs", for removal of all "Temporary Signs", and for all equipment, tools, labor, and incidentals necessary to complete the work.

3. a. The pay item "Barricade, Type II" is used to pay for three items ("Barricades, Type II", "42 inch (1070 mm) Reflectorized Cones", and "Reflectorized Drums").

b. "Barricades, Type II", which includes "42 inch (1070 mm) Reflectorized Cones", and "Reflectorized Drums", will be paid for as an "established" contract unit price item. The established unit price is identified on the "Schedule of Items" shown in the Proposal.

4. Payment for vertical panels includes all posts, brackets, or hardware necessary to install and maintain the vertical panel units.

5. Temporary Traffic Signals:

a. The Contractor shall be responsible for the utility costs to install or relocate the power service for temporary traffic signals.

b. The Contractor shall also pay for power to operate the temporary signals. However, costs for power to operate a temporary signal that replaces an existing operating signal shall be paid by the jurisdiction responsible for the power costs of the permanent signal.

c. Direct payment will not be made for power costs. Power costs shall be considered subsidiary to the temporary traffic signal.

6. All warning lights will not be measured for payment but shall be considered subsidiary to the items for which direct payments are provided.

7. No direct payment will be made for opposing lane dividers repositioned, reattached, replaced or for their removal.

8. The repositioning, reattachment, removal, or replacement of a tubular post is subsidiary to the pay item "Tubular Post."

9. Inertial Barrier Systems:

a. Payment for inertial barrier systems and replacement modules shall include all modules required to build and maintain the required array of barrels, sand filler material, salt, object markers, installation, maintenance, earthwork required for placing the system on flat ground, removal of the system, and cleaning of the site.

b. "Relocate Inertial Barrier" will be paid for each relocation.

10. Payment is full compensation for all work described in this Section.

SECTION 423 -- PERMANENT PAVEMENT MARKING

423.01 -- Description

1. This work shall consist of furnishing and installing retroreflective preformed pavement markings in accordance with these Specifications and in conformance to the dimensions and lines shown in the contract or established by the Engineer. This Specification covers the following permanent pavement marking materials and application methods:

- a. Thermoplastic Pavement Marking.
- b. Thermoplastic Pavement Marking, Type Spray.
- c. Permanent Pavement Marking, Paint and Beads.

423.02 -- Material Requirements

1. Thermoplastic Pavement Marking Materials:

a. The composition minimum percentages by weight are shown in Table 423.01.

Table 423.01

Minimum Composition Requirements		
	White Minimum Percentage	Yellow Minimum Percentage
Binder	18	18
TiO ₂ (Type 2 Rutile)	8	N/A
Glass Beads	35	35
Yellow Pigment	N/A	5.0

b. The alkyd binder shall consist of maleic modified medium lead chromate pigment with a minimum of 50% lead-free content.

c. The alkyd binder shall consist of maleic modified rosin ester and not more than 20% petroleum derived resin.

d. The yellow pigment used shall be a heat established medium lead pigment with zero percent lead content.

e. Physical Requirements:

(1) Color:

(i) The white thermoplastic shall be pure white and free from any tint. When tested with a Colorimeter, such as a Gardner Color Difference Meter, the material shall not show deviations from a magnesium oxide color standard that are greater than shown in Table 423.02.

Table 423.02

Color Deviations		
Scale Definitions	Magnesium Oxide Standard	Sample
RD Reflectance	100	75% Min.
a Redness- Greenness	0	-5 to +5
b Yellowness- Blueness	0	-10 to +10

(ii) The color of the yellow thermoplastic shall visually match that of FHWA PR Color #1 when tested in accordance with ASTM D 4960. The daytime reflectance values and chromaticity coordinates shall fall within the limits in Table 423.03.

Table 423.03

Reflectance and Chromaticity				
Reflectance	45% Min.			
Chromaticity	Shall fall in an area bounded by these coordinates:			
Coordinates x, y	x - 0.470	0.493	0.516	0.490
	y - 0.455	0.467	0.444	0.433

f. Color Retention: The thermoplastic materials shall maintain the color values specified herein for white and yellow after the samples are prepared and subjected to an ultraviolet light source as described in ASTM D 795. A General Electric 275 watt sun lamp (Type RS) with a built-in reflector may be substituted for the light source.

g. Water Absorption: The thermoplastic compound shall have no more than 0.5% by weight of retained water when tested in accordance with ASTM D 570.

h. Softening Point: The compound shall have a softening point of not less than 195°F (90°C), as determined by ASTM E 28.

i. Low Temperature Stress Resistance: A concrete substrate coated with a minimum of 32 square inches (206 cm²) of thermoplastic material shall be immersed in cold water for one hour; then immediately placed in an insulated cold compartment and maintained at a temperature of minus 50°F (minus 45°C) for a period of 24 hours. When removed and allowed to come to room temperature, the sample shall still adhere to the contact substrate with no cracking or flaking.

j. Reheating: The thermoplastic compound shall maintain proper performance properties when heated four times to the application temperature. After heating to 425°F (218°C) for 6 hours while continually stirring at 50 to 100 RPM, the Brookfield viscosity shall not exceed 16,000 cps at 12 RPM.

k. Safety: In the plastic state, the material shall not give off fumes which are toxic or otherwise injurious to persons or property.

l. Specific Gravity: The specific gravity of the compound as determined by the water-displacement method shall be between 1.9 and 2.5.

m. Drying Time: When the material is applied at 400°F (204°C), the line shall be completely solid and show no effect of tracking after 15 minutes.

n. Indentation Resistance: The hardness shall be measured by a Shore Durometer, Type A-2, as described in ASTM D 2240. The durometer and the panel shall be at least 110°F (43°C). With a 4.4 pound (2 kg) load applied, the reading shall not be less than 45 after 15 seconds.

o. Abrasion Resistance: The sample shall show a maximum loss of 0.0132 pound (6 g) when tested by the blasting box method.

p. Impact Resistance: The average impact resistance of (four) separate samples shall not be less than 10.0 inch-pounds (1.13 N-m) when tested according to Method A of ASTM D 256.

q. Sealing Primer: The particular type and the proportions used shall be as recommended by the manufacturer of the thermoplastic compound.

r. Glass Beads:

(1) Refractive Index: The reflective glass beads pre-mixed into the compound and the reflective glass beads used for surface application shall have a refractive index of not less than 1.50 when tested by the liquid emersion method at 75°F (24°C).

(2) Roundness: Not less than 75% of the beads overall and not less than 70% of the beads retained on any specified sieve shall be true spheres when tested by ASTM D 1500.

(3) Heavy Metal Concentration:

Glass beads shall not contain more than 75 ppm (total) of arsenic or 100 ppm (total) of lead, when tested in accordance with EPA Methods 3052 and 6010B. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass beads for arsenic and lead.

s. Coatings: The intermix and drop-on beads shall have an adhesion promoting coating which is specific for the thermoplastic system. The beads for surface application shall be resistant to clumping caused by moisture.

t. Flowing Properties:

(1) The glass beads shall flow uniformly through dispensing equipment in atmospheric humidity up to 94%.

(2) 0.22 pounds (0.1 kg) of glass beads, spread evenly and thinly in a suitable container, shall be conditioned at 75°F (24°C) for 4 hours over a solution of sulfuric acid (Sp. Gr. 1.10) in a closed desiccator. After 4 hours, the glass beads shall flow readily through a clean glass analytical funnel, 60 degrees, 0.20 inch (5 mm) diameter and 4 inch (100 mm) stem. Inside diameter of the stem shall be a nominal 1.4 inches (35 mm).

u. Adhesion Coating: The glass beads shall be coated with an adhesion promoting coating that is compatible with thermoplastic material and that passes the dansyl chloride test procedure.

v. Gradation: The intermixed and surface applied glass beads shall meet the gradation requirement in Table 423.04.

Table 423.04

Glass Bead Gradation	
<u>Sieve Size</u>	<u>Percent Passing</u>
No. 16 (1.18 mm)	100
No. 20 (850 μm)	75-95
No. 30 (600 μm)	20-40
No. 50 (300 μm)	0-5
No. 100 (150 μm)	0-2

w. Application:

(1) The surface application of beads shall be not less than 12 lbs/100 SF (0.58 kg/m²).

(2) Properties of Finished Striping and Marking Installation:

(i) The stripe shall not be slippery when wet.

(ii) The compound shall not lift from the pavement in freezing weather.

(iii) The compound shall not deteriorate by contact with sodium chloride, calcium chloride, or oil drippings from traffic.

(iv) After application and proper drying time, the stripe shall show no appreciable deformation or discoloration under traffic at temperatures up to 140°F (60°C).

(v) The stripe or marking shall maintain its original dimensions and placement. The exposed surface shall be free from tack. Cold ductility of the material shall be such as to permit normal movement with the road surface without chipping.

x. The Contractor shall field verify the pavement marking quantities required for the project prior to purchasing material. The Department will not be responsible for the Contractor's shortage or surplus of material.

2. Thermoplastic Pavement Marking, Type Spray:

a. Binder: The binder shall consist of a mixture of synthetic alkyd resins, at least one of which is solid at room temperature. The total binder content of the thermoplastic compound shall be well distributed through the compound. The binder shall be free from all foreign objects or ingredients that would cause bleeding, staining or discoloration. The binder shall be at least 25% by weight of the thermoplastic compound.

b. Pigment:

(1) White. The pigment used for the white thermoplastic compound shall be a high-grade pure (minimum 93%) titanium dioxide (TiO₂). The white pigment content shall not be less than 10% by weight and shall be uniformly distributed throughout the thermoplastic compound.

(2) Yellow. The pigments for the yellow thermoplastic compound shall be heat stabilized medium lead chromate pigment with a minimum of 50% lead-free content. The yellow pigment shall not be less

than 5% by weight and shall be uniformly distributed throughout the thermoplastic compound.

c. Filler: The filler to be incorporated with the resins as a binder shall be a white calcium carbonate, silica, or an approved substitute. Any filler which is insoluble in 5N a hydrochloric acid shall be of such particle size as to pass a No. 100 (150 μm) sieve.

d. Mixed Compound: The mixed thermoplastic compound, after heating for 4 hours \pm 5 minutes at $375^\circ \pm 3^\circ\text{F}$ ($191^\circ \pm 2^\circ\text{C}$) and cooled to 77°F (25°C), shall meet the following requirements for daylight reflectance and color when tested using a color spectrophotometer with 45 degree circumferential, 0 degree geometry, illuminant C, and 2 degree observer angle. The color instrument shall measure the visible spectrum from 380 to 721 nm with a wavelength measurement interval and spectral bandpass of 10 nm. Reflectance and chromaticity limits are shown below.

Reflectance and Chromaticity Limits				
White:	Daylight Reflectance (Y) 75% minimum			
* Yellow:	Daylight Reflectance (Y) 42-59%			
* Shall match Federal 595 Color No. 33538 and chromaticity limits as follows:				
X	.470	.510	.485	.530
Y	.455	.485	.452	.456

e. Specific Gravity: The specific gravity of the thermoplastic material shall not exceed 1.85.

f. Softening Point: After heating the thermoplastic material for 4 hours \pm 5 minutes at $375^\circ \pm 3^\circ\text{F}$ ($191^\circ \pm 2^\circ\text{C}$) and testing in accordance with ASTM E 28, the material shall have a minimum softening point of 180°F (82°C) as measured by the ring and ball method.

g. Tensile Bond Strength: After heating the thermoplastic material for 4 hours \pm 5 minutes at 375°F (191°C), the drawdown film thickness shall be 0.065 inch (1.65 mm); and when tested at $75^\circ \pm 2^\circ\text{F}$ ($24^\circ \pm 1^\circ\text{C}$) in accordance with ASTM D 4796, the tensile bond strength to unprimed, sandblasted Portland cement block shall exceed 180 psi (1.24 Mpa).

h. Impact Resistance: The thermoplastic material shall be heated for a period of 4 hours \pm 5 minutes at a temperature of 375°F (191°C). A 0.065 inch (1.65 mm) thick drawdown film shall be created on an unprimed, sandblasted Portland cement concrete block. The sample shall be allowed to reach room temperature by standing overnight. The sample shall be tested, using a suitable falling ball apparatus that includes the male indenter 5/8 inch (16 mm) (no female die), by impacting the sample and observe for any cracking or loss of bond. When tested in accordance with ASTM D 2794, the material shall have a minimum impact resistance of 150 inch-pounds (17 N-m) with no visible cracks or loss of bond.

i. Yellowness Index: The white thermoplastic material shall not exceed a yellowness index of 12 when tested in accordance with ASTM D 1925.

j. Packaging:

(1) The thermoplastic material shall be packaged in suitable containers which will not adhere to the product during shipment and storage. The container's weight shall be approximately 50 pounds (23 Kg). Each container shall designate the color, type of binder, spray, and user information. The label shall warn the user that the material shall be heated in the range of 350 to 425°F (177 to 218°C).

(2) Each package shall be marked with the name of the manufacturer, the type of material, the month and year the material was packaged, and the lot number.

k. Glass Beads:

(1) Intermix Beads:

(i) Intermix beads shall be uncoated and shall be uniformly sized throughout the thermoplastic material at the rate of not less than 35% by weight [retained on the No. 100 sieve (150 μm)] of the thermoplastic material.

(ii) Intermix beads shall meet the gradation requirements in Table 423.05.

Table 423.05

Intermix Bead Gradation	
<u>Sieve Size</u>	<u>Percent Passing</u>
No. 20 (850 μm)	100
No. 30 (600 μm)	75-95
No. 50 (300 μm)	15-35
No. 100 (150 μm)	0-5

(2) Drop-on Beads:

(i) Drop-on beads shall be moisture resistant, embedment coated, and shall consist essentially of transparent, water-white glass particles of a spherical shape. They shall be manufactured from a glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering and shall conform to the requirements specified herein.

(ii) Drop-on beads shall meet the gradation requirements in Table 423.06.

Table 423.06

Drop-On Bead Gradation	
<u>Sieve Size</u>	<u>Percent Passing</u>
No. 16 (1.18 mm)	100
No. 20 (850 μm)	75-95
No. 30 (600 μm)	20-40
No. 50 (300 μm)	0-5
No. 100 (150 μm)	0-2

l. Specific Properties of Intermix and Drop-on Beads:

(1) Imperfections. The surface of the glass beads shall be free of pits and scratches. The glass beads shall be spherical in shape and shall

contain not more than 20% by weight of irregular shapes when tested by the standard method using a vibratile inclined glass plate.

(2) Index of Refraction. The index of refraction of the glass bead shall be not less than 1.50 when tested by the immersion method at 77°F (25°C).

(3) Silica Content. The glass bead shall contain not less than 65% silica (SiO₂).

(4) Chemical Stability. Glass beads which show a tendency toward decomposition, including surface etching, when exposed to paint or thermoplastic constituents will be rejected. The glass beads shall be tested by Federal Specification TT-B-1325D Section 4.3.9 (water resistant soxhlet extraction method), with the following exceptions:

(i) The size of sample to be tested shall be 1 ounce (28 g).

(ii) The reflux time shall be 5 hours and, upon examination after testing, the glass beads shall show no dulling effect.

(5) Flowing Properties:

(i) The glass beads shall flow uniformly through dispensing equipment in atmospheric humidity up to 94%.

(ii) 0.22 pound (100 g) glass beads, spread evenly and thinly in a suitable container, shall be conditioned at 77°F (25°C) for 4 hours over a solution of sulfuric acid (Sp. Gr. 1.10) in a closed desiccator. After 4 hours, the glass beads shall flow readily through a clean glass analytical funnel, 60 degrees, 0.20 inch (5 mm) diameter and 4 inch (100 mm) stem. The inside diameter of the stem shall be a nominal 1.4 inch (35 mm).

(6) Adhesion Coating. The glass beads shall be coated with an adhesion promoting coating that is compatible with thermoplastic material and that passes the manufacturer's adhesion test.

(7) Packaging. Glass beads shall be delivered in approved, moisture-proof bags consisting of at least 5-ply paper construction. Each bag shall contain 50 pounds (23 kg) net, and shall be legibly marked with the name of the manufacturer, type of bead, lot number, and the month and year the glass beads were packaged.

(8) Heavy Metal Concentration: Glass beads shall not contain more than 75 ppm (total) of arsenic or 100 ppm (total) of lead, when tested in accordance with EPA Methods 3052 and 6010B. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass beads for arsenic and lead.

3. Permanent Pavement Marking Paint

a. General Requirements

(1) The Contractor shall use an Acrylic Resin Waterborne Traffic Paint.

(2) The traffic paint shall be furnished ready-mixed in two colors (white and yellow).

(3) The traffic paint shall be suitable for use with Type 1, drop-on, dual-coated, moisture resistant glass beads.

(4) The traffic paint shall bind glass beads in such a manner as to produce maximum adhesion, reflection, and refraction. The paints shall show proper capillary action at the interstices existing between the beads to provide good anchorage and refraction.

(5) Reflectorized stripes of the traffic paints on pavement shall show good durability and good night visibility throughout their useful life.

(6) The paint shall not be used that is older than one year after the packaging date, unless additional testing assures it is suitable.

(7) The volatile content of the finished paint shall contain less than 150 grams of volatile organic matter per liter of total non-volatile paint material in accordance with ASTM D 3960. Certification of volatile organic content will be required for each batch of paint.

(8) The paint shall be free of any mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, ethylene-based glycol ethers and their acetates, and any carcinogens.

b. Pigment:

(1) Titanium Dioxide – This material shall comply with the specification for Titanium Dioxide Pigments, ASTM D 476, Type II, Rutile.

(2) Pigment Yellow C.I. #65 – The material shall have very good light and weather fastness. The material shall be first quality paint grade pigment and shall be free from toxic heavy metals. The manufacturer shall provide independent test results and certification that the dry film is compliant to the EPA TCLP toxic metal limits for arsenic, barium, cadmium, chromium, lead, mercury, and selenium.

(3) Yellow Iron Oxide – The material shall have very good light and weather fastness. The material shall comply with ASTM D 768 and shall be free from toxic heavy metals. The manufacturer shall provide independent test results and certification that the dry film is compliant to the EPA TCLP toxic metal limits for arsenic, barium, cadmium, chromium, lead, mercury, and selenium.

(4) Calcium Carbonate – This material shall comply with the specification for Calcium Carbonate Pigments, ASTM D 1199, Type GC, Grade 1, with a minimum of 94% total calcium and magnesium reported as carbonates and Type PC, Grade 1, with a minimum 96.5% calcium carbonate.

c. Vehicle:

(1) Acrylic Emulsion Polymer – The non-volatile portion of the vehicle shall be a 100% acrylic polymer such as Dow Fastrack 3427, Encor DT 250, or an approved equal.

(2) Methyl Alcohol – ASTM D 1152 Specific Gravity, 20/20°C, 0.7920 to 0.7930.

(3) Propylene Glycol – ASTM D 5164

(4) Water – Potable

d. Miscellaneous Materials:

(1) The type and/or composition of the following materials shall be left to the discretion of the manufacturer as long as the finished product meets the traffic paint requirements as specified herein:

- Dispersant
- Surfactant
- Defoamer
- Rheology Modifier
- Coalescent
- Preservative

e. Standard Formulation:

(1) The following standard formulas shall be the basis for the paint. No variations will be permitted except for the replacement of volatiles lost in processing or those approved by the Engineer. Amounts are shown in pounds of material.

Color of Traffic Paints	White	Yellow
C. I. Pigment Yellow 65	---	50
Titanium Dioxide, Rutile Type II	100	40
Yellow Iron Oxide	---	2
Calcium Carbonate, Type PC	150	125
Calcium Carbonate, Type GC	430	450
Rheology Modifier	0.5*	0.3*
Acrylic Emulsion, 50% Solids	541	535
Coalescent	24	23
Defoamer	5	6
Dispersant	8	10
Surfactant	2	2
Methyl Alcohol	15	15
Propylene Glycol	15	14
Preservative	1.5	1.5
Water	10	15
Total Pounds	1302	1288.8

*Rheology Modifier amount may be varied by up to 0.1 pound to adjust viscosity to desired range.

f. Pigment Composition:

<u>Analysis of the extracted pigment</u>	<u>Percent by Weight of Pigment</u>		<u>Test Method</u>
	<u>Specification</u>		
	<u>White</u>	<u>Yellow</u>	
Organic Yellow 65	---	7.5 min.	*
Titanium Dioxide	11.6 min.	4.5 min.	NDOT D 4764
Calcium Carbonate	86 max.	89 max.	NDOT C 25
Yellow Iron Oxide	---	0.3 min.	*

* To be determined by x-ray fluorescence, color spectrophotometry, or any other method the Department may choose.

g. Physical Properties:

<u>Analysis of the physical properties</u>	<u>Specification</u>	<u>Test Method</u>
Total Solids, percent by weight	73 min.	NDOT D2369
Pigment, Percent by weight	49 to 54	NDOT D3723
Vehicle, Percent by weight	46 to 51	
Non-volatile in Vehicle, Percent by weight	44 min.	(Total Solids – Pigment)/(100 – Pigment)
Weight per Gallon, lbs		
White	13.0 ± 0.3	NDOT D1475
Yellow	12.6 ± 0.3	
Consistency, at 77°F, Krebs Units	83 to 98	ASTM D562
Fineness of Grind, Hegman Scale	3 min.	ASTM D1210
pH	9.6 min.	NDOT E70
Drying Time, Dry Through, minutes	130 max.	NDOT D1640
Drying Time, No Pick Up, minutes	10 max.	NDOT D711
Reflectance		
White	83 min.	NDOT E1349
Yellow	50 min.	
Contrast Ratio, 15 mils wet	0.96 min.	NDOT D2805

h. Detailed Requirements

(1) Condition in Container – The paint shall be finely ground. It shall not show excessive settling; there shall not be gelling, curdling, livering, caking, lumps, skins, or color separation and shall be easily dispersed with a hand paddle to a smooth, homogeneous state. The pigment shall be readily dispersed and the consistency of the paint shall not have changed more than 5 KU (Krebs Units) from that of the freshly delivered paint, after storage for periods up to 1 year from the date of packaging.

(2) Color

(i) White traffic paint: The color after drying shall be a flat white, free from tint, furnishing good opacity and visibility under both daylight and artificial light.

(ii) Yellow traffic paint: The color shall closely match Color 33538 of Federal Standard 595b and shall be +/- 6% from the PR #1 chart central color when read over the black portion of a Leneta black and white paper chart. Measurements shall be performed according to NDOT E 1349 using a color spectrophotometer with a 45°/0° circumferential viewing geometry, illuminate "C", and an observer of 2°.

(3) Drying Time, No Tracking

(i) No tracking shall be the time in minutes required for the line to withstand the running of a standard automobile over the line at a speed of approximately 40 mph, simulating a passing procedure without tracking of the reflectorized line when viewed from a distance of 50 feet.

(ii) The paint shall dry to no tracking conditions under traffic in three minutes maximum. When 15 mils is applied, the maximum tracking time shall not be exceeded when the pavement surface temperature varies from 50°F to 120°F at a relative humidity of 80% or less.

(4) Spraying Properties – The traffic paints (as received) shall have satisfactory spraying properties.

(5) Appearance of Dry Film – The sprayed paints shall dry to a smooth, uniform finish free from roughness, grit, unevenness, and other surface imperfections. There shall be no bleeding, streaking, separation, blistering, wrinkling, or cracking.

i. Sampling Requirements

(1) All paints must be on the Department's Approved Products List (APL) prior to use.

(i) Once per calendar year or a minimum of thirty days prior to the application of the paint, a 1 quart sample from the Manufacturer shall be shipped to the Materials and Research Division. The following information shall be required for each sample:

- Type of paint
- Manufacturer code number
- Batch number
- Color
- Manufacture date

(2) Project Level Sampling:

(i) The Contractor shall provide a 1 quart sample according to the frequency found in the Department's Materials Sampling Guide. When sampling is required, the Department will provide the 1 quart container.

(ii) The shipping container shall be sampled according to ASTM D8008.

(iii) The following information shall be required for each sample:

- Project number
- Type of paint
- Manufacturer code number
- Batch number
- Color
- Manufacture date
- Sampling device used for sampling

(iv) The Engineer will take immediate custody of the sample and send to the Central Laboratory.

j. Testing Requirements

(1) Testing will take approximately 10 working days to accomplish by the Department after receipt of the samples.

k. Certification Requirements

(1) A certification of compliance is required for every project. For projects not requiring a sample, the traffic paints will be accepted on the basis of a Manufacturer's Certification of Compliance indicating that the paint meets the requirements of the current Nebraska Department of Transportation's Specification for Traffic Paint.

l. Glass Beads

(1) General Requirements

(i) The glass beads shall be applied on the wet film surface of traffic paint to improve the nighttime visibility of the pavement marking.

(ii) Glass beads for use with Acrylic Waterborne Traffic Paints shall be designated as AASHTO M 247 Type I Coarse Dual-Coated moisture resistant beads.

(iii) The glass beads, as received, shall be free from clumps and lumps, shall contain no extraneous material and shall flow freely when applied to traffic paint.

(iv) The glass beads shall be highly resistant to the effects of weathering as determined by laboratory tests and field tests. The glass beads shall show good adherence to the paint and provide good night visibility throughout the useful life of the reflectorized traffic paint.

(v) The glass beads shall allow sufficient capillary action to form a firm embedment in typical traffic paint when dropped on a freshly applied paint film of 15 ± 1.5 mils wet thickness.

(2) Detailed Requirements

(i) Imperfections – The percentage of imperfect beads and non-glass material shall be determined by testing conducted according to AASHTO PP 74. The percentage of total imperfect beads on all sieves shall not exceed 20 percent. In addition, the glass beads shall have not more than 30 percent imperfect beads passing any sieve with the exception of sieve #80. If less than 2 percent of the beads pass the #80 sieve, the imperfect bead requirement shall not apply and the percent imperfect shall

not be included when calculating the total imperfect beads. Imperfect beads are defined as ovate or otherwise nonspherical in shape; two or more beads fused together; and beads which show turbidity, pitting, scratching, surface wrinkling, internal air bubbles, or other inclusions.

(ii) Index of Refraction – The glass beads shall have an index of refraction of not less than 1.50 when tested by the liquid immersion method at 25° C according to AASHTO T 346.

(iii) Gradation – The drop-on glass beads in a representative sample shall meet the following gradation requirement when tested in accordance with AASHTO PP 74.

Nebraska Type I Coarse Dual-Coated Moisture Resistant Beads		
U.S. Standard Sieve No.	Sieve Opening Millimeters	Amount Passing, Percent
20	0.850	90-100
30	0.600	55-80
50	0.300	5-25
80	0.180	0-5

(iv) Moisture Resistance – The glass beads shall pass the “Moisture Resistance Test” according to AASHTO T 346 Section 13.

(v) Embedment Coating Test – The glass beads shall be tested for verification of silane presence/adhesion promoter, by performing the “Dansyl Chloride Test” according to AASHTO T 346 Section 11.

(vi) Heavy Metal Concentration – Glass traffic beads shall not contain more than 75 ppm (total) of arsenic or 100 ppm (total) of lead, when tested in accordance with EPA Methods 3052 and 6010B or AASHTO TP 106. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass spheres for arsenic and lead.

j. Sampling Requirements

(1) The Contractor shall provide a 1-quart sample according to the frequency found in the Department’s Materials Sampling Guide. The glass beads shall be sampled according to AASHTO T 346. The following information shall be required for each sample:

- Project number
- Type of glass bead
- Manufacturer code number
- Batch/lot number
- Pounds represented
- Manufacture date

(2) The Engineer will take immediate custody of the sample and send to the Central Laboratory.

k. Testing Requirements

(1) The testing will take approximately 10 days to accomplish by the Department’s Chemistry Laboratory after receipt of the samples.

I. Certification Requirements

(1) A certification of compliance is required for every project. For projects not requiring a sample, the glass beads will be accepted on the basis of a Manufacturer's Certification of Compliance indicating that the glass beads meet the requirements of the current Department Specification for Glass Beads.

4. All permanent pavement markings, except "Permanent Pavement Marking Paint", shall have the following acceptance requirements:

a. Following initial completion of all pavement marking, there shall be a 180 day observation period before final acceptance. During the observation period, the Contractor, at no additional cost to the Department, shall replace any markings that the Engineer determines are not performing satisfactorily due to defective materials, workmanship in manufacture, or application. At the end of the observation period, the minimum required retention percentage, by area, for markings installed shall be 95%.

b. The percentage retained shall be calculated as the nominal area of the strip less the area of loss divided by the nominal area and expressed as a percentage of the nominal area.

c. Notification of Corrective Work Required:

(1) The Contractor shall be notified in writing within 30 calendar days after the 180 day observation period if there is a failure to achieve the required percentage retained. The written notification to the Contractor will give an approximate percentage retained. The Contractor will be responsible for replacing all defective materials present at the time corrective actions are performed.

(2) When such a notification is made prior to August 1, the replacement material shall be installed during the same construction season. Replacement materials for any notification after August 1 shall be installed prior to June 1 of the following year. Marking replacement shall be performed in accordance with the requirements specified herein for the initial application, including but not limited to surface cleaning, primer applications, etc.

d. Final acceptance of all markings will include an inspection of the appearance of the markings during daylight and darkness. Any markings that fail to have a satisfactory appearance during either period, as determined by the Engineer, shall be reapplied at no additional cost to the Department.

e. Final acceptance of the pavement marking will be:

(1) 180 days after the initial completion of all pavement marking work, or

(2) Upon completion of all corrective work, whichever occurs last.

423.03 -- Construction Methods

1. General:

a. Line Appearance. Markings shall have a uniform cross section. The density and quality of markings shall be uniform throughout their

thickness. The applied markings shall have no more than 5%, by area, of holes or voids and shall be free of blisters.

b. The pavement markings shall be placed at the alignment markings established on the roadway. Deviation from the alignment established shall not exceed 2 inches (50 mm) and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet (25 mm per 60 m) of roadway nor shall any deviation be abrupt.

c. Longitudinal markings shall be offset at least 2 inches (50 mm) from construction joints of Portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

d. All permanent pavement markings shall be applied according to the manufacturer's instructions.

e. Prior to placing the pavement markings on the prepared surface, the Contractor shall layout, spot or string line the proposed pavement marking location. The pavement markings shall be aligned in such a way as to provide a smooth and gradual transition to and from the existing markings, and throughout both straight and horizontally curved sections of the project. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway. Materials used for alignment markings and equipment used to place such markings shall be approved by the Engineer.

(1) The pavement markings shall be applied in such a manner as to follow the existing lines on the roadway or as directed by the Engineer.

(2) No-passing zones shall be laid out in advance of the striping by the Contractor with information provided by the Engineer.

f. Two weeks prior to the installation of the permanent pavement marking, the Contractor shall provide to the Engineer a printed copy of the material manufacturer's installation procedures.

g. Surface Preparation

(1) New Concrete: Prior to the initial placement of the Pavement Markings, the pavement upon which the markings are to be placed shall be dry, cleaned and properly prepared by water, sand or shot blasting, as a minimum, and to the extent recommended by the manufacturer so that all contaminants, loose debris, and other deleterious material are completely removed.

(2) Existing Concrete and Asphalt: Surface preparation for any application shall consist of air blasting and brushing the roadway surface to remove all loose dirt, mud or other debris and to dry the surface.

(3) The pavement shall be clean and dry prior to the application of the pavement marking.

(4) The concrete surfacing shall be at least seven days old before surface preparation unless otherwise directed by the Engineer.

h. Existing painted pavement markings on both concrete and asphalt pavement shall be removed prior to placement of the permanent markings. Existing durable pavement markings shall be removed or prepared in a manner and to the extent recommended by the manufacturer

prior to placement of the new markings. Conflicting lines shall be removed and paid for with the appropriate pay item. The area of removal shall be the width needed for the new pavement marking or the existing lines, whichever is greater.

i. The Contractor shall check the pavement surface moisture each day prior to marking application. The Contractor shall place and hold a two square foot (0.2 m²) piece of clear plastic on the existing pavement for a period of 15 to 20 minutes. Remove and hold the plastic in a vertical position. If water drips from the underside of the plastic sheet, the pavement has excess moisture, do not install the pavement marking.

2. Thermoplastic Pavement Marking:

a. Dirt, grease, or any deleterious materials that would reduce the adhesion of the thermoplastic to the pavement must be removed by the Contractor before the application of thermoplastic material.

b. A binder-sealer material, either epoxy, butadiene, styrene, neoprene, or others recommended by the thermoplastic manufacturer, shall be applied in sufficient quantities to entirely cover the surface on which the marking is to be applied. This binder-sealer shall be required on all Portland cement concrete pavement surfaces, and all bituminous pavements over 60 days old.

c. Thermoplastic marking material shall not be applied until approval from the Department has been received. The Contractor shall notify the Engineer 72 hours prior to the placement of the thermoplastic markings in order that an inspector can be present during the operation. At the time of this notification, the Contractor shall indicate the manufacturer and lot numbers of thermoplastic and glass beads intended for use. A check will be made to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

d. In no case shall thermoplastic pavement marking material be applied after November 15 or earlier than April 15 or when pavement or air temperatures are less than 50°F (10°C); or in accordance with the manufacturer's recommendations.

e. Thermoplastic material must be installed in a molten state between 450°F and 465°F (232° C and 241°C).

f. Thermoplastic material shall be installed at a thickness of not less than 1/8 inch (3 mm) or more than 3/16 inch (5 mm). The initial measurement will be made above the pavement surface. The material may slightly penetrate the pavement on fresh bituminous concrete.

g. If the material appears to be less than 1/8 inch (3 mm) thick above the pavement surface, the line will be "chipped" and checked to determine the actual thickness. If the actual thickness is less than 1/8 inch (3 mm), the deficient portions of the line shall be ground down to no more than 0.05 inch (1.3 mm) above the pavement surface and sufficient thermoplastic and glass beads placed over the line to bring it up to the specified thickness.

h. Thermoplastic material may be applied over the temporary painted edge line markings. Unless otherwise specified, lines shall be laid a minimum of 2 inches (50 mm) from longitudinal joints.

i. Unless otherwise specified, pavement markings, words, and symbols shall be the *MUTCD* standard size. Deviations from reasonable standards of workmanship are cause for rejection.

j. Thermoplastic pavement marking material may be installed by the Extrusion Method or Ribbon Extrusion Method.

k. Equipment used for placing markings shall be manufactured for that purpose and of sufficient size and stability to ensure a smooth and straight application.

(1) A full-sized, truck-mounted unit capable of maintaining an operating speed of 3 to 5 mph (5 to 8 km/h) shall be required. It shall have the capability of automatically placing intermittent as well as continuous lines from either the left or right side of the vehicle. The vehicle shall be capable of applying either extrusion or ribbon thermoplastic in uniform dimensions and accurately following pavement irregularities.

(2) The Engineer may allow the use of a hand-operated or small riding machine where a limited quantity of edge and lane lines are required, or for turn lanes, gore areas or other small work, provided sufficient traffic control is in place to close the lane adjacent to the marking operations.

I. Reflectivity:

(1) Immediate reflectivity shall be accomplished by the application of glass beads to the surface of the marking through a gun that is located directly behind the thermoplastic applicator. The beads shall be applied into the material in a manner that will result in the surface beads being embedded to about their midpoint. Glass beads shall be applied uniformly at a minimum rate of 12 lb/100 SF (0.58 kg/m²). These beads shall be in addition to those that are provided as part of the thermoplastic mixture itself.

(2) The glass bead dispenser shall be adjustable to regulate the flow of the beads and shall uniformly dispense the glass beads over the entire width of the line.

(3) The beads shall adhere to the cured thermoplastic, or all marking operations shall cease until corrections are made.

3. Thermoplastic Pavement Marking, Spray Type:

a. Application Equipment. All equipment for application of thermoplastic marking materials shall be of such design and maintained in such condition as to properly heat, mix and apply the materials.

b. Melting Kettle. The melting kettle shall be capable of heating the thermoplastic material to its recommended application temperature and maintaining that temperature without scorching. The heating kettle shall have a heat transfer medium, and the flame shall not come in direct contact with the material container surface. A temperature gauge shall be visible on the outside of the kettle to indicate the temperature of the thermoplastic material. The melting kettle shall have a continuous mixer or agitator capable of thoroughly mixing the material at such a rate as to maintain homogeneity of material and uniformity of temperature throughout.

c. Thermoplastic Dispensing Devices. The equipment shall be capable of applying molten thermoplastic material at the temperature

recommended by the manufacturer of the thermoplastic material in lines from 4 inches to 12 inches (100 mm to 300 mm) wide at a 30 mils (760 μm) thickness. Dispensing devices shall be of the spray type.

d. Surface Preparation. The pavement surface on which the thermoplastic material is to be placed shall be clean and dry. Pavement surfaces shall be inspected for cleanliness and any dirt, debris, or other contaminants on the surface to be marked shall be removed as required by the manufacturer.

e. Temperature Limitations. The pavement surface where the thermoplastic material is to be placed shall have a minimum temperature of 50°F (10°C). The air temperature shall be at least 50°F (10°C) during marking operations. The pavement surface temperature and air temperature shall be determined before the start of each day of marking operation and at any other time deemed necessary by the Engineer.

f. Primer Application. A primer shall not be required on new bituminous surfaces unless recommended by the manufacturer of the thermoplastic material. If primer is recommended, it shall be applied and cured in accordance with the recommendations of the manufacturer of the thermoplastic material.

g. Thermoplastic Application. The thermoplastic marking material shall be sprayed onto the pavement surface.

h. The temperature of the thermoplastic material at the time of application shall be at least 350°F (177°C) and less than 425°F (218°C). The temperature of the thermoplastic material shall be checked on the surface as it is placed with a calibrated thermometer at the beginning of each day's marking. Check the temperature after the material is added to the dispensing device, after delays in the marking operation, and any time deemed necessary by the Engineer.

i. Pavement striping shall comply with the standard striping practices shown in the contract. The Contractor shall begin centerline and lane line striping at the beginning of the last existing 10 foot (3 m) stripe in order to maintain a 40 foot (12 m) cycle along the entire pavement.

j. Finished markings shall have well defined edges, and lateral deviation shall not exceed 1 inch in 200 feet (25 mm in 60 m). The minimum thickness of thermoplastic markings shall be 30 mils (760 μm) and the maximum shall be 50 mils (1270 μm). The thickness will be measured as a wet film, except the Engineer may measure cured film by placing the thermoplastic material and then removing a section of cured line and measuring its thickness.

k. Damage to pavement marking caused by the Contractor's operation shall be repaired or replaced at his/her expense.

l. Glass Bead Application.

(1) The drop-on bead shall be mechanically deposited on the molten thermoplastic line immediately after placement of the thermoplastic at the rate of at least 18 lbs/100 SF (0.9 Kg/m²). The glass beads shall not be dropped at the point of application of the thermoplastic or ahead of that point. The beads shall adhere to the cured thermoplastic, or all marking operations shall cease until corrections are made.

(2) The glass bead dispenser shall be adjustable to regulate the flow of the beads and shall uniformly dispense the glass beads over the entire width of the line.

(3) The beads shall adhere to the cured thermoplastic, or all marking operations shall cease until corrections are made.

m. Quality Control:

(1) Workmanship. The applied thermoplastic markings shall be inspected continually for overall workmanship. Markings shall have clean cut edges. The glass beads shall appear uniform on the entire marking surface. Adhesion to the pavement surface shall be checked with a stiff putty knife or similar instrument. The marking should not be removable from a concrete surface. The marking can be removed from a bituminous surface; however, residue of the bituminous substrate shall be stuck to the marking material.

(2) If the thermoplastic line does not provide initial nighttime reflectivity or if the marking does not have the required minimum thickness, the Contractor shall, at no additional cost to the Department, apply additional thermoplastic material to obtain the nighttime reflectivity and/or the total thickness specified. If the marking does not meet the required color, the Contractor shall, at no additional cost to the Department, remove the marking in a manner approved by the Engineer and re-apply the material. If the markings do not comply with the specifications for any other reason, the Engineer may require complete removal or correction at no additional cost to the Department.

4. Permanent Pavement Marking Paint

a. Permanent Pavement Marking shall consist of installing lines at the locations shown in the contract or as directed by the Engineer. These Specifications cover the application of traffic paint and drop-on floating conventional beads on bituminous or Portland cement concrete pavements.

b. Equipment

(1) The striper used for applying traffic marking paint and beads shall be self-propelled. The striper used for pavement marking shall:

(i) be capable of applying three lines simultaneously on the left side for centerline markings and/or one line on the right side of the unit for edgeline markings,

(ii) be capable of applying the traffic marking paint the width specified in the contract and to a dry thickness of 12 ± 1 mils ($300 \mu\text{m} \pm 25 \mu\text{m}$) that is uniform across the width and length of the stripe,

(iii) be equipped with reservoirs that keep the paint mixture smooth and even,

(iv) be equipped with an automatic skip device that applies a stripe and gap of a specified length with a tolerance of 3 inches (75 mm) per cycle of skip. This tolerance shall not be accumulated in subsequent cycles. The striper shall be able to adjust the cycle while striping to allow for matching the existing stripe,

(v) be capable of applying the traffic marking beads to the wet paint immediately after the application of the paint at a rate required

in the contract. The bead applicator shall be equipped with an automatic shut off synchronized with the paint flow.

(2) The trailing vehicles shall be capable of providing the necessary traffic control as shown in the contract.

c. The Contractor shall supply the traffic control shown in the contract. Variations to the traffic control plans shall be submitted in writing to the Engineer. No changes may be instituted until approved in writing by the Engineer. Traffic shall be maintained through the work area at all times. Traffic shall be controlled through the work area until the pavement markings have dried sufficiently to prevent tracking. Traffic control cones may be necessary in some cases to keep traffic off the markings and prevent tracking of the paint.

d. Application of Marking Materials.

(1) Pavement marking materials as specified shall be applied with equipment meeting the Specifications above. Where an irregular area is to be painted, hand sprayers and manual bead application is acceptable. Paint shall be applied within the manufacturer's recommended ambient temperature range unless otherwise ordered by the Engineer in writing. The paint shall not be applied when wind prevents the Contractor from placing markings acceptable to the Engineer. Striping shall be performed only during daylight hours.

(2) The beads shall be applied at the rate of 6 pounds per gallon (0.7 kg/l) of paint applied. If application rates are not within the requirements, the marking application shall be stopped until corrections are made.

(3) The paint shall have a dry thickness of 12 ± 1 mils ($300 \mu\text{m} \pm 25 \mu\text{m}$) and shall be the width shown in the contract $+1/2"$ (12 mm). The Engineer will take periodic samples to ensure the thickness and width of the stripe.

(4) Finished lines shall have well defined edges and lateral deviations shall not exceed 2 inches in 200 feet (50 mm in 60 m). The dashed lines shall be within 3 inches (75 mm) of their intended length and intended placement. When placing new lines, the cycle of dashed line and gap shall not vary more than 3 inches (75 mm). This tolerance shall not be accumulated in subsequent cycles. Lines not meeting these requirements may, at the discretion of the Engineer, be ordered removed and replaced at no cost to the Department.

(5) Permanent pavement markings damaged by the Contractor's operation shall be repaired at the Contractor's cost.

423.04 -- Method of Measurement

1. All permanent pavement marking is measured as follows:

a. Arrows and legends are measured by the each. Arrows shall be counted by each head. The remaining parts of the arrow are subsidiary to the arrowhead(s) of which payment is made.

b. Lines are measured by the linear foot (meter) of material installed for each width of lines installed. Gaps between line segments are not measured.

2. Surface Preparation requiring water, sand or shot blasting shall be measured per linear foot (meter) for the item "Pavement Marking, Surface Preparation". Surface preparation, consisting of air blasting and brushing, shall be subsidiary to other items which payment is made.

3. All temporary traffic control required for this work, with the exception of flagging if required by the Engineer, is subsidiary to items for which direct payment is made.

423.05 -- Basis of Payment

1. Pay Item	Pay Unit
_____ inch (mm) _____ Thermoplastic	Linear Foot (LF) [Meter (m)]
_____ Thermoplastic	Each (ea)
_____ inch (mm) _____ Thermoplastic, Type Spray	Linear Foot (LF) [Meter (m)]
_____ Thermoplastic Type Spray	Each (ea)
_____ Permanent Paving Marking, Paint	Linear Foot (LF) [Meter (m)]
Pavement Marking, Surface Preparation	Linear Foot (LF) [Meter (m)]

2. Removal or preparation of existing pavement marking for the placement of the new material shall be considered subsidiary to the pavement marking items.

3. Glass beads shall be subsidiary to other items which payment is made.

4. Payment is full compensation for all work described in this Section.

SECTION 424 -- TEMPORARY PAVEMENT MARKING

424.01 -- Description

1. The Contractor shall furnish, install at the locations shown in the contract, maintain, and when work is complete, remove the temporary pavement marking as described in this Section.

2. General Requirements:

a. The Contractor shall, at the preconstruction conference, provide the Engineer with the names and telephone numbers of personnel who will be available on a 24-hour-per-day, 7-days-per-week basis. These people shall be responsible for repair, correction, replacement, and maintenance of the temporary pavement marking.

b. The Contractor shall take all necessary precautions for the protection of the work and the safety of the public. The Contractor shall be alert at all times to any and all deficiencies in the placement and maintenance of any temporary pavement marking and shall take immediate action to correct any deficiencies.

c. The Department may elect at any time to correct the temporary pavement marking deficiency and deduct from monies owed to the Contractor for all costs necessary to correct the problem.

d. The Contractor shall immediately notify the Engineer of any hazard or changed roadway condition that is not identified in the contract.

3. a. "Temporary Pavement Marking, (Type _____)":

(1) The pay item "Temporary Pavement Marking, Type _____" has 4 options.

- Temporary Pavement Marking, Type I (Tape)
- Temporary Pavement Marking, Type II (Tape)
- Temporary Pavement Marking, Type Paint
- Temporary Pavement Marking, Type RPM

(2) The pay item "Temporary Pavement Marking" has 4 optional materials unless otherwise restricted by the contract. The options are:

- Type I (Tape)
- Type II (Tape)
- Type Paint
- Type RPM

(3) The application and type of pavement marking to be used will be as specified in the contract.

(4) All temporary pavement marking shall conform to the requirements in this Section for materials, equipment used, application, measurement and payment.

b. "Overlay Broken Lines" and "Overlay Solid Lines":

(1) The pay items "Overlay Broken Lines" and "Overlay Solid Lines" are used to provide and apply lines on asphalt pavement where the marking is renewed at the end of each day as in overlay work.

(2) Both pay items have four optional materials:

- (i) Paint
- (ii) Tape – Type I
- (iii) Tape – Type II
- (iv) Raised pavement markers

(3) The contract will indicate the appropriate marking material to be used. If the contract does not indicate the type of material, then the Contractor may select any of the four options.

c. Temporary Pavement Marking, Type Paint:

(1) This work consists of the placement of white or yellow paint stripes with embedded glass beads for retroreflectivity. The paint stripes shall be the color, size, and type specified in the contract. The paint stripes shall be placed in the locations specified in the contract or as directed by the Engineer.

d. Temporary Pavement Marking, Type I and II (tape):

(1) This work shall consist of the application of preformed temporary pavement marking tape.

e. “_____Temporary Pavement Marking Type_____” is the pay item for temporary arrows, words, and symbols on all asphalt and PCC pavement. These markings shall be either painted with beads or tape as indicated in the pay item.

424.02 -- Equipment

1. Paint Equipment

a. The equipment used to paint the line shall be designed to apply painted traffic lane markings of the type, width, and thickness required.

b. The machine shall be equipped with an adjustable guide to assure the line's proper placement. Hand application or towing of the equipment will not be allowed.

c. The paint machine shall be capable of applying an even, clean-cut line without excessive drifting of paint. The cutoff mechanism on the paint machine shall be capable of making a clean-cut end section without dripping or stringing fine lines of paint.

d. The bead dispenser shall be equipped with an automatic cutoff control synchronized with the cutoff on the striping material.

2. Tape Equipment: Preformed pavement line markings consisting of Type I and II tape shall be installed with a mechanical applicator, which shall be capable of placing pavement lines in a neat, accurate and uniform manner. The mechanical applicator shall be equipped with a film cut off device.

3. Water Blasting Equipment

a. Water blasting equipment shall be capable of removing deleterious material, cure compound or existing striping without damaging the concrete surface.

b. The water blasting equipment shall have a recovery system capable of collecting the used water.

424.03 -- Material Requirements

1. Temporary Pavement Marking, Type Paint and "Overlay Broken/Solid Lines (Paint)" shall meet the following requirements:

a. Paint. The paint shall be commercially available traffic paint capable of receiving and holding glass beads for producing reflectorized traffic markings. The paint shall be furnished ready mixed and shall not be diluted or thinned. The paint shall be compatible with drop-on floating conventional beads. The color for white paint after drying shall be a flat white, free from tint, furnishing good opacity and visibility. For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595.

b. Beads. The glass beads shall be free from clumps and suitable for application to the type of paint selected by the Contractor. The glass beads shall show good adherence to the paint binders and provide good night visibility throughout the manufacturer's predicted useful life of the reflectorized binders. The beads shall allow sufficient capillary action to form a firm embedment in typical traffic paint when dropped on a freshly applied paint film. The glass beads shall be AASHTO Type I.

2. Temporary Pavement Marking, Type I and II (tape) shall be on the Approved Products List.

424.04 -- Construction Methods

1. The Contractor shall install, maintain, and remove all reflectorized temporary pavement markings in accordance with the details of and at the locations shown in the contract.

2. Temporary Pavement Marking/Overlay Solid Lines/Overlay Broken Lines (General):

a. The Contractor shall install reflectorized temporary pavement markings of the color, width, line configuration, and dimensions shown in the contract. Work includes arrows, words and symbols marked on the pavement.

b. The Engineer may approve the use of raised pavement markers for yellow solid lane lines with a maximum spacing of 10 feet (3.0 m). Raised pavement markers may also be used as edge lines, but only when shown in the contract.

c. Raised pavement markers and paint or tape shall not be interspersed or used with each other to simulate the same line. However, they may be used together to supplement a line when required by the contract or the Engineer.

d. The contract will indicate where each type of temporary pavement marking will be applied.

e. Prior to placing the temporary pavement markings on the prepared surface, the Contractor shall layout, spot or string line the proposed temporary marking location. The temporary markings shall be aligned in such a way as to provide a smooth and gradual transition to and from the existing markings, and throughout both straight and horizontally curved sections of the project.

f. When painting over existing lines, the pattern shall match the existing pattern.

g. Raised pavement markers shall not be used for right edge lines unless shown in the contract.

h. Line Dimensions:

(1) When temporary pavement markings (including "Overlay Broken Line") are used to delineate lanes with broken lines in rural areas, the following minimum dimensions shall be used:

Table 424.01

Rural Area

Marking	Minimum Dimension
Paint	Minimum 4 inches (100 mm) wide by 10 feet (3 m) long with 30 foot (9 m) max. gaps.
Tape	Minimum 4 inches (100 mm) wide by 4 feet (1.2 m) long placed every 40 feet (12 m).
Raised Pavement Markers	2 markers, placed 5 feet (1.5 m) apart with 35 foot (10.7 m) gaps.

(2) When temporary pavement markings (including "Overlay Broken Line") are used for lane delineation with broken lines in urban areas, the following minimum dimensions shall be used:

Table 424.02

Urban Area

Marking	Minimum Dimension
Paint	Minimum 4 inches (100 mm) wide by 6 feet (2 m) long with 18 foot (5.5 m) max. gaps.
Tape	Minimum 4 inches (100 mm) wide by 2 feet long (600 mm) placed every 24 feet (7 m)
Raised Pavement Markers	2 markers, placed 3 feet (1 m) apart with 21 foot (6.4 m) gaps.

3. Surface Preparation

a. New Concrete: Prior to the initial placement of the Temporary Pavement Markings, the pavement upon which the markings are to be placed shall be dry, cleaned and properly prepared by water, sand or shot blasting, as a minimum, and to the extent recommended by the manufacturer so that all contaminants, loose debris, and other deleterious material are completely removed.

b. Existing Concrete and Asphalt: Surface preparation for any subsequent application shall consist of air blasting and brushing the roadway surface to remove all loose dirt, mud or other debris and to dry the surface. Each additional application of paint shall be applied over the previously painted stripes.

c. The pavement shall be clean and dry prior to the application of the temporary pavement marking.

d. The concrete surfacing shall be at least seven days old before surface preparation unless otherwise directed by the Engineer.

4. Temporary Pavement Marking, Type I and II (tape) and Overlay Solid Line (tape) shall be placed to form a continuous line when used as a solid line, breaking only at intersections.

5. Temporary Pavement Marking, Type Paint and Overlay Solid/Broken Lines (Paint):

a. The material shall be applied to the pavement at a minimum wet film thickness of 0.015 in. (0.38 mm).

b. The beads shall be distributed evenly over the wet paint at a reasonably accurate rate of 5 pounds per gallon (0.60 kg/l) of paint, unless the Engineer specifies a different rate. Beads applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads are dispensed immediately upon the completed line.

c. The paint shall be applied in such a manner as to follow the existing lines on the roadway or as directed by the Engineer. When deemed necessary by the Engineer to achieve the correct alignment, the Contractor shall, at no additional cost to the Department, place additional markings to guide the placement of the lines. The guide markings shall be temporary in nature and the material and equipment used to place these guidelines shall be approved by the Engineer.

d. The completed line shall be a uniform cross section. The traffic paint stripe shall not be applied when there is moisture on the pavement that would cause a poor bond between the paint and the pavement.

e. Environmental Conditions

(1) The Contractor shall apply Temporary Pavement Marking when atmospheric temperature is 40° F (4° C) and rising, unless directed by the Engineer.

(2) When painting is required with air temperatures below 50° F (10° C), the paint shall be heated according to the manufacturer's recommendation prior to application on the dry, clean and properly prepared pavement.

(3) Initial paint application at the direction of the Engineer made when the air temperature is below 40° F (4° C) will be paid for by the Department. The warranty will not be applied when the paint is applied below 40° F (4° C) at the direction of the Engineer.

f. The Contractor shall follow all manufacturer recommendations for application of traffic paint so as to obtain the best results.

g. The paint shall be applied at a minimum of 4 inches (100 mm \pm 12 mm) in width with a dry thickness of at least 10 mils (0.25 mm) (approximately 10.7 gallons of paint per mile (25.2 l/km) of solid line).

h. Warranty

(1) Any temporary painted line or segment of line, placed before December 1, which fails to adhere to the roadway surface for a minimum of 60 days under normal vehicular traffic or which appears wavy, nonuniform, thin, poorly applied, misaligned, beadless or nonreflective, shall be replaced as directed by the Engineer. For temporary painted pavement markings placed between December 1 and March 15, the minimum time requirement shall be 15 days with the same conditions applicable. No direct payment will be made for replacement within the 60 day or 15 day warranty periods.

(2) After the minimum 60 day or 15 day warranty periods, the Contractor may be required to repaint the temporary traffic markings, as directed by the Engineer. Direct payment will be made for each additional application. However, should the additional application fail within the 60 day or 15 day warranty periods, the provisions as stated in the previous paragraph shall apply.

(3) The Contractor must begin each additional repainting application within 72 hours after notification by the Engineer. Should the Contractor fail to begin repainting within this 72 hour period, the Engineer may use State forces or hire a private contractor to repaint the temporary traffic markings. The Contractor will be assessed any costs above the contract unit price "Temporary Pavement Marking, Type Paint" incurred by the State as a result of performing the corrective action by others, and the project will be shut down until the painting is completed.

6. When markings are no longer needed, the Contractor shall remove them. If removing markings from the final wearing surface, the removal process shall not mar or damage the surface. Removed marking shall no longer be visible on the final wearing surface.

7. Overlay Broken/Solid Lines:

a. At the end of each day, the temporary lines shall be placed so that, when combined with existing or previously placed lines, the entire project is marked.

b. When raised pavement markers, paint or tape is applied and the adjacent layer of asphaltic concrete has not been placed, the markings shall be placed on the higher layer approximately 6 inches (150 mm) from the longitudinal joint. The Contractor shall be required to remove the raised pavement markers and the overlay markers on all lifts.

c. The location of the temporary edge line shall coincide with the permanent line in its final position.

424.05 -- Method of Measurement

1. Temporary Pavement Markings:

a. "Temporary Pavement Markings _____" and "Temporary Pavement Marking" shall be measured by the linear feet (meter) of each line applied. All gaps are not measured.

b. Surface Preparation requiring water, sand or shot blasting shall be measured per linear foot (meter) for the item "Temporary Pavement Marking, Surface Preparation". Surface preparation, consisting of air blasting and brushing, shall be subsidiary to other items which payment is made.

c. Overlay Lines:

(1) "Overlay Solid Lines" and "Overlay Broken Lines" are measured by the station.

(2) Measurements may be made from the estimated length of each segment.

(3) Measurements shall be along the centerline or edgeline, as appropriate.

(4) Breaks or gaps that are not part of a standard pattern (such as identified in Tables 424.01 and 424.02.) and which are more than 100 feet (30 m) in length are not measured for payment.

(5) Breaks or gaps that are part of a standard pattern in "Overlay Broken Lines" are measured.

(6) Any broken or solid lines that fail to meet dimensions or spacing in Tables 424.01 and 424.02 shall not be accepted and no payment will be made for all pavement marking applied that day, until correct installation resumes.

c. Arrows, words, and symbols shall be measured by the each. Arrows shall be counted by each head.

d. Excluded from payment are any applications for maintenance within the warranty period.

e. When traffic must be routed over a new application of asphalt and the traffic is directed over pavement markings, then the Department will pay to replace the markings that have been removed by traffic.

2. Raised Pavement Markers:

a. Raised pavement markers are measured by the linear foot (meter).

b. When the spacing between the raised pavement markers is 10 feet (3 m) or less, the length to be paid for shall be the distance between the first and last markers measured along the path represented by the markers.

c. When the spacing between raised pavement markers is greater than 10 feet (3 m), the distance shall be considered a gap and shall not be measured for payment.

d. All other marking materials shall be measured by the actual length of line installed, excluding gaps.

3. Pavement Marking Removal:

a. "Pavement Marking Removal" shall be measured by the linear foot (meter) of actual length for each permanent (not "temporary") line removed, excluding gaps.

b. Removal of Arrows, Symbols or Legends will be measured by the square foot (meter).

4. Temporary Pavement Marking Removal:

a. "Temporary Pavement Marking Removal" shall be measured by the linear foot (meter) of actual length for each temporary line removed, excluding gaps.

b. Removal of temporary Arrows, Symbols or Legends will be measured by the square foot (meter).

424.06 -- Basis of Payment

1. **Pay Item**

Pay Unit

Temporary Pavement Marking, Type ____	Linear Foot (LF) [Meter (m)]
Temporary Pavement Marking, Surface Preparation	Linear Foot (LF) [Meter (m)]
Raised Pavement Marker	Linear Foot (LF) [Meter (m)]
Overlay Broken Lines	Station (Sta) [Station (StaM)]
Overlay Solid Lines	Station (Sta) [Station (StaM)]
Temporary Pavement Marking	Linear Feet (LF) [Meter (m)]
____ Temporary Pavement Marking Type ____	Each (ea)
Pavement Marking Removal	Linear Foot (LF) [Meter (m)]
Pavement Marking Removal	Square Foot (SF) [Square Meter (m ²)]
Temporary Pavement Marking Removal	Linear Foot (LF) [Meter (m)]
Temporary Pavement Marking Removal	Square Foot (SF) [Square Meter (m ²)]

2. "____ Temporary Pavement Marking Type ____" is the pay item for arrows, symbols or legends.

3. Removal of temporary pavement markings including overlay broken/solid lines will be paid for except:

a. When the temporary markings are intended to be covered up by permanent markings.

- b. When surface preparation removes the temporary markings.
- 4. Marking material specified in the contract should not be changed without a change order.
- 5. Payment is full compensation for all work described in this Section.

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SECTION 501 -- GENERAL REQUIREMENTS

501.01 -- General

1. This Section describes materials, procedures and equipment that are common to items of work described in Division 500. The requirements in Section 501 are applicable to all work, unless otherwise indicated.

2. Materials:

a. Asphaltic Materials include:

- (1) Performance Graded Binder (PG Binder)
- (2) Emulsion
- (3) Cutbacks
- (4) Other liquid asphalt based materials

b. Asphaltic Surfacing Materials include:

- (1) Coats (i.e.: Tack Coats, Armor Coats, etc.)
- (2) Seals (i.e.: Fog Seal, Scrub Seal, Chip Seal, etc.)
- (3) Layers using Asphaltic materials (i.e.: Asphaltic Concrete,

etc.)

c. All asphalt materials which are outside the specified property ranges shall be paid for at the contract unit price multiplied by the product of the pay factors determined by the pay factor tables in their respective Sections.

3. Bituminous Surfacing includes the application of coats, seals or layers that utilize Asphaltic Materials, excluding bituminous foundation course. Bituminous surfacing work shall be performed in accordance with the contract.

4. Before placing the bituminous surfacing, the Contractor shall clean the surface to be treated with mechanical brooms or hand tools as necessary to remove all vegetation, loose surface materials, dirt, mud, old crack sealant, unstable bituminous or other deleterious materials. Any surfacing materials not securely bonded to the surface shall be removed. Material cleaned from the surface shall be swept to the sides or windrowed as required and removed from the project by the Contractor at no additional cost.

5. Stockpiles and plant sites shall be maintained according to the Contractor's Storm Water Pollution Prevention Plan (SWPPP).

6. The Contractor shall protect all structures and roadway appurtenances like signs, guardrails, and curbs. If any items are damaged by the Contractor or because of the Contractor's negligence, then they shall be repaired or replaced in kind at no additional cost to the Department.

7. Bituminous surfacing operations shall not be allowed between sunset and sunrise without permission of the Engineer or unless otherwise specified in the contract.

8. The Contractor shall apply asphaltic materials within the temperature ranges specified in the contract, or within written manufacturer recommended temperatures so that uniform mixing and spreading is attained.

9. Volume Measurement:

a. All volumes of asphaltic materials (except tack coat and fog seal) shall be measured at 60°F (15°C).

b. If the temperature is other than 60°F (15°C), then the measured volume shall be corrected as follows:

Calculated Volume for Payment

Pay Volume (English)	=	AV [1.00000 + [.00025 (60°F - T)]]
Pay Volume (Metric)	=	AV [1.00000 + [.00045 (15°C - T)]]
T	=	Asphaltic Material Temperature in Degrees Fahrenheit (Celsius)
AV	=	Actual Volume at Field Temperature (T)

501.02 -- Equipment

1. All equipment shall be adequate for its intended purpose and shall be maintained in satisfactory working condition.

2. The Contractor shall be responsible for all equipment calibrations.

3. The hauling equipment shall consist of trucks equipped for dumping material into spreader boxes, hoppers, or in a windrow. They shall be constructed and maintained to prevent loss of materials during hauling operations.

4. Equipment used for heating asphaltic materials shall be able to heat the material properly. The equipment shall be provided with an accurate temperature measuring device to indicate the temperature of the asphaltic material in the unit. The use of equipment or methods which will introduce moisture or damage the material will not be allowed.

5. Distributors:

a. All distributors and supply tanks shall be mounted on pneumatic tired trucks or trailers. The units shall be designed to avoid roadbed rutting or other damage. They shall be powered to maintain the required speed for effective operation.

b. Distributors shall be equipped with the following devices:

(1) Tachometer and distribution tables.

(2) Pressure gauges or pump control devices capable of maintaining uniform distribution of required quantities.

(3) Adjustable length, full circulating spray bars with nozzles having rotation adjustment.

(4) Heating coils and a burner.

(5) Thermometer well and an accurate thermometer.

(6) Suitable opening in the dome.

(7) Calibrated measuring stick.

c. The spray bar length shall allow adjustable increments of approximately 1 foot (300 mm). All nozzles shall be adjustable vertically to various heights above the road surface and provide uniform spray coverage.

d. The Contractor shall furnish certified copies of the distributor and supply tank calibrations to the Engineer.

6. Aggregate Spreaders:

a. Aggregate spreaders shall be self-propelled, equipped and operated so that the aggregate will be spread uniformly, continuously and without segregation at the required rate over the full width of the asphaltic material in one pass.

b. The spreading hopper shall be equipped with adjustable cutoff gates to allow spreading of aggregate over the required width of asphaltic material.

c. The unit shall have a rear hopper to receive the aggregate from the haul trucks.

d. A grill shall be mounted over the spreading hopper with openings that will retain all oversize and foreign objects.

7. Mechanical brooms shall be power-driven rotary brooms equipped with a shield to prevent damage to the operator and motorists.

8. In urban areas, sweepers must be designed to operate near vehicles, pedestrians, and other typical obstacles.

9. Truck beds or other equipment with which the bituminous mixture comes in contact may only be cleaned with products from the Department's Approved Products List. Diesel fuel may be used as a cleaning solvent only at the end of the work day to avoid contaminating the asphaltic materials. Diesel fuel shall be used in accordance with all applicable environmental laws and regulations.

SECTION 502 -- ASPHALTIC CONCRETE PAVEMENT SMOOTHNESS

502.01 -- General

1. This Specification establishes a standard for evaluating asphaltic concrete pavement smoothness, and acceptance parameters. The intent of the specification is to produce a finished asphaltic concrete pavement driving surface with an International Roughness Index (IRI) no greater than 68 inches per mile. Pavement smoothness will be evaluated as described in this section.

2. When the pay item "Asphalt Pavement Smoothness Testing I/D" is included in the contract, all the requirements of the following sections including the incentive/disincentive provisions shall apply.

3. When the pay item "Asphalt Pavement Smoothness Testing" is included in the contract, the incentive/disincentive provisions of this section do not apply, but the smoothness testing, evaluation, and pavement surface correction shall be performed as described in this provision.

4. When the contract contains no item for smoothness testing, the asphaltic concrete pavement shall be evaluated in accordance with Paragraph 11 of Subsection 503.04.

502.02 -- Equipment

1. The Contractor shall furnish a non-contact inertial pavement profiler that meets the requirements of ASTM Standard E 950, verified by the manufacturer. The profiler must be approved by the Nebraska Department of Transportation as specified in Subsection 502.03.

2. The non-contact profiler may be a lightweight version or a high speed version.

3. The non-contact profiler shall be equipped with a computerized system that will record, analyze, print and electronically transfer the test data. The profiler shall be equipped with a guide bar.

4. The non-contact profiler shall produce a printed pavement profile report. The report shall include the following information:

- a. Project number
- b. Test date
- c. Traffic lane
- d. Test direction
- e. Test path
- f. Pass number (1 for initial test; 2, 3, etc. for repeat runs)
- g. Operator's name
- h. Project stations
- i. Data filter values
- j. IRI values for each test section
- k. Bump locations for each test section, as determined by California profilograph emulation.

5. The non-contact profiler must also produce and print profilograph emulation results that are consistent with results that would be obtained using a Department-approved California-style profilograph. The profilograph emulation shall be used to determine the locations of correctable bumps and/or dips, as specified in Paragraphs 1.b and 1.c of Subsection 502.05.

6. Diamond grinding equipment used for surface correction shall be power driven, self-propelled units specifically designed to grind and texture pavements. The cutting head shall be at least 36 inches (0.9 m) wide and consist of many diamond blades with spacers. The Engineer may approve other profile correction grinding equipment that can demonstrate on-site the ability to produce acceptable final smoothness and texture of CSP-2 or better using the International Concrete Repair Institute's Concrete Surface Profile rating system.

502.03 -- Certification and Independent Assurance Testing

1. The Department shall calibrate and certify the Contractor's non-contact profiler annually at a test site established by the Department.

a. The non-contact profiler shall be inspected for compliance with general equipment requirements, including data analysis system, guidance system, and overall condition.

b. The non-contact profiler shall be calibrated for distance measurement by moving it over the described path of a premeasured test distance to determine its distance calibration factor.

c. The non-contact profiler shall be checked for vertical measurement accuracy by performing the height measurement calibration procedure in Section 6 of AASHTO R56, Certification of Inertial Profiling Systems.

d. The non-contact profiler shall be checked for overall performance by driving it over the described path of a pre-measured pavement test section at its normal operating speed.

e. Distance measurement indicated by the non-contact profiler shall be within 0.2% tolerance of the actual pre-measured test section distance. To ensure accurate distance measurement during test runs, the air pressure of the distance measurement tire must always be maintained at the same level used for calibration.

f. The IRI reported by the non-contact profiler for the test section shall be within 10.0% tolerance of the IRI reported by a Nebraska Department of Roads non-contact profiler for the same test section.

g. A dated and signed decal will be placed on the non-contact profiler to certify its acceptability for use on Nebraska Department of Roads pavement construction projects. The certification expires one year from its issue date.

2. The Department will certify the Contractor's non-contact profiler operator at least every 5 (five) years. The operator may be certified by presenting certification from another State Highway Agency or by completing certification training conducted by the Nebraska Department of Transportation.

3. The Department will schedule and perform Independent Assurance tests for the Contractor's non-contact profilers and operators at least once per construction season. Independent Assurance testing shall be conducted at a randomly selected time on an active construction project. The criteria for the test will be similar to those used for certification.

502.04 -- Profile Test Procedures

1. The Contractor shall perform all pavement smoothness specification tests except the 10-foot (3 m) straight edge testing as shown in Paragraph 15 of this Subsection.

2. The Engineer shall furnish a report form to the Contractor identifying all required test sections.

a. The pavement surface shall be divided into lane-width segments that end at a bridge, railroad crossing, or other designated termini.

b. The lane-width segments shall be further divided into individual 528 feet long test sections in the direction of project stationing. The last test section in a segment is usually shorter than 528 feet.

c. If a test section is less than 300 feet long, it shall be combined with the preceding 528 feet long test section for analysis.

3. The Contractor's certified non-contact profiler operator shall perform smoothness specification tests in the Engineer's presence. Smoothness testing shall be performed during normal daylight working hours unless otherwise approved by the Engineer.

4. The asphaltic concrete pavement surface temperature shall be 150 degrees F (65 degrees C) or lower when smoothness tests are performed.

5. The non-contact profiler operator shall perform pavement smoothness measurements in both wheel paths defined as 3 feet and 9 feet from the center line or lane line for all driving lanes, and shall be performed in the direction of traffic, as directed by the Engineer, including climbing and fly-by lanes. Average the two wheel path profile indexes for each segment.

6. The Contractor shall remove all objects and foreign material from the pavement surface before testing, including any extra run-in and run-out lengths required for the non-contact profiler. Unless adequate traffic and personnel control is provided by the Contractor, the non-contact profiler must not be operated in active construction zones congested with construction equipment and/or personnel.

7. The non-contact profiler operator shall guide the profiler along the specified wheel path of each traffic lane at a constant speed and directional path throughout the length of pavement being tested. The speed of the non-contact profiler must be within the speed range recommended by the manufacturer. Sudden changes in speed or direction during a test run will disqualify that test, and a new test must be performed.

8. A lateral location indicator shall be used to align the non-contact profiler in the required test path during testing. Pavement edges, longitudinal joints, or longitudinal pavement markings may be used as reference lines.

9. Before testing, the non-contact profiler operator shall perform routine check procedures of the measurement system as recommended by

the manufacturer. To ensure consistent distance measurement, the operator shall also check and adjust the distance recording wheel tire pressure several times a day.

10. All station references on the non-contact profiler reports shall be actual project stations. Stations shall be accurately noted on any printed profiles at least every 200 feet. The distance measured by the non-contact profiler shall compare within 0.2% of the actual distance tested, as determined using project stationing, for all testing and retesting runs. Test runs that do not compare within 0.2% will disqualify that test. New tests shall be performed for all disqualified tests, following calibration of the distance measuring system.

11. Immediately after completion of the tests, the non-contact profiler operator and the Engineer shall sign any printed reports and profiles to verify their authenticity. The signed prints then become the property of the Department. Upon completion of the project, the data files shall be given to the Engineer in the latest version of ProVAL-compatible data file.

12. The verification testing may be performed on at least 10% of the lane miles of pavement surface, with a non-contact profiler owned by the Department. This verification testing will be performed in conjunction with the Contractors profile testing. The Contractors IRI results shall be within 10% of the Departments IRI results.

13. If the verification test, Independent Assurance tests, or other observations indicate that the Contractor's procedures and/or results are not acceptable or accurate, the Engineer may do any or all of the following:

- a. Require the Contractor to calibrate the non-contact profiler and re-run the tests on some or all previous projects in the current construction season.
- b. Disqualify the Contractor's equipment and/or operator.
- c. Perform the tests for part, or all, of the project with a non-contact profiler owned by the Department, and charge the Contractor \$500.00 per lane mile for all testing performed by the Department.

14. The following areas of pavement shall be excluded from the IRI requirements, unless otherwise specified in the contract.

- a. Detour pavement, crossovers and paved shoulders.
- b. Pavement within 50 feet of a transverse joint that separates the pavement from an approach slab to a bridge deck or existing pavement not constructed or overlaid under the contract.
- c. Pavement for truck weigh stations or rest areas, acceleration/deceleration lanes, and interchange ramps and loops.
- d. Pavement within 50 feet of railroad crossings and associated transitions.
- e. Pavement with a posted speed limit of 45 miles per hour or less.
- f. Pavement where the Engineer requires the Contractor to open an area prematurely to cross traffic at intersections and driveways.
- g. Pavement less than 9 (nine) feet in width.

h. Additional exceptions shown on the summary sheet in the plans.

15. Excluded pavement sections shall be measured for bumps and dips with either a profilograph, non-contact profiler or a 10 foot straight edge. If the profilograph or non-contact profiler is used, the deviation shall not exceed 0.40 inch in a 25 ft span. The deviation of the surface shall not exceed 1/8 inch if a 10-foot straightedge is used.

16. The Contractor shall complete all surface profile testing within 7 (seven) calendar days or 5 (five) working days (whichever is later) following the completion of the mainline pavement. In addition, the following shall apply:

a. The initial (uncorrected) surface of all top-lift asphaltic concrete pavement sections shall be profile tested within 2 (two) working days of being placed.

b. The surface of all asphaltic concrete pavement sections that receive corrective work shall be profile tested within 2 (two) working days of the completion of this work.

c. The Contractor shall notify the Engineer of their intent to perform profile testing at least 2 (two) calendar days prior to the testing (or as mutually agreed) to allow the Engineer to be present at the time of the testing.

d. The Contractor shall allow the Engineer to witness all aspects of the profile testing, including traveling in the profiler conveyance vehicle.

e. The profile test results shall be provided to the Engineer immediately after completion of the testing.

502.05 -- Evaluation

1. The Contractor shall determine an IRI and the number of correctable bumps and dips for each test section, record the information on the report form, and provide a copy of the report to the Engineer.

a. The IRI shall be calculated by the non-contact profiler software using the quarter-car simulation. IRI shall be reported in units of inches per mile.

b. Correctable bumps shall be separately identified by the non-contact profiler software in a summary report using the California profilograph emulation. Bumps will appear as high points on the printed profile, and correspond to high points on the pavement surface. Correctable bumps are vertical deviations on the pavement surface that exceed 0.40 inch in height above a base line span of 25 feet.

c. Correctable dips shall be separately identified by the non-contact profiler software in a summary report using the California profilograph emulation. Dips will appear as low points on the printed profile, and correspond to low points on the pavement surface. Correctable dips are vertical deviations on the pavement surface that exceed 0.40 inch in depth below a base line span of 25 feet.

502.06 -- Pavement Surface Correction

1. The Contractor shall locate and perform all required pavement surface corrective work, with the approval of, and in the presence of, the Engineer.

2. Corrective work may be required for any bump, dip, or a combination of bumps and dips or other roughness that, in the opinion of the Engineer, produces an objectionable ride. Corrective work shall be accomplished at no cost to the Department.

a. When the initial IRI of a test section is 96 in/mi or less, bump and dip correction is the only corrective work allowed for that section.

b. When the IRI of a test section exceeds 96 in/mi, corrective work shall be performed.

c. The Contractor shall retest all corrected test sections.

3. All bumps, as defined in Paragraph 15 of Subsection 502.04, and Paragraph 1.b of Subsection 502.05, and all test sections with an IRI exceeding 96 in/mi shall be corrected by diamond grinding.

a. Bumps shall be considered corrected when they are at or below the 0.40 inch maximum height.

b. Sections with an IRI exceeding 96 in/mi shall be considered corrected when the IRI for that section has been reduced to a value of 96 in/mi or less.

4. All dips, as defined in Paragraph 15 of Subsection 502.04, and Paragraph 1.c of Subsection 502.05, shall be corrected until they are at or below the 0.40 inch (10 mm) maximum depth. All dips shall be corrected by diamond grinding on either or both sides of the dip.

5. Pavement surface correction by diamond grinding shall be limited so that newly placed asphaltic materials are not reduced in thickness to less than the required plan thickness minus 1/4 inch. In the event that (a) bumps, (b) dips, or (c) test sections exceeding 96 in/mi cannot be corrected by diamond grinding to the specified limits without violating thickness criteria, the Contractor shall have the following options that will be subject to the approval of the Engineer.

a. Remove and replace a sufficient length of the surface layer to correct the deficiency, under the following conditions:

(1) The Contractor shall furnish replacement material that meets the original specifications for the material removed.

(2) Removal and replacement shall be for the full lane width.

(3) The thickness of the replacement asphaltic materials shall be a minimum of 3 (three) times the nominal aggregate size of the asphaltic concrete mixture.

b. A combination of diamond grinding and removal and replacement methods.

c. Elect to leave in place an uncorrected or partially corrected bump, dip, or test section exceeding an IRI of 96 in/mi, for a monetary deduction in accordance with Subsection 502.09.

502.07 -- Traffic Control

1. The Contractor shall provide all traffic control for smoothness testing and corrective work at no cost to the Department.

502.08 -- Method of Measurement

1. "Asphalt Pavement Smoothness Testing I/D" and "Asphalt Pavement Smoothness Testing" shall be measured on a lump sum basis.

2. a. When the pay item "Asphalt Pavement Smoothness Testing I/D" is included in the contract, the unit price of the accepted quantity of asphaltic concrete of each non-contact profiler test section shall be adjusted according to the schedule in Table 502.01, subject to the limitations in Paragraphs 3 and 4 of this Subsection. Pavement sections excluded from this smoothness specification shall not qualify for incentive pay.

b. When the pay item "Asphalt Pavement Smoothness Testing" is included in the contract, the incentive/disincentive provisions of this Subsection do not apply.

Table 502.01

Payment Adjustment Schedule	
International Roughness Index (IRI) Inches Per Mile	Percent of Contract Prices
0 to 37	107
Greater than 37 to 43	105
Greater than 43 to 49	103
Greater than 49 to 56	102
Greater than 56 to 68	100
Greater than 68 to 74	98
Greater than 74 to 80	96
Greater than 80 to 86	94
Greater than 86 to 93	92
Greater than 93 to 96	90
Greater than 96	Corrective Work Required

3. When the initial IRI of a test section is 96 in/mi or less, that value shall determine the percent of incentive pay for the section, unless bump and dip correction performed in that section increases the percent of pay.

4. When the initial IRI of a test section is greater than 96 in/mi, corrective work performed in that section may increase the percent of pay up to the 100% level indicated in Table 502.01.

502.09 -- Basis of Payment

1. When the pay item "Asphalt Pavement Smoothness Testing I/D" is included in the contract, the overall smoothness pay factor for the Quality Incentive/Disincentive for the accepted quantity of asphaltic concrete shall be determined according to the formula in Table 502.02. This pay factor shall be used in the cumulative pay factor determination as calculated on NDOR provided Quality Incentive/Disincentive software for the project's Lump Sum final pay calculation.

Table 502.02

Pay Factor Formula
$PF = \frac{A(1.07) + B(1.05) + C(1.03) + D(1.02) + E(1.00) + F(0.98) + G(0.96) + H(0.94) + I(0.92) + J(0.90)}{A + B + C + D + E + F + G + H + I + J}$
Where:
A = Length of pavement with an IRI of 0 to 37 in/mi
B = Length of pavement with an IRI greater than 37 to 43 in/mi
C = Length of pavement with an IRI greater than 43 to 49 in/mi
D = Length of pavement with an IRI greater than 49 to 56 in/mi
E = Length of pavement with an IRI greater than 56 to 68 in/mi
F = Length of pavement with an IRI greater than 68 to 74 in/mi
G = Length of pavement with an IRI greater than 74 to 80 in/mi
H = Length of pavement with an IRI greater than 80 to 86 in/mi
I = Length of pavement with an IRI greater than 86 to 93 in/mi
J = Length of pavement with an IRI greater than 93 to 96 in/mi

2. a. The Contractor shall be assessed an additional \$500.00 deduction for each of the following uncorrected or partially corrected smoothness irregularities that are left in place.

(1) Bumps

(2) Dips

(3) Sections with an IRI value exceeding 96 in/mi, but less than 105 in/mi.

b. The Contractor shall be assessed an additional \$1000.00 deduction for each uncorrected or partially corrected section with an IRI value of 105 in/mi or greater.

3. The work of Asphalt Pavement Smoothness Testing I/D” and “Asphalt Pavement Smoothness Testing” shall be paid at the lump sum contract unit price. This price shall be full compensation for all materials, labor, and equipment to accomplish the smoothness testing as set forth in this Specification.

SECTION 503 -- ASPHALTIC CONCRETE

503.01 -- Description

1. This work shall consist of producing and placing asphaltic concrete as shown in the contract.

503.02 -- Material Requirements

1. Asphaltic concrete shall conform to the requirements in Section 1028.

2. Performance Graded Binder (PG Binder) shall be the type and grade specified in the contract and shall conform to the requirements in Section 1029.

3. The PG Binder used in the State maintenance patching shall be the same type used in the asphaltic concrete mixture that is being produced at the time the patching material is procured.

503.03 -- Equipment

1. General Requirements:

- a. The Contractor shall provide plant calibration documentation.
- b. Tank volume values shall be available at the plant.

2. Asphaltic Concrete Mixing Equipment:

a. General Requirements:

(1) The equipment that is used for heating, proportioning, and mixing the aggregates and PG Binder shall be able to produce a uniform mixture.

(2) The dryers shall be able to dry and heat all aggregates to the required temperatures with positive control. Aggregates shall be agitated continuously during the process of heating. Damage to PG Binder in dryer-drum type mixing plants shall be avoided.

(3) Recycled Asphalt Pavement shall not be exposed to open flame.

(4) Continuous temperature and time readings of the asphaltic materials shall be electronically recorded whenever the plant is operated. A daily copy of the temperature records shall be given to the Engineer. Temperature and time displays shall be easily accessible. Temperature and time sensors will be provided at the following locations:

(i) Inside the asphaltic concrete mixture discharge chute.

(ii) Inside the surge bin. (The Contractor may manually take and record the temperature. Readings will be taken every 2 hours when the plant is in operation.)

(iii) Inside the PG Binder storage tank. (Readings shall be taken every 2 hours when the plant is in operation.)

(5) (i) Equipment used for heating PG Binder shall conform to the requirements of Section 501.

(ii) During storage, the PG Binder temperature shall be maintained in accordance with binder supplier recommendations. All plants shall be equipped with a circulating system which is designed to assure proper and continuous circulation of the PG Binder during the operating

period. Storage tanks shall have sufficient capacity to provide for continuous operation. The tanks shall be situated and constructed to allow the volume of the PG Binder to be safely and accurately determined at any time.

(6) (i) The plant may have surge bins for the temporary storage of asphaltic concrete.

(ii) The asphaltic concrete taken from the surge bin shall not differ from the material taken directly from the plant.

(iii) The surge bin shall be completely emptied at the end of each operating day.

(7) All plants shall be equipped with a continuously operated dust collector. The collected material may be wasted or returned to the mix.

(8) All plants shall be equipped with a system to meter dust returned to the mix.

(9) Mineral filler bins shall be protected from moisture.

b. Dryer-Drum Plants:

(1) These plants shall include cold aggregate feeders, vibratory screening units for removing oversize material from both virgin and reclaimed material, proportioning devices for controlling the quantity of each ingredient in the mixture, and any other equipment necessary to produce the mixture as specified.

(2) Plants shall be equipped with a pump synchronized to the feeding mechanism so that the required percentage of PG Binder will be applied continuously and uniformly.

(3) The feeding system shall be synchronized to the rest of the plant.

(4) Plants shall be equipped with a system that provides a continuous electronic readout and collection of all setting data and made available to the Engineer.

3. Hauling Equipment:

a. The truck beds shall be clean and shall be constructed so that all materials remain in the bed while the truck is in transit.

b. All trucks shall be equipped with a suitable waterproof cover.

c. Any truck that causes excessive material segregation or contamination shall not be used.

4. Placement Equipment:

a. Asphaltic Concrete Mixture Laydown Machines (paver):

(1) The paver shall place the full-lane width shown in the contract. The paver shall be self-propelled and able to spread and finish the material to the required thickness without material or temperature segregation of the mixture. The finish machines shall produce a smooth and uniform surface, a profile that meets the required cross section, and layers of uniform density.

(2) The paver shall be equipped with a hopper to receive the asphaltic concrete. It shall be equipped with a distributing auger or other

acceptable devices that will distribute the asphaltic concrete evenly across the entire screed width.

(3) The paver shall produce continuous and uniform consolidation of the asphaltic concrete. The screed of the paver shall be adjustable to the crown and heated across its entire length. The screed shall be vibratory and adjustable to meet the manufactures recommendations for the mix in use. Controls will be provided to prevent overheating the asphaltic material. Screed extensions shall be set to extrude the asphaltic concrete mixture at the same level as the main screed such that the compacted roadway or shoulder will have a uniform slope.

(4) The paver shall employ an automated screed control to regulate slope and grade adjustments. A variation of 1/8 inch (3 mm) along the reference line and a minimum variation of 1/8 inch (3 mm) in required transverse slope for each 12 feet (3.6 m) of lane width will be detected and compensated for by the equipment.

(5) The screed shall be controlled by a self-contained grade reference system with a span length (length between extreme points of contact with the roadway) of at least 30 feet (9 m).

(6) When the leading edge of the reference system encounters a localized [less than 3 feet (1 m) long] change in the roadway elevation, the sensing point shall react to compensate for 25% of the actual change in elevation.

(7) The self-contained grade reference system shall be used at or near the centerline of the roadway unless this is not possible; in which case, the recommendations of the manufacturer of the finishing machine shall be used.

(8) The self-contained grade reference system shall be used to place all layers of the asphaltic concrete mixture, except that a joint matching shoe may be used when matching the adjacent pass of the final layer and for shoulder surfacing work.

(9) When required by the contract or the Engineer, such as when matching project ends, bridges, railroad crossings, and approach ends or filling settlement areas to the correct grade, the electronic screed shall be controlled by sensors on a string line reference erected by the Contractor to the required elevations.

b. Side-Delivery Machines (road widener):

(1) Side-delivery machines shall be self-propelled and capable of spreading and finishing the material to the required thickness with a strike-off device without segregating the mixture. The machine shall be designed for placement of asphaltic concrete in the lane adjacent to the lane in which it is operating. Side-delivery machines shall produce a smooth, uniform surface of the required cross section and density.

(2) The side-delivery machine shall be equipped with a hopper to receive the asphaltic concrete before distribution to the strike-off.

(3) The side-delivery machine shall be able to control the depth of placement by sensors or other devices using the surface of the adjacent lane as a reference.

(4) When a side-delivery machine is used, a mechanical broom shall follow the delivery machine to sweep any spilled material onto the newly placed and uncompacted surface.

5. Elevating Equipment (pickup machine):

a. Pickup machines shall transfer, without segregating, asphaltic concrete from the roadway surface to the paver's receiving hopper.

b. The pickup machine shall remove essentially all the asphaltic concrete from the roadway surface without inclusion of subgrade material or damage to the existing surface.

6. Material Transfer Vehicles (MTV):

a. Before crossing any bridge, these vehicles must be unloaded.

7. Compaction Equipment:

a. All roller wheels shall be smooth and free from defects that would mar the surface of the work. Adjustable spring scrapers shall be fitted to each roller to scrape in both directions.

b. All rollers shall have full width wheel sprinkling devices and drip pans designed to keep contamination off the roadway surface.

8. Curb Forming Equipment:

Curb forming equipment shall extrude and compact the asphaltic concrete mixture to the required cross section.

9. Portable Scales:

a. Scales shall be installed in accordance with the manufacturer's recommendations. They shall have sufficient capacity to determine the weight of a fully loaded truck.

b. The Contractor shall calibrate the scales, accurate to 0.5% of a fully loaded truck, in the Engineer's presence, or the scale shall have a current Nebraska Department of Agriculture inspection certificate. Documentation showing that scales were calibrated by a scale company service crew during the current season is also acceptable.

c. The scale shall be cross-checked at the Engineer's discretion for accuracy by comparing its results with a load's gross weight on an approved commercial scale.

d. If the scales are not able to weigh all axles at once, the approaches shall be extended so that the entire hauling unit will be level as each axle is measured.

e. Suitable protection shall be provided against wind currents that may affect the accuracy of the scales. The platform of the scale shall be kept clean and free from accumulations of materials.

10. Notched Wedge Equipment

a. The notched wedge joint device shall be a manufactured strike-off device attached to the asphalt paver screed and able to produce the required shape and configuration after compaction, as detailed in the plan typical.

- b. The device shall be self-adjusting, spring-loaded, and able to generate a smooth, uniform surface and slope without disrupting the smoothness of the paving mat.
- c. The device shall be capable of applying vertical loads by pressure or ballasting methods.
- d. The device may or may not have capability of vibration.

503.04 -- Construction Methods

1. Preparation:

a. (1) The Contractor shall prepare the roadbed, subgrade, base, and/or foundation courses as described in Division 300.

(2) Before placing the asphaltic concrete, the surface of the trimmed subgrade shall be tight, dust-free, dry and rolled to firmly incorporate any loose or disturbed material and provide a suitable foundation for the subsequent construction.

b. The Contractor shall clean the pavement surface of all dirt, deleterious material, loose surfacing material, or unstable bituminous patches.

(1) For all projects (including single lift projects), excessive or loose asphaltic crack filler or joint sealing material shall be removed flush with the surface.

(2) For single lift projects only, all asphaltic crack filler or joint sealing material in joints or cracks 1 1/2 inches (38 mm) or more in width shall be removed to a depth of at least 1 inch (25 mm) below the pavement surface.

c. When grade correction is necessary to meet a surface elevation, it shall be accomplished by milling or removal as shown in the contract.

d. The Contractor shall dispose of any surfacing material along the project right-of-way left by maintenance forces.

e. (1) The Contractor shall apply a tack coat in accordance with the requirements of Section 504 after the existing surface has been prepared and between each successive layer of asphaltic concrete.

(2) Asphaltic concrete shall not be placed over emulsified tack coat until the emulsion has broken and all free moisture has evaporated or drained off the surface.

2. Asphalt Testing and Asphalt Mix Control Strip:

a. At the Contractor's option, the control strip may be waived. The decision to omit the control strip must be communicated to the Engineer prior to the start of production. When the control strip is waived:

(1) The moving average of four air voids values for the first three asphaltic concrete sub lots is not valid and a pay factor of 1.0 shall be applied.

(2) The first three asphaltic concrete sublots shall be subject to the following removal criteria and removal shall be at no cost to the Department.

Table 503.01

Sublot	Removal Criteria
1-1	Va ₁₋₁ less than 1.5 or greater than 7.0
1-2	(Va ₁₋₁ + Va ₁₋₂) ÷ 2 less than 1.67 or greater than 6.67
1-3	(Va ₁₋₁ + Va ₁₋₂ + Va ₁₋₃) ÷ 3 less than 1.83 or greater than 6.33

Where: Va₁₋₁ = the single test air voids for Sublot 1-1
 Va₁₋₂ = the single test air voids for Sublot 1-2
 Va₁₋₃ = the single test air voids for Sublot 1-3

b. If the control strip is not waived, on the first production day, a 600 ton (544 Mg) control strip shall be placed and approved before full production begins. The Contractor shall construct the control strip using the approved asphalt mix design with lay down and compaction procedures that are representative for the project.

(1) The Contractor shall take at least 3 control strip mixture samples and record the test results for the mixture properties. The Contractor will also record compaction density values and rolling pattern information. This data will be for information only and shared with the Engineer.

(2) Random samples shall be taken, and the air voids shall be between the values shown in Table 503.02

Table 503.02

Control Strip Sampling			
Sample No.	Ton (Mg)	Air Voids for SPH	Air Voids for SPR
1	0 to 200 (0-180)	2.5 to 6.0	1.5 to 5.0
2	201 to 400 (181-363)	2.5 to 6.0	1.5 to 5.0
3	401 to 600 (364-544)	2.5 to 6.0	1.5 to 5.0

(3) Marshall or Gyratory air voids of each sample shall be calculated using the maximum specific gravity of that sample.

(4) The test results must fall within the specified tolerances, but if subsequent tests continue a trend toward the target values specified, the Department may tentatively accept the control strip with written assurance from the Contractor that adjustments will be made in an effort to attain and then maintain target Specifications.

(5) The control strip will be accepted at 100% pay if all of the following test results are met. If any of the following test results are not met, the control strip will be subject to removal.

(i) The Dust to Binder ratio is between 0.70 and 1.70.

(ii) CAA is no more than 5% lower than the minimum specified shown on Table 1028.02 using blended cold feed material or ignition oven test results. FAA is no more than 0.5% lower than the minimum specified using blended cold feed material or no more than 1.0% lower than the minimum specified using ignition oven test results shown on Table 1028.03.

(iii) Air voids are between 2.5% to 6.0% SPH and between 1.5% to 5.0% for SPR, SLX, and SRM.

(6) Department personnel will observe testing procedures.

(7) The Contractor shall repeat the control strip process for each mix type and until an acceptable control strip is produced.

(8) When placed in areas that are to be paved, accepted control strips may remain in place and be measured as a part of the completed pavement.

(9) Full production of a specific mix type may begin only after a control strip for that specific mix type is accepted.

(10) At locations where the contract requires more than one layer (lift) of asphalt and when different mixes are used in each layer, then the control strips for the upper layers can be placed in the lower layers.

(11) Asphaltic Concrete Type SPS is excluded from any control strip requirements.

(12) When a control strip is constructed, the Contractor will use the three individual air void tests within the control strip and apply those individual values to the individual air void test result of the first subplot of Lot 1 to calculate the initial moving average of four and resulting pay factor for the initial subplot.

3. Placement Limitations:

a. Table 503.03 shall be used when there is a need to restrict the routine placement of asphaltic concrete as a result of cold temperatures.

b. The Engineer may restrict the placement of asphaltic concrete when weather conditions or other project specific conditions exist.

Table 503.03

Cold Weather Asphaltic Concrete Placement	
<u>Lift Thickness</u>	<u>*Minimum Surface Temperatures</u>
Less than 2 inches (50 mm)	45°F (7°C)
2 to 3 inches (50 mm to 75 mm)	37°F (3°C)
Greater than 3 inches (75 mm)	35°F (2°C)

*** 32°F (0°C) for all lift thicknesses when a warm mix additive is in accordance with the contract.**

c. The surface layer shall be laid in one continuous thickness over the length of the project, including core out sections. Thickness adjustment in the transition sections shown in the contract shall take place in the lower layers.

d. The Contractor shall place the asphaltic concrete mixture on a dry and frost-free surface.

e. (1) After September 15, if the haul distance exceeds 3 miles (5 km), all hauling vehicles shall be equipped with a tarp. Tarping and insulation will be required if it is determined by the Engineer that uniform temperature control of the mixture is not being maintained.

(2) Each surface of a hauling vehicle's box shall be insulated and have an "R" value of approximately 1.0 ft²-hr-F°/BTU[RSI 1.0m²(°C/W)].

(3) All insulating material shall be firmly attached to the truck box, whether inside the box or out, and shall have no bulges, tears, gaps, or uneven seams.

(4) Unsatisfactory or deteriorated insulating materials shall be replaced.

f. No asphaltic concrete mixture shall be placed after October 31 except as follows.

(1) The Contractor may make a written request to continue asphalt placement after October 31. The request shall include the type of asphaltic concrete mixture and estimated tons to be placed. The Engineer will provide a written notice if approved. The approval will be conditional based on daily conditions. The approval may include conditions for safety, quality and traffic control.

(2) The Engineer may order the contractor to continue.

4. Delivery and Production Requirements:

The delivery of asphaltic concrete shall be scheduled to allow continuous lay down operations.

5. Placement Operations:

a. (1) The actual mixing temperature shall be selected by the Contractor, in accordance with binder supplier recommendations, to provide adequate aggregate coating and mixture compaction at lay down.

(2) The temperature of the asphaltic concrete mixture shall not exceed 350°F (177°C) immediately after discharge from the mixer.

(3) Never shall the selection of the mixing temperature be such that drainage of the PG Binder from the aggregate will exceed contract specifications.

b. (1) Asphaltic concrete used in the construction of sections having a uniform width, and the surface layer of intersections and driveways, shall be placed with a paver.

(2) The surface lift of asphaltic concrete shoulders shall be placed with a paver. Lower lifts of asphaltic concrete shoulder material may be placed with a side-delivery machine.

(3) In deep, irregular, or narrow sections such as flumes, ditch lining, island noses, or where it is impractical to use a paver, the Contractor may use other appropriate methods for spreading the mixture.

(4) Dumping bituminous mixtures on pavement which is not to be resurfaced will not be allowed.

c. Each asphaltic concrete layer shall meet the following thickness requirements:

(1) When constructed under traffic maintained conditions, the top layer's nominal thickness shall not exceed 2 inches (50 mm).

(2) The bottom layer's thickness shall be at least 3 inches (75 mm) when placed on a base course or the subgrade.

d. The entire width of a layer shall be placed before any of the subsequent layer is started.

e. Under traffic maintained conditions, the Contractor shall begin each day's placement in the lane adjacent to the previous day's placement when the longitudinal distance between the terminus points for the layers in the adjacent lanes is greater than 500 feet (150 m).

(1) The Contractor has the option of constructing a notched wedge joint. If the Contractor chooses to construct this joint, it shall be built as shown in the contract. This work shall consist of constructing a notched wedge longitudinal joint between adjacent passes of asphaltic concrete lifts over 1 inch on pavement that will be open to traffic and contains uneven lanes. The notched wedge joint shall consist of a vertical notch 1/2 the thickness of the asphalt lift, and an 8 inch to 12 inch uniform taper extending into the adjoining lane.

(i). The notched wedge joint device shall be heated prior to the beginning of laydown either manually or as part of the notched wedge joint device.

(ii). The notched wedge joint shall be constructed in one pass of the paver. A constant head of asphaltic concrete shall be supplied in front of the notched wedge to provide pre-compaction of the notched wedge joint.

(iii). The taper of the notched wedge joint will be a minimum of 8" and a maximum of 12".

(iv). The notched wedge joint shall be used at any longitudinal joint locations situated between two driving lanes. The Contractor also has the option to utilize the notched wedge joint at other longitudinal joint locations.

(v). A tack coat shall be applied to the full face of the in-place notched wedge joint, prior to the placement of full lane tack coat application.

f. Any longitudinal joint shall be parallel and coincident to the major traffic lane edges.

g. Asphaltic concrete lugs shall be constructed at all unsurfaced entrances, driveways, or intersections. They shall be 1 foot (300 mm) by 40 feet (12 m) measured along the project centerline. For shared entrances, the length may be increased 20 feet (6 m) for each additional entrance.

h. When surfacing extends beyond the intersection or driveway surfacing areas, the elevation transition shall extend a minimum of 3 feet (900 mm) for each inch of elevation.

i. When the project includes surfaced intersections or driveways for which resurfacing is not shown in the contract, the roadway or shoulder resurfacing shall be feathered onto the existing intersections or driveways a minimum of 3 feet (900 mm) for each inch of elevation difference.

j. The asphaltic concrete mixture shall be dumped in the center of the finishing machine's hopper without overloading. Care shall be exercised to avoid spilling the mixture on the existing surfacing. The finishing machine shall be operated to produce a lane of uniform temperature, thickness and density.

k. Immediately after screeding and before compaction is started, the surface shall be checked. Accumulations of poorly mixed asphaltic concrete which drop onto the surface shall be removed and replaced. All irregularities in alignment and grade shall be corrected.

l. The roller shall not pass over the unprotected end of the freshly placed mixture. When placement is discontinued, the end shall be protected by a wedge of asphaltic concrete, feathered 3 feet (900 mm) in length for each inch (25 mm) of layer thickness, shall be placed at the end of the lane.

6. Construction of Transverse and Longitudinal Joints:

a. All joints shall be well bonded.

b. The Contractor shall clean and apply a tack coat to the surfaces.

c. (1) The Contractor shall cut the surface to expose material the full thickness of the layer when constructing a transverse joint at the end of the existing layer.

(2) The hot mixture shall be placed in contact with the exposed surface and raked to the proper depth and grade.

d. When constructing longitudinal joints, all voids shall be filled and the joint shall be properly "set up" to receive the maximum compression under rolling.

7. Compaction:

a. The Contractor shall roll and compact the asphaltic concrete mixture while it is in a workable condition.

b. (1) Finish rolling shall be accomplished with a steel drum roller.

(2) When paving adjacent to a previously placed lane or when placing the top layer of surfacing adjacent to an existing pavement or curb, the last pass of the roller in which the full roller width is entirely on the freshly placed material shall be kept approximately 6 inches (150 mm) from the existing facility. The final pass of the roller shall then be made over the remaining uncompacted 6 inch (150 mm) strips, tucking the material into the joint.

(3) Rolling on superelevated curves shall progress from the low side in each lane, maintaining the 6 inch (150 mm) from the edge requirement of the preceding paragraph.

c. Rolling shall be continued until all roller marks are eliminated and the specified density is achieved.

d. The frequency and amplitude of vibratory rollers shall be adjusted to the manufacturer's recommendations for the thickness of layer being placed and the speed at which the roller is being operated. The Manufacturer's recommendations shall be made available to the Engineer two weeks prior to placement.

e. The speed of the roller shall be adjusted to avoid displacement of the hot mixture. Any displacement that occurs shall be corrected. Rolling shall proceed continuously until all roller marks are eliminated.

f. Areas where rollers cannot be properly operated shall be compacted with appropriate equipment.

8. Preparation of Expansion Relief Joints:

a. When an asphaltic concrete pavement is constructed on a Portland cement concrete pavement, the Contractor shall construct expansion relief joints as shown in the contract.

b. The Contractor shall remove a continuous full depth transverse section of the concrete pavement approximately 4 inches (100 mm) wide and backfill the void with asphaltic concrete. The Contractor may use asphalt millings with the Engineer's approval.

9. No traffic shall be allowed on newly constructed pavement having a temperature of 165°F (75°C) or greater.

10. Any core hole made in the pavement by the Contractor or the Department shall be filled with asphaltic concrete and compacted to the same density as the surrounding material.

11. The Engineer may evaluate any surface irregularities caused by workmanship, such as segregation, deleterious material, tears, delamination or any other irregularities. These irregularities shall be corrected as directed by the Engineer at no cost to the Department.

503.05 -- Method of Measurement

1. a. The "Asphaltic Concrete" shall be measured for payment in tons (Megagrams) on approved scales.

b. The "Asphaltic Concrete" shall be measured with automatic batching plant scales.

c. The scale tickets shall be prepared in duplicate. The Contractor shall carry the original copy of the scale ticket to the delivery point and give it to the Engineer.

d. (1) The measured quantity shall be the total weight of asphaltic concrete shown on the scale ticket without deduction for the PG Binder weight in the mixture.

(2) The Engineer shall deduct the weight of all material lost, wasted, damaged, rejected, or applied contrary to these Specifications.

2. Placement of driveways and intersections is measured in square yards (square meters). The materials used in driveways and intersections shall be included in the roadway material bid items.

3. a. PG Binder will be measured in tons (megagrams).

b. In the event the Contractor cannot provide evidence to verify the PG Binder quantity from the scale ticket, the Contractor's laboratory test shall be used to determine the PG Binder percentage, unless the verification test results require the Department's test results be used.

4. Expansion relief joint preparation is measured by the linear foot (meter). The materials used in the expansion relief joint will be paid for in the roadway material bid items.

5. The construction of a notched wedge joint will not be measured and paid for but will be subsidiary to the associated asphaltic concrete.

6. Warm Mix Asphalt (WMA) additives are measured by the unit of each for the item “Hydrated Lime/Warm Mix Asphalt” for each ton of hot mix asphalt produced.

503.06 -- Basis of Payment

1. Pay Item	Pay Unit
Asphaltic Concrete, Type ____	Ton (Tn) [Megagram (Mg)]
Performance Graded Binder ____	Ton (Tn)[Megagram (Mg)]
Placement of Asphaltic Concrete for Intersections and Driveways	Square Yard (SY) [Square Meter (m ²)]
Prepare Expansion Relief Joint	Linear Foot (LF) [Meter (m)]
Hydrated Lime/Warm Mix Asphalt	Each (ea)

2. For each subplot of Asphaltic Concrete Type SPS, SPR, SPH, SLX, and SRM, the asphaltic concrete shall be paid for each ton of “Asphaltic Concrete Type _____” placed and accepted. The incentive/disincentive shall be calculated on a lump sum basis based on the unit price, tonnage and quality pay factors. This will be a product of all applicable pay factors, including density and smoothness. This factor will be calculated on Department software and will provide for a weighted pay factor for each type of Asphaltic Concrete on the project, and then summed up and paid for as a single incentive/disincentive as a lump sum. The tonnage that is applicable toward this incentive/disincentive shall only be tonnage that is paid for by ‘mainline roadway and shoulder tonnage items’ and for the full thickness and tonnage paid for and accepted. No incentive will be paid for project patching or tonnage used for maintenance patching. When a control strip is not constructed, the pay factor for the running average of four air voids shall be fixed at 1.0 for the first three asphaltic concrete sublots.

3. The final pay factor for total project tonnage for any one type of superpave asphaltic concrete, expressed as a percentage, shall be computed as follows:

$$\frac{P1(T1) + P2(T2) + P3(T3)...}{T1 + T2 + T3...}$$

Where P1, P2, P3 = percent pay factor for each subplot
T1, T2, T3 = tons (Mg) at respective pay factor

4. a. If the temperature exceeds 350°F (177°C) but does not exceed 400°F (204°C) immediately after discharge from the mixer, the pay factor shall be 0.90.

b. If the temperature of the mixture exceeds 400°F (204°C), the material will be rejected or, if used on the project, the pay factor for the material will be 0.40.

5. PG Binder and Rejected Material

a. Pay Factor for PG Binder is determined by the specifications in Section 1029.

b. When asphaltic concrete in any lot or portion of a lot is rejected and removed from the road, payment will not be made for the asphaltic concrete or for the PG Binder contained in the rejected material. The determination of the quantity of PG Binder for which payment will not be

made will be based on the percent of virgin PG Binder used in the rejected material.

(1) The order of precedence to determine the PG Binder quantity is:

- (i) Actual lot tests.
- (ii) The average of the day's run.
- (iii) The job-mix formula.

c. The test data from the actual "rejected" lot of asphaltic concrete will be used to determine the quantity of virgin PG Binder that is rejected.

6. Pay factors for asphaltic concrete mixtures do not alter the price paid for PG Binder.

7. Tack coat will be paid for in accordance with Section 504.

8. Disposal of the surfacing material discarded by maintenance forces will be measured in accordance with the requirements of Subsection 919.04 and paid for in accordance with Subsection 919.05.

9. a. Any asphaltic concrete found contaminated by petroleum distillates, hydraulic fluid, or other asphalt solvents may be rejected. If already incorporated in the work, it shall be removed and replaced at no additional cost to the Department or, at the Engineer's option, may be left in place and paid for at 40% of the bituminous mixture's contract unit price.

b. The quantity of asphaltic concrete to be removed or paid for at the reduced price will be based on full lane widths extending beyond the limits of the contaminated area 25 feet (7.6 m) in both directions.

10. If more than one type of asphaltic concrete is required, the pay item will be subdivided so the quantities of each type are documented.

11. The coring, filling, and testing of density cores are subsidiary to "Asphaltic Concrete, Type ____".

12. Payment is full compensation for all work described in this Section.

SECTION 504 -- TACK COAT

504.01 -- Description

1. Tack coat is the application of asphaltic materials to bases or surfacing. The tack coat shall be applied to surfaces on which bituminous materials will be placed. When specified, tack coat will be applied on other surfaces.

504.02 -- Material Requirements

1. The type and grade of emulsified asphalt shall be specified in the contract and shall conform to the requirements in Sections 1031 or 1032. Fast-Set type emulsified asphalt shall meet the requirements of Table 504.01.

Table 504.01

CFS-1, FS-1 Emulsified Asphalt Requirements	
Tests on emulsion:	Specification
Viscosity, Saybolt Furol, T 59, 25°C (77°F), sec.	20 – 100
Sieve Test, Percent Retained, maximum (note 1)	0.10
Residue by Distillation, Percent, minimum	57.0
Storage Stability, Percent, maximum (note 1)	1.0
Tests on distillation residue:	
Penetration, dmm.	40 - 175
Ductility, 25°C (77°F), cm., minimum	40
Solubility in Trichloroethylene, Percent, minimum	97.5
Note 1: See note "b" of AASHTO M 208 - 2015 Shall be formulated as either a cationic or anionic, fast-setting emulsion that is suitable for tack coat dilution, and to have an accelerated breaking time in cooler temperature applications.	

504.03 -- Construction Methods

1. Before the application of tack coat, the surface shall be cleaned as described in Section 501.

2. The Contractor shall furnish and apply the tack coat.

3. a. A pressure distributor shall be used for the application of the tack coat. Uniform application is required. Hand sprayers may be used in applying tack coat to small or irregular sections.

b. Emulsified asphalt shall be diluted with potable water at a rate of one part water to one part emulsified asphalt by either the Supplier or the Contractor.

c. The rate of application shall be adequate to bond the new bituminous layer to the existing surface. This shall be from 0.10 to 0.20 Gal/SY (0.45 to 0.90 L/m²) when applied to existing or milled surfaces and from 0.05 to 0.10 Gal/SY (0.23 to 0.45 L/m²) when applied to the freshly laid asphaltic concrete.

4. The Contractor shall furnish and apply a tack coat as directed by the Engineer to seal surfaces and prevent infiltration of moisture when construction will be interrupted by weather or the project is shut down for the winter.

504.04 -- Method of Measurement

1. Tack coat shall be measured in gallons (liters) of diluted (field and refinery) solution applied to the surface.

504.05 -- Basis of Payment

1. Pay Item	Pay Unit
Tack Coat	Gallons (Gal) [Liter (L)]

2. Any amount of tack coat emulsified asphalt which is outside the specified property ranges of Table 504.02, shall be paid for at the contract unit price multiplied by the pay factor determined in Table 504.02. If the resultant Pay Factor for the material indicates rejection as an option, the Engineer will determine if the non-compliant material will be removed.

Table 504.02

Tolerances and Pay Factors		
Specified Property	Tolerance	Pay Factor
AASHTO T 59, Prior to Dilution, Residue after Distillation	≥ 56.0%	1.00
	54.0% - 55.9%	0.85
	52.0% - 53.9%	0.70
	< 52.0%	0.40 or Reject
<p>Pay Factors for Tests for ALL other Properties Specified*</p> <p>1.00 for deviation of ± less than or equal to 10%</p> <p>0.75 for a deviation of ± greater than 10% to less than or equal to 25%</p> <p>0.40 or Reject for deviation of ± greater than 25%</p> <p>* When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied to the listed criteria.</p> <p>Note: When more than one specified property exceeds specification tolerances, the single largest Pay Factor Reduction will be the one applied.</p>		

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 4 days of receiving the notification of deficiency. This written request is also affirmation and agreement that the testing may occur beyond the 14 day testing timeframe of the asphaltic emulsion specifications.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing.

When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Water used to dilute emulsified asphalt is subsidiary to "Tack Coat" and is included in the solution that is placed and measured for payment.
5. Payment is full compensation for all work described in this Section.

SECTION 505 -- ASPHALTIC CONCRETE CURB

505.01 -- Description

1. This work consists of constructing asphalt curbs as shown in the contract.

505.02 -- Material Requirements

1. The curb will be constructed of the same type of asphaltic concrete mixture used in the surface course or a commercially available asphaltic concrete approved by the Engineer.

505.03 -- Construction Methods

1. Asphaltic concrete construction methods described in Section 503 shall also govern the construction of curbs.

2. The Contractor shall shape and compact curbs with a curb machine. Uniform density and smooth surface texture must be attained.

3. The Contractor shall clean and apply a tack coat to the contact surface. The tack coat shall be applied in accordance with the requirements of Section 504 and shall extend 4 inches (100 mm) beyond the curb contact surface in all directions. The rate of application shall be as directed by the Engineer. Heating the surface may be required to achieve a bond with the new asphaltic concrete. The heating shall be done so that no portion of the asphaltic concrete is damaged by excessively high temperatures.

4. The newly constructed curb and a 24 inch (600 mm) width of the adjoining surface (gutter) shall be sealed by the application of a tack coat. The rate will be determined by the Engineer.

505.04 -- Method of Measurement

1. Asphaltic concrete curb length is measured by the linear foot (meter).

505.05 -- Basis of Payment

1. Pay Item

Constructing Asphaltic Concrete Curb

Pay Unit

Linear Foot (LF)
[Meter (m)]

2. Materials required to construct curbs are included in the pay items "Asphaltic Concrete, Type ____" and "Performance Graded Binder ____" of the surface course in Section 503.

3. Payment is full compensation for the work described in this Section.

SECTION 506 -- ASPHALTIC CONCRETE ISLAND NOSES AND MEDIANS

506.01 -- Description

1. This work consists of constructing asphaltic concrete island noses and medians as shown in the contract.

506.02 -- Material Requirements

1. Island noses and medians shall be constructed from the same type of asphaltic concrete mixture used in the surface course or a commercially available asphaltic concrete approved by the Engineer.

506.03 -- Construction Methods

1. Asphaltic concrete construction methods described in Section 503 shall also govern island nose and median construction.

2. The Contractor shall use equipment and methods that insure the asphaltic concrete island noses and medians are constructed to a uniform density with a smooth surface texture.

3. a. The Contractor shall clean and apply a tack coat to the contact surface. The tack coat shall be applied in accordance with the requirements of Section 504 and shall extend 4 inches (100 mm) beyond all sides of the nose. The rate of application shall be as directed by the Engineer.

b. Heating the surface may be required to achieve a bond with the new asphaltic concrete. The heating shall be performed so that no portion of the asphaltic concrete is damaged by excessively high temperatures.

4. The Contractor shall seal the newly constructed island nose and/or median by the application of a tack coat. The application rate will be determined by the Engineer.

506.04 -- Method of Measurement

1. "Construct Asphaltic Concrete Island Nose" will be measured by the each.

2. Asphaltic concrete for a median is included in the roadway materials and a separate pay item for median construction is not authorized.

506.05 -- Basis of Payment

1. Pay Item	Pay Unit
Constructing Asphaltic Concrete Island Nose	Each (ea)

2. Materials required to construct island noses and all construction costs for medians are included in the roadway pay items for "Asphaltic Concrete, Type _____" and "Performance Graded Binder _____".

3. Payment is full compensation for all work described in this Section.

**SECTION 507 -- ASPHALTIC CONCRETE FOR STATE
MAINTENANCE PATCHING**

507.01 -- Description

1. Asphaltic concrete for State maintenance patching shall be the type designated by the pay item. Department trucks shall be allowed to load material at any time specified types of asphaltic concrete are being produced, provided the Contractor has been given 1 day's notice.

507.02 -- Method of Measurement

1. Asphaltic concrete for State maintenance patching shall be measured on approved scales.

507.03 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|-----------------------------|
| Asphaltic Concrete for State
Maintenance Patching, Type _____ | Ton (Tn)
[Megagram (Mg)] |
| Performance Graded Binder _____
for State Maintenance Patching | Ton (Tn)
[Megagram (MG)] |
2. Payment is full compensation for all work described in this Section.

SECTION 508 -- JOINT SEALING - ASPHALT TO CONCRETE

508.01 -- Description

1. This work shall consist of sealing joints between asphaltic concrete surfacing and Portland cement concrete pavement.

508.02 -- Material Requirements

1. Rubber-asphalt joint filler shall be a mixture of, paving grade asphalt binder, vulcanized recycled rubber, and other additives such as polymer modifier(s).

2. The mixture, when heated in accordance with the supplier's instructions, shall produce an easily applied, flexible, and adhesive compound that will effectively seal joints between Portland cement concrete and the asphaltic concrete under typical Nebraska climatic conditions.

3. The joint filler shall contain no solvents, shall be self-leveling, and shall cure upon cooling to a consistency that will not be tracked by traffic.

4. The joint filler shall be suitable for melting and application with a conventional melter-applicator unit.

5. The joint filler shall be a pre-reacted blend of product. The joint filler shall not require additional heating time for application after it has reached the manufacturer's recommended minimum application temperature. New joint filler may be added to the material that has already been heated to the minimum application temperature.

6. When heated in accordance with ASTM D5167 to the maximum heating temperature, the joint filler shall meet the Nebraska Specifications of CR18B, as noted below in Table 508.01.

Table 508.01

Test	Specification
Cone Penetration, non-immersed, 77° F (25° C) (ASTM D5329)	50 – 90 dmm
Flow, 140° F (60° C), 5 hours (ASTM D5329)	5.0 mm max.
Resilience, 77° F (25° C) (ASTM D5329)	25 – 60%
Bond, non-immersed, -20° F (-29° C) 50% extension (1/2" specimen) (ASTM D5329) ⁽¹⁾	Pass 3 cycles (ASTM D6690, Table 1, Note A)
Flexibility, Mandrel Bend, -29° F (-34° C), 1" mandrel, 90 degrees, 10 sec. Sample strip size is 3" long, 1" wide, 0.125" thick. (ASTM D3111, modified)	Minimum 2 of 3 specimens shall pass.
Asphalt Compatibility, 140° F (60° C), 72 hours (ASTM D5329)	Pass ⁽²⁾
Recycled Rubber Content (by weight of asphaltic components). Extraction by ASTM D2172, Method A	18% Minimum ⁽³⁾
<p>Notes: (1) Concrete blocks will be constructed by the Department. The materials used are a common design in Nebraska concrete paving specifications. The design is a 47B concrete mixture as specified in Section 1002 of the NDOT Standard Specifications. The design is amended to not include flyash. All other specifications for Portland Cement Concrete will apply.</p> <p>(2) There shall be no failure in adhesion, nor formation of an oily exudate at the interface between the hot pour filler and the asphalt concrete specimen, nor softening or other deleterious effects on the asphaltic concrete or hot pour filler.</p> <p>(3) Due to the interlace variations of the asphalt/rubber matrix, a 2% testing tolerance deviation from specification is allowable.</p>	

a. Sample conditioning, preparation, and heating shall be in accordance with ASTM D5167 with the following exceptions:

(1) The following sentence of 8.1.2, "Also, if present, remove container liner by cutting it away", is void and superseded by the following:

Also, if present, as much of the polyethylene bag as possible, shall be removed by cutting it away. Wholly-meltable type container in contact with the sample section shall be left in place.

(2) The last sentence of 8.1.2 is void and superseded by the following:

The entire vertical section which has been cut, shall be placed into the pot for melting.

(3) The Section of 8.2.2.1 "Solid Materials" is void.

(4) The Section of 8.2.3 is void and superseded by the following:

After the solid segment is added to the melter, the material shall be allowed to minimally melt to a uniform viscous state suitable for the installation of the stirrer or paddle. The sample shall then be stirred for one

full hour. The oil bath temperature shall be regulated to bring the material to the maximum heating temperature within the one hour of stirring.

(5) The Section of 8.2.4.1 is void and superseded by the following:

During the one full hour of stirring, check the temperature of the material at maximum 15 minute intervals using a Type K thermocouple with the calibration verified in accordance with Section 6.1.7 to ensure conformance with the specified temperature requirements. Stop the mechanical stirrer when measuring temperatures. If material temperatures ever exceed the maximum heating temperature, or ever drop below the minimum application temperature after the maximum heating temperature was reached, discard the sample and re-do the heating. Maintain appropriate records of times and temperatures to verify conformance with specification requirements.

(6) The Section of 8.2.4.2 is void.

b. ASTM D5329 shall include the following changes:

(1) Sections 6.4 and 12.4 "Specimen Preparation" shall have the reference of "177 ml (6 oz.)" replaced with "3 oz."

(2) Section 6 "Cone Penetration, Non-Immersed" shall be superseded with the following exceptions:

(i) Section 6.5 "Procedure" is void and superseded by the following: Place the specimen in a water bath maintained at 77 +/- 0.2°F (25 +/- 0.1°C) for two hours immediately before testing. Remove the specimen from the bath and dry the surface by shaking gently to remove free water from the surface of the specimen. Using the apparatus described in Section 6.3, make one determination at or near the center of the specimen. Take care to ensure the cone point is placed on a point in the specimen that is representative of the material itself, and is free of dust, water, bubbles, or other foreign material. Due to the high rubber content, ensure that the cone is not placed on a piece of rubber.

(ii) Section 6.6 "Report" is void and superseded by the following: Record the value as penetration of the specimen in dmm units.

(3) Section 12 "Resilience" shall be superseded with the following changes:

(i) Section 12.5 "Procedure", void the sentence "Make determinations at three points equally spaced from each other and less than 13mm (1/2 inch) from the container rim" and supersede with the sentence "Make one determination at or near the center of the tin."

(ii) Section 12.6 "Report" is void.

7. The vulcanized recycled ground rubber shall be free of wire, fabric, or other contaminating materials. The gradation shall be 95-100% passing the No. 10 (2.00mm) sieve, 35-55% passing the No. 20 (850 µm) sieve, and 0-25% passing the No. 40 (425 µm) sieve.

8. Acceptance of the manufactured material will be based on pre-approval by either on or off-site sampling. Acceptable hot pour sealant lots are listed on the Department's Approved Products List.

a. Department on-site field sampling shall be in accordance with the Department's Materials Sampling Guide.

b. Off-site (Proxy) sampling shall be in accordance with ASTM D5078.

(1) Proxy sampling shall be overseen by an outside party approved by the Department, preferably another DOT Agency. Proxy samples shall include a manufacturer's Certificate of Compliance. Proxy samples shall also include a dated signature of origin by the Representative that is not affiliated with the manufacturer, and can either be on the Certificate of Compliance, or separate letter.

(2) For convenience in both sampling and shipping samples, sample containers smaller than a manufacturer's usual production containers are allowed, as long as the sample is a minimum of 1500 grams.

(3) Samples shall be sent to the Department Laboratory, or alternatively, sent to a Department approved independent laboratory for testing which will be at no cost to the Department. If a Department approved independent laboratory is used, the Contractor shall notify the Department Laboratory so that concrete blocks for the Bond testing can be sent.

9. The hot pour rubber asphalt joint filler can be packaged in either cardboard box or wholly-meltable type containers.

a. Cardboard box containers shall be manufactured from double wall kraft board producing a minimum bursting test certification of 350 PSI (241 N/cm²) and using water-resistant adhesives. The use of metal staples or fasteners of any kind will be prohibited for closing the lids of the boxes. Tape or other like material is acceptable.

(1) The rubber asphalt joint filler shall be in meltable [300°F (149°C)] polyethylene bags.

b. Wholly-meltable type containers, and any of their components, shall be fully meltable and integrational with the hot pour rubber asphalt joint filler by the time the manufacturer's minimum application temperature is reached.

(1) The wholly-melted and integrated container must not adversely affect the test specifications of the rubber asphalt joint filler.

c. Each individual container shall include information regarding manufacturer, lot or batch number, type of product, minimum application temperature, and maximum heating temperature. The maximum heating temperature must be at least 20°F (11°C) higher than the minimum application temperature.

508.03 -- Construction Methods

1. The Contractor shall prepare and construct the joint between the concrete pavement and asphaltic concrete to the dimensions of the typical sections shown in the contract. The full depth of the cut shall be cleaned by routing or any other method which results in a clean cut.

2. The Contractor shall apply sealant in accordance with the sealant manufacturer's recommended procedures. In no case shall the temperature of the sealant fall below the minimum, or exceed the maximum recommended by the manufacturer during application.

508.04 -- Method of Measurement

1. Longitudinal joint sealing will be measured by the station along the roadway centerline for each joint between the beginning and ending points of the work.

2. Transverse and all other joints are measured by the linear foot (meter) along the joint, and the total length is converted to an equivalent number of stations.

508.05 -- Basis of Payment

1. Pay Item	Pay Unit
Joint Sealing - Asphalt to Concrete	Station (Sta) [Station (StaM)]

2. When sealant materials comply with the Specification requirements, joint sealing shall be paid for at the contract unit price per Station (StaM).

a. When testing of on-site sealant materials is outside of the specified property ranges, joint sealing shall be paid for at the contract unit price multiplied by the Pay Factors in Table 508.02.

Table 508.02

Pay Factor	Specified Property
1.00	Deviation of up to (+/-) 5.0%
0.95	Deviation of (+/-) 5.1% to 10.0%
0.90	Deviation of (+/-) 10.1% to 15.0%
0.80	Deviation of (+/-) 15.1% to 20.0%
0.70	Deviation of (+/-) 20.1% to 25.0%
0.40 or Reject	Deviation of 25.1% or greater

(1) When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied according to the above table.

(2) When more than one specified property exceeds specification tolerances, the single largest pay factor reduction will be the one applied.

(3) Material not meeting a Pass/Fail requirement falls under the Pay Factor of 0.40 or reject.

b. If the material is found to be out of specification, the material will be rejected if not already used. All material out of specification, regardless of pay factor, not in place will be rejected and shall be removed from the site.

c. If the pay factor is less than 1.00 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material is determined by the above pay factor table.

d. Material that exhibits unacceptable field application will be rejected and removed from the approved products list. Material already used shall be removed and replaced at no cost to the Department.

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 30 days of receiving the written notification of deficiency.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Payment is full compensation for all work described in this Section.

SECTION 509 -- BITUMINOUS SAND BASE COURSE

509.01 -- Description

1. This work will consist of furnishing all materials and constructing a compacted base course composed of sand from the roadbed, aggregate, mineral filler, and cut-back asphalt or emulsified asphalt. Materials shall be mixed using a traveling mixing plant method or with a grader blade.

509.02 -- Material Requirements

1. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 509.01.

Table 509.01

Material Requirements	
Applicable Materials	Section
Mineral Aggregates	1033.01, 1033.02, Para. 1., 2., 5.
Mineral Filler	1033.02, Para. 1., 2., 4.
Liquid Asphalts	1030

2. Emulsified asphalt for use in bituminous sand base course shall be HFE-300 or CM-4 conforming to the requirements of Sections 1031 and 1032.

3. The type of asphaltic material to be applied to the bituminous mixture will be indicated in the contract. The percentage of asphaltic material to be applied to the mixture will be determined by the Materials and Research Division.

4. Mineral aggregate shall meet gradation requirements in Table 1033.05.

509.03 -- Equipment

1. a. Blade machines shall be equipped with pneumatic tires and designed, constructed, and maintained to insure thorough mixing of the asphaltic materials and aggregates and uniform spreading and finishing of the mixed materials.

b. Blade machines shall be equipped with suitable moldboards.

c. Blade machines that cause corrugations or other damage to the finished base are unacceptable.

2. a. Traveling mixing plants shall be designed to prevent the loss of any filler material during mixing.

b. Traveling mixing plants shall be designed to deliver thoroughly mixed material in a uniform manner without damage to the subgrade or mixing surface.

c. All traveling mixing plants shall be equipped with sufficient valves and a by-pass in the oil line between the pump and the spray bar to help calibrate the pump's output.

d. The traveling mixing plants shall be equipped with a thermometer well and thermometer of sufficient range to accurately determine the temperature of the asphaltic material.

e. The plants shall also be equipped with a meter that will show the actual gallons (liters) delivered by the plant and a gauge that will show the rate of delivery in gallons per minute (liters per minute).

f. (1) Tandem rollers shall be self-propelled by engines of sufficient power to insure smooth operation at speeds up to 6 mph (10 km/hour).

(2) The roller shall be of such size and capacity that it may be loaded to a total weight of 15,500 pounds (7000 Kg).

(3) Both roller drums shall have a minimum width of 48 inches (1.2 m). The drive drums shall have a minimum diameter of 48 inches (1.2 m). The roller shall be designed so that it may be loaded to develop a minimum compression of 200 lb/in. (3.62 Kg/mm) of roller width.

509.04 -- Construction Methods

1. Roadbed Preparation:

a. The Contractor shall grade the bituminous sand base course and the subgrade to the profile shown in the contract.

b. The Contractor shall limit the grading operations to those sections of the project where it is anticipated the work of applying the asphaltic material will be performed during the same construction season.

c. The Contractor will not be allowed to place base course material until the subgrade is at the proper stiffness and moisture content.

d. When material is obtained from local pits, it shall be obtained in accordance with the provisions of Sections 205 and 209.

2. Hauling, Measuring, and Distributing Aggregates and Filler:

a. (1) The Contractor shall establish a method of numbering, labeling, and tallying the hauling vehicles so that the correct quantities and distribution of the materials delivered on the road may be determined at any time.

(2) Mineral aggregates and mineral fillers shall be measured in cubic yards (cubic meters) at the point of delivery. The Contractor will be required to strike off the materials to uniform heights for volume determination.

(3) All vehicles hauling the same type of material shall be loaded with the same volume of material unless otherwise allowed by the Engineer.

(4) To establish a weight-volume conversion factor, the Contractor shall daily weigh 2 loads of each material being hauled.

b. (1) The materials approved for delivery to the road surface shall be distributed by the Contractor as shown in the contract. When several types of aggregates are required, the Contractor shall haul the aggregates in the order specified by the Engineer. The aggregates and mineral filler shall be distributed uniformly over the full width of the proposed bituminous sand base course. The use of a spreader box will be required if other methods fail to provide uniform distribution.

(2) When using a traveling mixing plant designed to proportion only the asphaltic material, then 40 to 60% of the required asphaltic material shall be applied to the upper subgrade for the full width and depth of the base course before placing mineral filler on the roadbed.

(3) Additional mixing with blades or other equipment shall begin immediately on the upper portion of the subgrade on which the partial application of asphaltic material has been made. This mixing shall continue until the asphaltic material is uniformly dispersed with a sufficient volume of the subgrade to shape and compact a 1 1/2 to 2 inch (38 mm to 50 mm) thick layer of mixed material.

(4) The mixed material shall be shaped with a blade and rolled with a pneumatic-tired roller as necessary to provide a stable foundation for the distribution of the mineral filler and to reduce the loss of moisture or distillate.

(5) The mineral filler shall be the last material to be incorporated in the combined windrow and shall be pulverized before placement on the roadbed. The Contractor shall pulverize this material as described in Subsection 1033.02, Paragraph 4.

(6) The material shall be folded into the windrow immediately and in such a manner to avoid loss of material.

c. Hauling will not be allowed when the weather and road conditions are such that hauling operations might produce ruts or otherwise damage the surface of the roadbed.

3. Heating Asphaltic Materials:

a. (1) The Contractor shall furnish and heat asphaltic materials with equipment conforming to the requirements of Section 501. If asphaltic material is heated in the distributor or supply tank, adequate provision shall be made for circulating the material during the heating process. Agitation and heating methods used shall not introduce any free steam or moisture into the asphaltic material.

(2) (i) Asphaltic materials heated to temperatures higher than the maximum temperatures shown in Table 501.01 shall be rejected.

(ii) The material may be resampled and retested.

(iii) The resampled material will be accepted if retests show it was not damaged.

b. When the designated application temperature cannot be maintained, the Contractor shall use hauling or storage units equipped with insulated tanks and/or auxiliary heater equipment.

4. Applying and Mixing Asphaltic Materials:

a. The Contractor shall combine the sand, mineral aggregate, mineral filler, and asphaltic materials in the proportions shown in the contract.

b. (1) After the Contractor hauls, measures, and distributes the aggregates and filler, the materials shall be uniformly mixed, dried, and windrowed.

(2) The maximum allowable moisture content of the combined aggregate before the application of asphaltic oil will be 5.0%.

(3) The allowable moisture content of the combined aggregate will be 5.0 to 9.0% before the application of emulsified asphalt.

c. The Contractor may add water to increase the moisture content of the combined aggregate. The application of water and subsequent mixing operations shall be arranged so that the moisture content is uniform throughout the width and depth of the combined material.

d. (1) When a traveling mixing plant designed to proportion both the aggregate and asphaltic material is used, the mineral aggregates shall be picked up, proportioned, and mixed with the required quantity of asphaltic materials.

(2) The windrow shall be evened with a materials gauge to insure a uniform end area before mixing begins.

(3) The windrow shall be evened until all measured end areas taken at 150 foot (46 m) intervals are not less than 95% or more than 105% of the end area required.

(4) The pick-up device shall pick up the aggregate as cleanly as practicable, and any remaining aggregate shall be swept into the windrow of bituminous aggregate.

e. When the traveling plant is of the type which measures only the asphaltic material and incorporates it into the aggregate, care shall be taken to avoid applying the asphaltic material to a greater depth (volume) of base course than that shown in the typical cross section.

f. Cut-back asphalts shall not be applied to the aggregates when the ambient temperature is below 60°F (16°C). The application of asphaltic materials will not be allowed after September 15.

g. The application of asphaltic material shall be limited to a quantity of base course materials that can be mixed completely during the next 5 days of work.

h. Before a winter shut down, the Contractor shall protect graded areas that are to receive a bituminous sand base course. The protection shall include:

(1) Mixing half the required asphaltic material with the upper subgrade material for the full width of the planned base course.

(2) (i) Applying "Prime Coat" as directed by the Engineer after the Contractor has compacted the mixture.

(ii) No aeration, other than that accomplished during the mixing operation, will be required for this application.

(iii) The requirements for minimum temperature, maximum moisture content, seasonal limitations on construction, and aeration are void as far as the above "Prime Coat" applications are concerned.

(3) Performing erosion control on all disturbed areas outside the bituminous course.

5. Mixing and Aerating:

a. The Contractor's method of mixing may be either the blade mix method or traveling mixing plant method.

b. (1) Mixing shall begin immediately following completion of the application of asphaltic material.

(2) The mixing must be sufficient to result in thorough dispersion of the bituminous material throughout the proper quantity of the combined aggregate.

(3) Care shall be taken to avoid the inclusion of excessive quantities of sand from the roadbed.

c. The degree of thoroughness of the mixing with the traveling plant will be at the Contractor's option, but if the material deposited by the plant is not mixed thoroughly, further mixing shall be done with blades or other equipment. Sufficient equipment shall be provided so that the aggregates can be thoroughly and uniformly coated.

d. All mixing with blade machines shall be conducted to prevent segregation of the various aggregate sizes, drifting of the material, or damage to the existing surface.

e. (1) The bituminous aggregate shall be aerated to allow the volatile portion of the asphaltic oils to evaporate to increase the viscosity of the asphaltic material remaining in the mixture and to reduce the moisture content to less than 2%.

(2) The upper 80% of the base course material shall be aerated uniformly to the required degree, but such aeration shall not exceed 75%, as determined by the method described below:

Percent of Aeration	
A	= Percent aeration = $100 - \frac{100E(100 + N)}{5 ND}$
E	= milliliters of distillate in a 500 g sample tested as described in NDOT T 110.
N	= Actual percent of oil applied to combined aggregate (based on the dry mass of the aggregate)
D	= Percent of distillate in the asphaltic oil at 360°C

f. (1) If bituminous aggregate becomes aerated to the required degree before thorough mixing and reduction of the moisture content are accomplished, the Contractor shall apply a sufficient quantity of distillate to restore the workability of the bituminous aggregate.

(2) No aeration of bituminous sand base course containing emulsified asphalt will be required except to reduce moisture content for mixing and compaction.

g. If rain falls during the mixing or aerating operations, the work shall be suspended until resumption of the work will facilitate evaporation and reduce the moisture content of the mixture. All mixing operations shall be suspended when the ambient temperature falls below 60°F (16°C).

6. Laying, Compacting, Finishing, and Sealing:

a. (1) After the combined aggregate and asphaltic material are mixed thoroughly, the windrow of bituminous aggregate shall be made uniform in cross section by the Contractor.

(2) All materials that have drifted during mixing operations shall be hauled to sections where a deficiency exists.

(3) The windrow of bituminous aggregate will be considered uniform when its cross sectional area at any location is within 10% of the average cross sectional area of the section.

b. (1) Bituminous aggregate shall be spread only on a base or prepared subgrade that has no free moisture on the surface.

(2) Before bituminous aggregate mixed with asphaltic oil is approved for spreading, it shall contain less than 2.0% moisture by weight.

(3) Before bituminous aggregate mixed with emulsified asphalt is approved for spreading, the moisture content shall be reduced sufficiently so that proper compaction and a satisfactory surface may be attained.

c. All oversize or foreign materials brought into the mixture from the shoulders or subgrade shall be removed by the Contractor.

d. (1) The bituminous aggregates shall be spread with blade machines in several uniform layers to the dimensions shown in the plan typical cross sections.

(2) The entire windrow of bituminous aggregate shall be moved from its original position during spreading operations.

(3) All subgrade beneath the original position of the windrow that does not meet moisture and stiffness requirements shall be repaired before spreading the bituminous aggregate on that portion of the roadbed.

(4) Rolling with at least 2 rollers shall proceed as the material is being spread in several uniform layers.

(5) When satisfactory compaction or alignment of the edges is not accomplished in any other manner, the Engineer may require the Contractor to spread the material to a width greater than that shown in the plan typical cross sections and then trim the edges back to the required width.

(6) The final blading of the surface shall continue until the base course is smooth. If irregularities develop which cannot be removed by rolling, the portion of the surface that is not smooth shall be scarified and relaid.

e. (1) The entire base course shall be compacted thoroughly and uniformly by rolling.

(2) Rolling shall be done in a direction parallel to the centerline of the roadway being laid and shall begin near the edge of the base and proceed toward the center, lapping at least one-half the width of the roller.

(3) Alternate trips of the roller shall be stopped at least 3 feet (900 mm) from any preceding stop.

(4) At least one trip of the roller shall be made over the edges of the layer not previously rolled.

(5) The final roller coverage over the bituminous base course shall be performed with a tandem roller to remove pneumatic tire marks.

f. All laying operations shall be suspended when the atmospheric temperature falls below 60°F (16°C), unless otherwise ordered by the Engineer.

g. After final compaction, the surface of the bituminous sand base course shall be smooth and true to the established crown and grade. Any low or defective areas shall be remedied as directed by the Engineer. The finished surface will be checked for smoothness with a 10 foot (3 m) straightedge placed parallel to the centerline of the roadbed. The allowable surface variation is 3/16 inch (5 mm).

h. Before the placement of the earth shoulder material, the Contractor shall trim the outer edge of the bituminous sand base course to a vertical face in accordance with the typical cross sections shown in the contract.

i. "Fog Seal" shall be applied to the entire base course surface at a rate of 0.1 to 0.15 Gal/SY (0.5 to 0.76 L/m²) in accordance with Subsection 504.03. The fog seal emulsion type will be identified in the contract.

7. a. The bituminous aggregate for intersections or other irregular areas shall be obtained from the windrow in the quantity and locations designated by the Engineer. The aggregate will be loaded, hauled, and delivered to the designated points.

b. Not more than 30 CY (14 m³) of bituminous material will be obtained from each mile (kilometer) of bituminous surfacing.

c. The haul distance shall never exceed 2 miles (3 km).

d. The material shall be dumped on subgrade that has been previously prepared and shall be laid, finished, and compacted as described in this Subsection.

8. Maintenance:

a. (1) The Contractor shall maintain the completed base course until the surface course is placed.

(2) This maintenance shall consist of maintaining a smooth, well-compacted surface by blading and rolling, if necessary, and correcting any sections that have failed due to faulty construction operations.

(3) Multiple-wheel, pneumatic-tired rollers or tandem rollers shall be used in the maintenance work, as required.

b. When bituminous material absorbs any appreciable quantity of moisture, the Contractor shall scarify the material, remix it until it is dry, and then replace it at no additional cost to the Department.

c. In the event that it becomes necessary to add distillate to restore the workability of the bituminous aggregate, it shall be added at no additional cost to the Department.

509.05 -- Method of Measurement

1. All mineral aggregates and mineral filler will be measured by the cubic yard (cubic meter) at the point of delivery. The Contractor will be required to strike off the materials to uniform heights for volume determination.

2. Asphaltic oil and emulsified asphalt material used in constructing bituminous sand base course will be measured for payment in gallons (kiloliters). The measured volume will be corrected to a standard volume at 60°F (16°C).

3. a. Bituminous sand base course construction shall be measured horizontally in 100 foot (meter) stations.

b. Extra construction for intersection returns and stubs, tapered sections, or irregular areas will be measured in equivalent 100 foot (meter) stations. The number of stations will be the quotient obtained by dividing the actual surface area of the section involved by the surface area of one station of the adjacent traveled way base course as shown in the contract.

4. Water used in adjusting the moisture content of the combined mineral aggregate when emulsified asphalt is used will be measured as described in Subsection 302.04.

509.06 -- Basis of Payment

1. Pay Item	Pay Unit
Bituminous Sand Base Course Asphaltic Oil	Gallon (Gal) [Kiloliters (kL)]
Bituminous Sand Base Course Emulsified Asphalt	Gallon (Gal) [Kiloliters (kL)]
Bituminous Sand Base Course	Station (Sta) [Station (StaM)]
Mineral Filler for Bituminous Sand Base Course	Cubic Yard (CY) Cubic Meter (m ³)
Mineral Aggregate	Cubic Yard (CY) Cubic Meter (m ³)
Water	Gallon (Gal) [Kiloliter (kL)]

2. When materials do not meet contract requirements, deductions will be made according to Tables 503.01A and B.

3. The fog seal is not subsidiary to "Bituminous Sand Base Course" and is paid for as a separate pay item.

4. Payment is full compensation for all work described in this Section.

SECTION 510 -- COLD MILLING

510.01 -- Description

1. Cold milling shall consist of removing and disposing existing surfacing material as shown in the contract. Cold milling is divided into the following classes and types:

2. Bituminous Surfaces:

a. Cold Milling, Class 1. The surface shall be milled to remove surface irregularities, including longitudinal wheel ruts. When milling is finished, there shall be no evidence of longitudinal wheel ruts. Milling to a specified transverse slope will not be required. Milling will include inlays to meet fixed elevations.

b. Cold Milling, Class 2. The surface shall be milled to remove surface irregularities and to attain the transverse slope shown in the contract. Milling will include inlays to meet fixed elevations.

c. Cold Milling, Class 3. The surface shall be milled to a uniform depth shown in the contract. Milling to a specified transverse slope will be required if shown in the contract. Milling will include inlays to meet fixed elevations.

d. Cold Milling, Class 4. The entire depth of existing surfacing shall be milled to the underlying base or subgrade. Approximately 1 inch (25 mm) of existing surfacing may be left in place to serve as a working platform. Milling will include inlays to meet fixed elevations.

e. Cold Milling, Class 5. Irregular sections of surfacing shall be milled as shown in the contract. Milling will include inlays to meet fixed elevations.

3. Concrete Surfaces:

a. Milling Concrete Curb. Concrete curbs shall be milled to a uniform depth shown in the contract.

b. Milling Concrete for Inlays. Concrete surfaces shall be milled to create an area to place an inlay.

c. Concrete Surface Milling. The concrete surface shall be milled as shown in the contract.

510.02 -- Material Requirements

1. Milled material shall be pulverized to pass a 2 inch (50 mm) sieve.

2. The Contractor shall not include any underlying material in the millings.

510.03 -- Equipment

1. The milling machine shall be able to perform this work to the Engineer's satisfaction. The milling machine shall be self-propelled and shall have sufficient power, traction, and stability to maintain an accurate depth of cut and transverse slope. Pavement removal by scarifying, blading, or heating will not be allowed as milling.

2. a. The milling machine shall be equipped with automatic controls capable of establishing profile line and grade at each edge of the machine. The reference shall be the existing pavement or taut reference lines, true to

line and grade, erected and maintained by the Contractor. A single reference may be used if the machine can maintain the designated transverse slope.

b. When referenced from existing pavement, the milling machine shall be controlled by a self-contained grade reference system provided by the machine's manufacturer for that purpose. The sensing point shall react to compensate for 25% of the actual change in elevation due to a hump or dip that is 3 feet (900 mm) or less in length. The self-contained grade reference system shall be used at or near the centerline of the roadway. On the adjacent pass with the milling machine, a joint matching shoe may be used.

3. Broken, missing, or worn teeth shall be replaced.

4. The machine shall be equipped with a loading elevator to remove the milled material from the roadway surface.

5. The machine shall be equipped with means to effectively control dust generated by the cutting operation.

510.04 -- Construction Methods

1. a. When the milled surface is open to traffic, vertical cuts resulting in an elevation differential of greater than 2 inches (50 mm) along a gutter line or shoulder line shall be protected by temporary barricades and warning signs erected by the Contractor in accordance with the requirements of Section 422.

b. When milling removes pavement markings, the Contractor must place temporary pavement marking before opening the road for public use.

2. If the milled surface is to be open to traffic for more than 30 days, the texture produced by the cold milling operation shall be uniform and provide a satisfactory riding surface and skid resistance. Continuous longitudinal striations will not be allowed.

3. a. When milling is done under traffic maintained conditions, the Contractor shall uniformly mill the entire lane width with one machine or a combination of milling machines in tandem.

b. The Contractor shall not leave a milled vertical edge greater than 1 inch tall between lanes overnight. One of the following options shall be performed if the milling will result in a vertical grade separation greater than 1 inch (25 mm) between lanes:

(1) Milling shall be performed in all adjacent traffic lanes on the same day so that at the end of each day, no drop off of over 1 inch (25 mm) remains.

(2) The milling shall create a tapered edge between the traffic lanes. The tapered edge shall have a slope from 3 [H]: 1 [V] to 4 [H]: 1 [V], not measured more than one foot in width nor extend into the lane more than one foot. Temporary pavement marking shall be placed at the top and contiguous with the tapered edge.

c. If the Contractor fails to complete the above options, the Contractor shall provide – at no cost to the Department – additional traffic control necessary to maintain traffic on the milled lane (or lanes) as directed by the Engineer. This additional traffic control may require the use of a pilot car, flaggers, lighted flagger station, etc.

d. Transitions between milled and unmilled surfaces in the direction of travel will be feathered either by milling or with wedges of bituminous material (maximum slope 1 vertical to 12 horizontal).

4. Surfacing material that cannot be removed by cold milling equipment because of physical or geometric constraints shall be removed by other methods approved by the Engineer.

5. The milled surface shall be swept with a mechanical broom before traffic is placed on it.

6. For Cold Milling, Class 4, approximately 1 inch (25 mm) of existing surfacing may be left in place to serve as a working platform. Bituminous surfacing left on the roadway as a working platform shall be disposed of in the subsequent operations at no additional cost to the Department.

7. The Contractor shall mill curbs in accordance with the contract.

8. a. The Contractor shall stockpile salvaged material for the Department at the locations shown in the contract.

9. a. All milling shall be done in such a manner to prevent ponding of water.

b. When the surfaced shoulders are not milled, drainage channels in the shoulders shall be cut by milling or by any other method approved by the Engineer. The width shall be 1.5 feet (450 mm) minimum, and the depth shall be the same as the milling depth with sufficient spacing and slope to provide proper drainage.

c. Drainage channels shall be repaired by patching with asphaltic concrete of the type in the adjacent surfacing. This work shall be done before the outside surfaced shoulders are fog sealed or surfaced.

d. Earth shoulders must be cut to an elevation that will allow drainage.

10. Concrete or asphalt millings from inlays will not be salvaged but shall be disposed of in accordance with the removal requirements of Section 203.

510.05 -- Method of Measurement

1. The contract will indicate whether the milling will be measured for payment by the ton (Mg), station, or square yards (m²) of completed and accepted work.

a. Roadways that are measured by the station [100 feet (100 m)] shall be measured horizontally along the project centerline between the beginning and ending points of the work.

(1) Areas outside the typical cross section shown in the contract will be measured in equivalent stations based on one station's area for the immediately adjacent roadway.

(2) If there is a length of the roadway where the entire roadway width is not milled, the length of that portion of the roadway shall be deducted from the payment stations.

b. Each shoulder will be measured separately in stations of 100 feet (meters) without regard to width.

(1) Stations will be measured horizontally along the project centerline between the beginning and ending points.

(2) Areas where there is no shoulder for 100 feet (30 m) or more shall be deducted from the total measured length of shoulder. Small [less than 100 feet (30 m)] intersections shall not be deducted from the shoulder station measurements.

c. Roadways that are measured by the square yard (square meter) shall be measured to ± 1 SY (± 1 m²).

(1) Areas outside the typical cross section shown in the contract will also be measured to ± 1 SY (1 m²).

(2) Deductions will be made for all areas greater than 1 SY (1m²) that are not milled.

d. Only "Cold Milling Class 4" is measured by the ton (Megagram). The amount of Class 4 millings shall be weighed on approved scales if the contract indicates payment is by the ton (Megagram).

2. Measurement of temporary traffic control devices will be made in accordance with Section 422.

3. Milling concrete or asphaltic concrete for inlays will be measured for payment by the each.

4. Milling concrete curb is measured in linear feet (meter) along the back face of the curb.

5. Milling of areas patched prior to cold milling, will not be measured separately, regardless of material used for patching, but will be included in the measurement for the Cold Milling item.

510.06 -- Basis of Payment

1. Pay Item	Pay Unit
Cold Milling, Class _____	Station (Sta) [Station (StaM)]
Cold Milling, Class _____	Square Yard (SY) [Square Meter (m ²)]
Concrete Surface Milling	Station (Sta) [Station (StaM)]
Concrete Surface Milling	Square Yard (SY) [Square Meter (m ²)]
Milling Concrete Curb	Linear Foot (LF) [Meter (m)]
Milling Concrete for Inlays	Each (ea)
Cold Milling, Class 4	Ton (Tn) [Megagram (Mg)]

2. Payment for temporary traffic control devices will be made in accordance with Section 422.

3. Asphaltic concrete for patching the drainage channels will be measured and paid for as "Asphaltic Concrete, Type _____" and "Performance Graded Binder, Type _____" as described in Section 503. Construction and patching of the drainage channels is subsidiary to these bid items.

4. Payment is full compensation for all work described in this Section.

SECTION 511 -- SALVAGING AND STOCKPILING BITUMINOUS MATERIAL

511.01 -- Description

1. This work will consist of salvaging, hauling, and stockpiling existing bituminous surfacing for the Department to locations shown in the contract.

2. The bituminous surface shall be removed by cold milling. If the road is closed to all but local traffic, the Contractor may use other approved methods, except heating, to remove and pulverize the bituminous material.

511.02 -- Material Requirements

1. The salvaged material shall be pulverized until all of the material will pass a 2 inch (50 mm) sieve. The Contractor shall avoid including any of the underlying material with the salvaged bituminous surfacing material.

511.03 -- Equipment

Cold milling equipment shall conform to the requirements of Subsection 510.03.

511.04 -- Construction Methods

1. Cold milling shall be performed in accordance with Section 510.

2. a. The Engineer will locate each stockpile.

b. The Contractor shall prepare stockpile sites by removing all vegetation on the portion of the site on which the material will actually be placed. The stockpile area shall be graded so that water will drain away from the stockpiled material. Unsurfaced areas upon which material is stockpiled shall be smoothed and rolled so that the salvaged material may later be removed with a minimum of loss.

c. The maximum height of stockpiles is 10 feet (3 m). Equipment shall not be driven over the stockpiled material.

511.05 -- Method of Measurement

1. The work of salvaging and stockpiling bituminous material will be measured for payment by the ton (Megagram) of material placed into stockpile sites.

511.06 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|-----------------------------|
| Salvaging and Stockpiling Bituminous Material | Ton (Tn)
[Megagram (Mg)] |
| 2. Cold milling will be paid for under Section 510. | |
| 3. Payment is full compensation for all work described in this Section. | |

SECTION 512 -- BITUMINOUS SURFACE COURSE

512.01 -- Description

1. This work will consist of constructing a surface course composed of milled or pulverized bituminous material obtained from sources shown in the contract. The bituminous material shall be distributed and spread as shown in the contract.

512.02 -- Material Requirements

1. The bituminous material shall be pulverized until all of the material will pass a 2 inch (50 mm) sieve.

512.03 -- Construction Methods

1. The Contractor shall obtain and place the bituminous materials as shown in the contract.

2. Before placing the material, the area on which this material is to be placed shall be smoothed and any vegetation removed by the Contractor.

3. The surface shall be adjusted to accommodate the thickness of the bituminous surface course.

4. The Contractor shall compact the bituminous material with three complete coverages of a roller or other approved compaction equipment.

512.04 -- Method of Measurement

1. The bituminous surface course will be measured for payment by the square yard (square meter).

512.05 -- Basis of Payment

- | | |
|---|--|
| 1. Pay Item | Pay Unit |
| Bituminous Surface Course | Square Yard (SY)
[Square Meter (m ²)] |
| 2. Payment is full compensation for all work described in this Section. | |

SECTION 513 -- FOG SEAL

513.01 -- Description

1. The fog seal shall be a light application to an existing surface of an emulsified asphalt diluted with water. The emulsified asphalt shall be similar to a tack coat, and applied at the required application rate. The application locations will be as shown in the contract.

513.02 -- Material Requirements

1. The fog seal shall be of the type and grade shown in the contract, and the emulsified asphalt shall conform to the requirements of Sections 1031 or 1032. Fast-Set type emulsified asphalt shall meet the requirements of Section 504, Table 504.01.

2. The Contractor shall dilute the emulsified asphalt at a rate of maximum one part water to one part emulsified asphalt. The percent residue by distillation of the diluted emulsified asphalt shall be no less than 28.5%.

a. If the dilution is performed in the field, and the rate can be verified, a sample for verification of proper dilution is not required. A sample of the undiluted material may be requested by the Department.

b. If the dilution is performed in the field, and the rate cannot be verified, a sample for verification of proper dilution of each truckload is required.

c. If the emulsified asphalt was diluted at the supplier terminal, the Department Laboratory may request a sample for proper dilution verification. The bill of lading or delivery ticket shall state the dilution rate.

513.03 -- Construction Methods

1. Before the application of the fog seal, the Contractor shall clean the surfaces as described in Section 501.

2. a. The application of asphaltic materials shall be allowed only when:

(1) The ambient air temperature is above 60°F (16°C).

(2) The surface is dry. The Engineer may allow the application of emulsified asphalt to a damp surface if all standing water has been removed from the surface and no further precipitation is expected.

b. The Contractor shall demonstrate the ability to distribute a uniform coat of asphaltic material before beginning work. A coat of the specified emulsified asphalt shall be applied to a test strip of tar paper or other suitable material. The strip shall be 10 feet (3 m) long and as wide as the spray bar. If the Engineer determines the application to be unsatisfactory, the Contractor shall adjust the equipment and repeat the test procedure until satisfactory results are obtained. The Contractor shall properly dispose of the test strip after use.

c. The emulsified asphalt shall be diluted in the distributor or transport with potable water as shown in the contract. The rate of application shall be 0.12 Gal/SY. The distributor shall be shut off before the tank is entirely empty.

d. Hand sprayers shall be used in applying asphaltic materials to small or irregular sections.

e. The Contractor shall conduct the operations to minimize construction traffic on completed portions of the Fog Seal.

f. Application widths shall coincide with existing traffic lane lines to the maximum extent possible. The Fog Seal shall be applied to the entire traffic lane at a time, confining traffic to the portion of the surface not being treated.

3. a. When an excessive fog seal quantity is applied, the Contractor shall furnish and distribute clean, fine sand uniformly on the surface to blot the excess asphalt.

b. The required rate of application shall be from 3.7 to 12.9 lb/SY (2 to 7 Kg/m²); but never shall the quantity be less than that required to completely blot the surface and to prevent asphaltic material from being picked up by traffic.

c. Excess accumulations of fog seal materials within isolated low spots or pockets shall be thinned out or sand blotted.

4. Traffic shall not be placed on the Fog Seal until the emulsion has broken and all free moisture has evaporated or drained off the surface.

513.04 -- Method of Measurement

1. Fog seal will be measured in gallons (kiloliter) of diluted solution applied to the surface.

2. Clean fine sand will not be measured.

513.05 -- Basis of Payment

1. Pay Item	Pay Unit
Fog Seal	Gallon (Gal) [Kiloliter (kL)]

2. Any amount of fog seal emulsified asphalt which is outside the specified property ranges of Table 513.01, shall be paid for at the contract unit price multiplied by the pay factor determined in Table 513.01. If the resultant Pay Factor for the material indicates rejection as an option, the Engineer will determine if the non-compliant material will be removed.

Table 513.01

Tolerances and Pay Factors		
Specified Property	Tolerance	Pay Factor
AASHTO T 59, Pre-Dilution, Residue	≥ 56.0%	1.00
	54.0% - 55.9%	0.85
	52.0% - 53.9%	0.70
	< 52.0%	0.40 or Reject
AASHTO T 59, Post- Dilution**, Residue	≥ 28.0%	1.00
	27.0% - 27.9%	0.85
	26.0% - 26.9%	0.70
	< 26.0%	0.40 or Reject
Pay Factors for Tests for ALL other Properties Specified* 1.00 for deviation of ± less than or equal to 10% 0.75 for a deviation of ± greater than 10% to less than or equal to 25% 0.40 or Reject for deviation of ± greater than 25% * When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied to the listed criteria. ** Test requirements of Saybolt Furol Viscosity, Storage stability, and Cement mixing, of post-diluted material are not applicable. Note: When more than one specified property exceeds specification tolerances, the single largest Pay Factor Reduction will be the one applied.		

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 4 days of receiving the written notification of deficiency. This written request is also affirmation and agreement that the testing may occur beyond the 14 day testing timeframe of the asphaltic emulsion specifications.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Clean fine sand will be subsidiary to fog seal.
5. Water used to dilute emulsified asphalt is subsidiary to fog seal.
6. Payment is full compensation for all work described in this Section.

SECTION 514 -- MICROSURFACING

514.01 -- Description

1. This work shall consist of an application of microsurfacing material to an existing surface. The microsurfacing material shall be a mixture of polymer-modified emulsified asphalt, aggregate, mineral filler, water, and other additives properly proportioned, mixed, and spread.

514.02 -- Material Requirements

1. The asphalt emulsion for use in this work shall be CQS-1H polymer modified material and shall conform to the requirements of Section 1032.

2. a. Crushed mineral aggregate for use in this work shall be gravel conforming to the gradation requirements in Table 514.01.

b. Chat aggregate shall conform to the gradation requirements shown in Table 514.01.

c. Quartzite or granite shall conform to either gradation.

Table 514.01

Microsurfacing Gradations Chat Gradation	
<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch (9.50 mm)	99 - 100
No. 4 (4.75 mm)	86 - 94
No. 10 (2.00 mm)	40 - 60
No. 50 (300 μm)	10 - 25
No. 200 (75 μm)	5 - 15
Crushed Mineral Aggregate Gradation *	
<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch (9.50 mm)	100
No. 4 (4.75 mm)	84 - 100
No. 10 (2.00 mm)	50 - 64
No. 50 (300 μm)	13 - 29
No. 200 (75 μm)	5 - 15

3. Aggregate shall have a minimum fine aggregate angularity of 45% in accordance with AASHTO T 304 Method A.

4. Los Angeles Abrasion loss percentage shall not exceed 40.

5. Aggregates shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

6. A sand equivalent value of 60 or higher shall be required for any of the aggregates specified. The sand equivalent shall be tested according to AASHTO T 176.

7. The Contractor must pass the aggregate over a 1/2 inch (13 mm) screen to remove any oversize material before the aggregate enters the mixing unit.

8. Mineral filler for use in this work shall be Portland cement, Type I or Type IP, that is free from lumps. Acceptance will be based on visual inspection. The amount of mineral filler needed shall be determined by the laboratory mix design and will be considered as part of the material

gradation requirement. An increase or decrease of less than 1% by weight may be allowed when the microsurfacing is being placed if it is found necessary for better consistency or set times.

9. Water shall be potable.

10. Other additives may be allowed in the mixture or any of the component mixtures to provide the specified properties. Set retarding agents may also be included.

11. a. The Contractor shall be responsible for the design and proportioning of the microsurfacing mixture.

b. The contractor shall submit a tentative design to the Engineer for approval, in writing, ten working days prior to beginning microsurfacing production. The design shall list all the ingredients of the mixture.

c. Mix Design Requirements are shown in Table 514.02.

Table 514.02

Microsurfacing Mix Design Requirements		
Property	Test	Requirements
Wear Loss (Wet Test Track)	ASTM D6372 (1 hour soak) (6 day soak)	50 g/ft ² , maximum 75 g/ft ² , maximum
Wet Cohesion	ASTM D6372 @30 minutes @60 minutes	10 in-lbs, minimum 17 in-lbs, minimum
Wet Stripping	ISSA TB-114	90%, minimum
Mix Time @ 77°F	ISSA TB-113	Controllable to 120 seconds, minimum

d. The Mix Design shall include all test results from Table 514.02.

e. The design shall list all the ingredient proportions and the gradation of the proposed aggregate.

f. Based on the dry weight of the aggregate, the microsurfacing mixture shall contain:

(1) 6% to 11% of residual asphalt.

(2) 0.5% to 3.0% of mineral filler.

(3) A sufficient quantity of water to produce a mixture having the proper consistency.

12. a. In the event a combination of aggregates is used, the aggregates shall be mechanically blended before loading the materials into the mixing machine.

b. Blending by loading alternate buckets will not be allowed.

514.03 -- Equipment

1. a. The material shall be mixed by a self-propelled continuous-flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, and water to a revolving multi-blade mixer and discharge the thoroughly-mixed product on a continuous flow basis.

b. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, and water to maintain an adequate supply to the proportioning controls.

c. The machine shall be capable of loading all materials while continuing to apply the microsurfacing.

2. The controls for proportioning each material shall be accessible for ready calibration. The controls shall be calibrated, properly marked, and located so that the Engineer may determine the amount of each material used at any time.

3. The aggregate feeder to the mixing unit shall be equipped with a revolution counter or similar device.

4. The emulsion pump shall be of the positive displacement type and shall be equipped with a revolution counter or similar device.

5. The mixing unit shall be equipped with an approved fine aggregate feeder that shall deliver a uniform, accurately metered flow of mineral filler. The delivery of mineral filler shall be coordinated with the aggregate feeder flow such that a properly proportioned mixture can be produced.

6. The mixing unit shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray to the roadway surface immediately ahead of the microsurfacing spreading equipment. The pump for dispensing water to the mixing unit shall be equipped with a meter that will register directly in gallons (liters). The pump shall have a minimum of two valves, one of which shall establish the required flow. The other valve shall be the quick acting type and shall be used to start and stop the water flow.

7. A rigid rear screed shall be used on the rut box, and it shall be adjusted to strike off the application of microsurfacing mixture flush with the edges of the rut depressions to the extent possible and within the limits imposed by the maximum aggregate particle size.

8. The laydown box shall use either a rigid metal primary strike off or a flexible rubber strike off. This strike off shall have three elevation adjustments to provide for quarter point elevation adjustments. Behind the primary strike off shall be a secondary strike off which is cantilevered to the laydown box. The secondary strike off shall have a flexible rubber squeegee and be equipped with elevation adjustments matching the primary strike off. The secondary strike off shall have a pivot point where it can be tilted for texturing or raised off the surface.

9. An inside skid shall be attached to the laydown box approximately 1 foot (300 mm) inside both ends of the box and running parallel to the outside skid. The inside skid shall be adjustable in height, allowing the weight of the laydown box to be carried on the inside skid while making adjacent passes.

10. Attached to each end of the distributor box shall be a "drip system" capable of adding a small amount of diluted set-retarding agent into both rear corners. This will help ensure that material being deposited at the longitudinal joint edges has not set before being placed.

514.04 – Calibration Methods

1. The laydown machine/mixing unit shall be calibrated before placement begins. The Contractor shall furnish the necessary accessories,

materials, personnel and shall perform the tests and calibrations on the equipment under the observation of the Engineer.

2. The aggregate feeder and emulsion pump shall be calibrated using the Calibration Computation Spreadsheet included in the Microsurfacing Workbook provided by the Department.

3. Emulsion pump calibration shall be based on the average of three calibration tests. The emulsion pump calibration tests shall be performed at pump rates that encompass those emulsion pump rates that will be used during production, or at a fixed production pump rate if the rate of microsurfacing (in pounds per revolution) will remain fixed throughout production. The individual test results shall not vary more than 0.5% from the average of the three tests.

4. The aggregate feed rate calibration shall consist of the development of a graphical relationship of the gate setting (opening size in inches) versus aggregate feed rate (pounds of dry aggregate per count). This relationship will be used by the Contractor to select the aggregate gate height that will produce microsurfacing that conforms to the Contractor's mix design. The aggregate feed rate calibration shall consist of the following:

a. If an aggregate feed system is used that can be set to automatically provide an aggregate feed rate that is uniform and proportioned to the emulsion feed rate to provide a mix that is consistent with the Contractor's approved mix design, then the gate setting requirements in b. below are unnecessary.

b. The production aggregate-gate-height setting shall be selected based on the following:

(1) The three various gate settings shall be selected to provide a production setting that is encompassed by the calibration gate settings. The calibration gate setting values shall plot equidistant along the aggregate gate height axis of the graphical relationship chart.

(2) The feed-rate tests shall be performed at a consistent aggregate belt speed (aggregate count rate) that is consistent with the aggregate belt speed that will be used during production. The aggregate feed-rate calibration tests shall have a minimum duration of feed-rate counts to produce a minimum of 1,000 lbs of wet aggregate per test.

(3) Adjustment for the moisture content of the aggregate to convert to a dry weight of aggregate shall be made.

c. The results of the three calibration tests shall be provided to the Engineer and plotted. The fixed aggregate-gate-height setting (production gate height setting) shall be selected by the Contractor. This setting shall produce a uniform proportion of aggregate and emulsion that conforms to the Contractor's mix design. The Engineer shall be notified of any changes to the aggregate/emulsion proportion or to the aggregate gate height.

d. The aggregate feed rate shall be calibrated based on the average of three calibration tests. These calibration tests shall be performed at the fixed aggregate-gate-height setting (production gate height setting). These calibration tests shall be performed at aggregate feeder rates that encompass those aggregate feeder rates that will be used during production

or at the fixed aggregate feeder rate if the rate of microsurfacing (in pounds per revolution) will remain fixed throughout production. The individual test results shall not vary more than 0.5% from the average of the three tests.

5. The calibration results shall be approved by the Engineer prior to placement of microsurfacing.

6. The Contractor shall notify the Engineer of all feed rate adjustments. A lock shall be placed on the aggregate feeder gate and the emulsion pump shall be mechanically linked to the aggregate feeder to insure that the fixed aggregate/emulsion proportion is not altered without the Engineer's approval.

514.05 -- Construction Methods

1. The Contractor shall furnish and apply the microsurfacing materials. The Contractor shall construct the microsurfacing as shown in the contract or as directed by the Engineer.

2. Immediately before applying the microsurfacing, the Contractor shall clean the surface of all vegetation, loose materials, excess joint material, excess oil, dirt, mud, and other objectionable materials.

3. The Contractor shall water the surface before the application of the microsurfacing. The water shall be applied at a rate such that the entire surface will be damp.

4. When ruts occur, regardless of the rut depth, the microsurfacing shall be placed in two separate applications.

a. The first pass will bring the ruts up to a minimum level of the existing pavement profile, and shall be performed using a scratch course. A scratch course does not require the use of a secondary strike off behind the rigid metal primary strike off plate. The first pass will not be subject to the repairs required in Subsection 514.05, Paragraph 15.

b. The second pass shall place microsurfacing material over the entire lane.

5. Areas that cannot be reached with the mixing machine shall be surfaced using hand tools to provide complete and uniform coverage. Such handwork and the machine application shall be completed simultaneously.

6. A sufficient amount of microsurfacing shall always be carried in all parts of the distributor box so that complete coverage is obtained.

7. No lumping, balling, or unmixed aggregate will be allowed. Any oversized aggregate or foreign materials shall be screened from the aggregate before delivery to the microsurfacing mixing machine. No streaks or slick spots shall be left in the finished surface.

8. a. Water used to produce the proper consistency shall be metered.

b. The use of water to routinely clean the box during placement will not be allowed.

9. Microsurfacing mixture shall be placed only when:

a. The atmospheric temperature is 50°F (10°C) or greater.

b. The temperature is expected to be above 32°F (0°C) for 24 hours after placement.

c. It is not foggy or rainy.

10. Longitudinal joints shall be placed on lane lines where possible. Joints shall overlap and shall not exceed 3 inches (75 mm). Care shall be taken to ensure straight lines along the roadway centerline, lane lines, and shoulder or curb lines. Lines at intersections shall be kept straight to provide a good appearance as determined by the Engineer.

11. At driveways, intersections, and other locations where sharp turning movements or vehicle accelerations may occur, additional time may be required for adequate curing before allowing traffic on the newly placed material.

12. On the first production day, a 1,000 foot test strip shall be placed and approved before full production begins. The Contractor shall construct the test strip using the approved job mix design, laydown procedures and equipment that will be used on the project.

a. Full production shall not begin until the Engineer has determined that:

(1) The material is curing properly to allow normal traffic on the surfaced roadway within 1 hour.

(i) Proper curing will be determined by the Engineer testing the section by driving their inspection vehicle on the material after 1 hour of curing, and the surface does not display tearing, marking, or any permanent deformation under the load of the vehicle in straight forward driving operations and in slight turn radius situations.

(2) The mix is in conformance with the mix design criteria.

(3) The edge lines are placed straight and remain straight.

(4) No lumping, balling or unmixed aggregate exist.

(5) The surface texture is uniform and free of streaks, slick spots or excessive drag marks.

b. When a test strip produces a mixture or surface that does not meet the specifications, the test strip shall be rejected and will not be measured as part of completed work. The Contractor shall remove and replace the test strip at no additional cost or overlay the test strip with microsurfacing that conforms to the project specifications, at the Engineer's discretion. The edges and ends of overlaid material shall be feathered to conform to the longitudinal and transverse joint requirements in Subsection 514.05, Paragraphs 16 and 17.

c. Accepted test strips, when placed in areas that are to be microsurfaced, will remain in place and be measured as part of the completed work.

d. A new test strip will be performed when there is field evidence that the system is not performing as specified, is out of control, or when a new mix design is required.

13. Microsurfacing shall cure to allow turning truck traffic within 3 hours. Adequate cure shall be verified by having truck operations with no

displacement. Microsurfacing that exhibits aggregate displacement or deformation shall be removed and replaced at no cost to the Department.

14. The transverse pavement cross section as measured using a 10 foot straight edge shall not have deviations that exceed 3/8 inch. This shall not apply to any area within 12 inches of the edge line, lane line, or center line.

15. The Contractor shall construct the surface course without excessive scratch marks, tears, rippling, or other surface irregularities. Repair tear marks greater than 1/2 inch wide and 4 inches long and marks greater than 1 inch wide and 1 inch long. Repair transverse ripples or streaks greater than 1/4 inch in depth as measured by a 4 foot straight edge. All repairs shall be either hand repairs made immediately after placement and before the microsurfacing material has broken, full-width repairs that shall require removing the full width of microsurfacing and replacing with microsurfacing that conforms to the project specifications, or overlay the defective areas with microsurfacing that conforms to the project specifications. Hand repairs shall have a finished surface texture and color that matches the adjacent microsurfacing. The edges and ends of overlaid material shall be feathered to conform to the longitudinal and transverse joint requirements in Paragraphs 16, 17 and 18 of this section.

16. Constructed longitudinal joints, with no more than 1/2 inch overlap thickness as measured with a 4 foot straight edge, and less than a 3 inch overlap on adjacent passes. Longitudinal construction joints and lane edges shall coincide with the proposed painted lane lines. Place overlapping passes, on the uphill side, to prevent ponding of water.

17. Construct transverse joints, with no more than 1/4 inch difference in elevation across the joint as measured with a 4 foot straight edge.

18. Construct edge lines along curbs, shoulders, lane lines and centerline with no more than 2 inches of horizontal variance in any 100 foot location. No runoff in these areas will be permitted.

19. The Contractor may restrict traffic to one lane while applying the microsurfacing. The Contractor shall take whatever other means necessary to protect the microsurfacing from damage by traffic. Any damage done by traffic shall be repaired by the Contractor at no cost to the State.

514.06 -- Method of Measurement

1. a. "Aggregate for Microsurfacing" shall be measured by the ton (Megagram). The weight shall be determined on approved scales under the observation of the Engineer. Deductions will be made for the moisture in the aggregate at the time it is weighed. Moisture determinations will be made for each of the first 5 loads and as often after that as is necessary to describe the fluctuations in the moisture content.

b. The weight of "Aggregate for Microsurfacing" may be determined using the aggregate feeder counter, as an alternative to using an approved scale, provided the aggregate feeder counter is calibrated. Lading certificates for the aggregate shall be provided to the Engineer. This payment alternative must be requested by the Contractor prior to the placing of microsurfacing and approved by the Engineer.

2. The "Emulsified Asphalt for Microsurfacing" is measured by the gallon (kiloliter). The volume of "Emulsified Asphalt for Microsurfacing" will be determined using the emulsion pump revolution counter, as an alternative to using refinery certified volumes, provided the emulsion pump revolution counter is calibrated. Refinery certificates with certified volumes shall be provided to the Engineer.

3. "Mineral Filler for Microsurfacing" shall be measured by the ton (megagram) of Portland cement. If furnished in bags, the weight shall be determined by converting the bag count to tons (megagrams).

4. The "Microsurfacing Placement" shall be measured by the station along the project centerline without regard for width or depth of the work and without regard for the number of passes needed to complete the work. The work of placing the Microsurfacing in all ruts is included in this measurement. When lug-outs, driveways and intersections will be microsurfaced as shown on the contract, they shall be considered subsidiary. Microsurfacing of driveways or intersections that extends past the end of the radius, in excess of 50 feet will be included in the pay length. Measurement of these segments will begin at the end of the radius.

514.07 -- Basis of Payment

1. Pay Item	Pay Unit
Aggregate for Microsurfacing	Ton (Tn) [Megagram (Mg)]
Emulsified Asphalt for Microsurfacing	Gallon (Gal) [Kiloliter (kL)]
Mineral Filler for Microsurfacing	Ton (Tn) [Megagram (Mg)]
Microsurfacing Placement	Station

2. The approved polymer-based modifier, other additives, and any additional emulsifying agents will not be measured for payment but shall be considered subsidiary to the item "Emulsified Asphalt for Microsurfacing".

3. Water used in the preparation of the microsurfacing mixture and for prewetting the surface of the roadway will not be measured for payment but shall be considered subsidiary to other items for which payment is made.

4. Any amount of microsurfacing emulsified asphalt which is outside the specified property ranges of Table 514.03, shall be paid for at the contract unit price multiplied by the pay factor determined in Table 514.03. If the resultant Pay Factor for the material indicates rejection as an option, the Engineer will determine if the non-compliant material will be removed.

Table 514.03

Tolerances and Pay Factors		
Specified Property	Tolerance	Pay Factor
AASHTO T 59, Residue after Distillation	≥ 61.0%	1.00
	59.0% - 60.9%	0.85
	57.0% - 58.9%	0.70
	< 57.0%	0.40 or Reject
AASHTO T 53, Softening Point	≥ 131.5°F	1.00
	< 131.5°F	0.75 or Reject
Pay Factors for Tests for ALL other Properties Specified* 1.00 for deviation of ± less than or equal to 10% 0.75 for a deviation of ± greater than 10% to less than or equal to 25% 0.40 or Reject for deviation of ± greater than 25% * When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied to the listed criteria. Note: When more than one specified property exceeds specification tolerances, the single largest Pay Factor Reduction will be the one applied.		

5. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 4 days of receiving the notification of deficiency. This written request is also affirmation and agreement that the testing may occur beyond the 14 day testing timeframe of the asphaltic emulsion specifications.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

6. Payment is full compensation for all work described in this Section.

SECTION 515 -- ARMOR COAT OR CHIP SEAL

515.01 -- Description

1. Armor Coat and Chip Seal is the sprayed application of emulsified asphaltic material with a covering of aggregate at the locations shown in the contract or as directed by the Engineer.

515.02 -- Material Requirements

1. Armor Coat and Chip Seal emulsified asphaltic material shall be the type and grade shown in the contract and shall conform to the requirements of Sections 1031 or 1032.

2. Aggregate for Armor Coat and Chip Seal shall conform to the requirements of Subsection 1033.02, Paragraphs 1. and 2. The aggregates shall have a Los Angeles Abrasion loss percentage of not more than 40.

3. Aggregate for Armor Coat shall have a soundness loss of not more than 5% by mass at the end of 5 cycles using sodium sulfate solution. The aggregate shall also conform to the gradation requirements of Table 515.01.

Table 515.01

Armor Coat Aggregate Gradation Limits	
Sieve Size	Percent Passing
3/8 inch (9.5 mm)	99 to 100
No. 4 (4.75 mm)	60 to 85
No. 10 (2.0 mm)	0 to 15
No. 50 (300 μ m)	0 to 10
No. 200 (75 μ m)	0 to 3

4. Aggregate for Chip Seal shall be limestone, expanded shale, granite, or quartzite. The aggregate shall have a soundness loss of not more than 7% by mass at the end of 5 cycles using sodium sulfate solution.

a. The limestone, granite, and quartzite chip seal aggregates shall conform to the gradation requirements of Table 515.02.

Table 515.02

Limestone, Granite, and Quartzite Chip Seal Aggregate Gradation Limits	
Sieve Size	Percent Passing
3/8 inch (9.5 mm)	99 to 100
No. 4 (4.75 mm)	0 to 70
No. 10 (2.0 mm)	0 to 10
No. 50 (300 μ m)	0 to 5
No. 200 (75 μ m)	0 to 3

b. The expanded shale chip seal aggregate shall conform to the gradation requirements of Table 515.03.

Table 515.03

Expanded Shale Chip Seal Aggregate Gradation Limits	
Sieve Size	Percent Passing
1/2 inch (12.5 mm)	95 to 100
3/8 inch (9.5 mm)	85 to 100
No. 4 (4.75 mm)	0 to 30
No. 10 (2.0 mm)	0 to 10
No. 200 (75 μ m)	0 to 3

5. Aggregates shall be sampled and tested as per the Department's Materials Sampling Guide.

515.03 -- Construction Methods

1. The Contractor shall furnish and place the Armor Coat or Chip Seal as indicated in the contract.

2. The application equipment and surface preparation shall be in accordance with Section 501.

3. Armor Coat or Chip Seal Application:

a. The application of asphaltic materials shall be allowed only when:

(1) The ambient air temperature is above 60°F (16°C).

(2) The surface is dry. The Engineer may allow the application of emulsified asphalt to a damp surface if all standing water has been removed from the surface and no further precipitation is expected.

b. The Contractor shall demonstrate the ability to distribute a uniform coat of emulsified asphalt and aggregate before beginning work. A coat of the specified emulsified asphalt shall be applied to a test strip of tar paper or other suitable material. The strip shall be 10 feet (3 m) long and as wide as the spray bar. A coat of the specified aggregate shall follow. If the Engineer determines the application to be unsatisfactory, the Contractor will be required to adjust the equipment and repeat the test procedure until satisfactory results are obtained. The Contractor shall properly dispose of the test strip after use.

c. Emulsified asphaltic material shall be applied at a minimum temperature of 160°F (71°C). The distributor shall be shut off before the tank is entirely empty. The application rates shall be as follows:

(1) Armor Coat: 0.27 to 0.30 Gal/SY (1.22 to 1.36 L/m²).

(2) Limestone, Granite or Quartzite Chip Seal: 0.29 to 0.33 Gal/SY (1.31 to 1.49 L/m²).

(3) Expanded Shale Chip Seal: 0.30 to 0.36 Gal/SY (1.36 to 1.63 L/m²).

(4) The Engineer may adjust these rates as a result of the test strip or field results.

d. Hand sprayers shall be used in applying asphaltic materials to small or irregular sections.

e. Special care shall be taken to secure an overlap of adjoining longitudinal applications.

f. Seamless transverse joints shall be obtained by placing 15 pound tar paper at the joint at the beginning and end of each shot. This should ensure that the correct rate of application is achieved for the full length of the shot and avoid double application of emulsified asphalt. The emulsified asphalt application shall commence with a running start on a strip of tar paper. The spray bar needs to be stopped on the tar paper at the end of each shot to ensure a straight transverse construction joint. Transverse joints shall have no more than 0.25 inch (6.5 mm) difference in elevation across the joint as measured with a 6 foot (2m) straightedge. The Armor Coat or Chip Seal edge shall be neat and uniform along the roadway lane, shoulder and curb lines. The Armor Coat or Chip Seal edge shall have no more than 2 inches (50mm) variance in any 100 foot (30m) section, along the roadway edge or shoulder.

g. The moisture content of mineral aggregate for Armor Coat or Chip Seal, at the time of application, shall be satisfactory to the Engineer. Except in the case of expanded shale, if the aggregate is dry, water shall be applied to thoroughly and uniformly moisten the aggregate before application.

h. The cover aggregate shall be applied within 1 minute after the application of the emulsified asphalt. The application rates shall be as follows:

(1) Armor Coat: 17 to 20 lb/SY (9.2 to 10.8 Kg/m²).

(2) Limestone, Granite or Quartzite Chip Seal: 17 to 23 lb/SY (9.2 to 11.4 Kg/m²).

(3) Expanded Shale Chip Seal: 9 to 12 lb/SY (4.9 to 6.5 Kg/m²).

(4) The Engineer may adjust these rates as a result of the test strip or field results.

i. For irregular areas, the Contractor may employ hand methods to provide uniform distribution.

j. The Contractor shall conduct the operations to minimize construction traffic on completed portions of the Armor Coat or Chip Seal. Armor Coat or Chip Seal equipment will not be allowed to travel on uncovered asphaltic materials.

k. Application widths shall coincide with existing traffic lane lines to the maximum extent possible. The Armor Coat or Chip Seal shall be applied to the entire traffic lane at a time, confining traffic to the portion of the surface not being treated.

l. When Armor Coat or Chip Seal is required on both roadway and surfaced shoulders, Armor Coat or Chip Seal materials shall be applied to the shoulder's full width before Armor Coat or Chip Seal materials are applied on any section of the adjacent traffic lane. Application widths shall coincide with lane and shoulder widths.

m. Traffic will not be allowed on the completed Armor Coat or Chip Seal until the aggregate is well embedded in the bituminous material.

4. Rolling:

a. Immediately after the Armor Coat or Chip Seal materials have been distributed, the rolling shall begin.

b. The entire area shall be rolled within 15 minutes after the cover material is applied and an additional 4 full rolling coverages shall be made within 1 hour after the cover material is applied.

c. Rolling operations shall provide uniform embedment of the aggregate and shall be arranged to ensure uniform rolling of all portions of the area to which the materials have been applied.

d. The Contractor shall perform all rolling with self-propelled, multiple-wheel, pneumatic-tired rollers. A minimum of three rollers will be required. The first two, drive side-by-side rolling the outer edges. The third roller then follows closely behind, rolling the center of the lane. The roller speed shall be no more than 5 mph (8 km/hr).

e. As soon as the emulsified asphalt has set and no further aggregate can be embedded, but by the end of the day of the application of the Armor Coat or Chip Seal materials, all loose aggregate shall be swept from the roadway surface by the Contractor. Care shall be taken to avoid dislodging embedded aggregate.

f. Sweeping shall be conducted between 1/2 hour after sunrise and 1/2 hour before sunset.

515.04 -- Method of Measurement

1. The emulsified asphalt is measured in gallons (kiloliters). Refinery certified volume shall be used as a basis of measurement of the emulsified asphalt if the entire shipment is used.

2. a. Aggregate for Armor Coat or Chip Seal will be measured by the cubic yard (cubic meter) at the point of delivery. The Contractor shall strike off the materials to uniform height for volume determination.

b. The Contractor may request early sampling and testing at the point of delivery, in which case the aggregate shall be stored in lot size stockpiles as defined in the Department’s Material Sampling Guide.

515.05 -- Basis of Payment

1. Pay Item	Pay Unit
Armor Coat Emulsified Asphalt _____	Gallon (Gal) [liter (L)]
Armor Coat Aggregate	Cubic Yard (CY) [Cubic Meter (m ³)]
Chip Seal Emulsified Asphalt _____	Gallon (Gal) [Liter (L)]
Chip Seal Aggregate	Cubic Yard (CY) [Cubic Meter (m ³)]

2. Aggregate not meeting the gradation requirements listed in Table 515.01, 515.02, or 515.03 will not be accepted for payment.
3. a. Any amount of Armor Coat or Chip Seal emulsified asphalt which is outside the specified property ranges of Table 515.04 shall be paid for at the contract unit price multiplied by the pay factor determined in Table 515.04. If the resultant Pay Factor for the material indicates rejection as an option, the Engineer will determine if the non-compliant material will be removed.

Table 515.04

Tolerances and Pay Factors		
Specified Property	Tolerance	Pay Factor
AASHTO T 59, Residue after Distillation	≥ 64.0%	1.00
	63.0%-63.9%	0.75
	< 63.0%	0.40 or Reject
AASHTO T 301, Elastic Recovery, 77°F, CRS-2P	≥ 49.5%	1.00
	44.0% - 49.4%	0.75
	< 44.0%	0.40 or Reject
Pay Factors for AASHTO Tests for ALL other Properties Specified* 1.00 for a deviation of ± less than or equal to 10% 0.75 for a deviation of ± greater than 10% to less than or equal to 25% 0.40 or Reject for deviation of ± greater than 25% * When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied to the listed criteria. Note: When more than one specified property exceeds specification tolerances, the largest pay Factor Reduction will be applied.		

4. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.
 - a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 4 days of receiving the written notification of deficiency. This written request is also affirmation and agreement that the testing may occur beyond the 14 day testing timeframe imposed by asphaltic emulsion specifications.
 - b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing.

When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

5. Emulsified asphalt materials used in the test strip are subject to the payment adjustments in Table 515.04.
6. All test strips are subsidiary to the armor coat and chip seal pay items.
7. Payment is full compensation for all work described in this Section.

SECTION 516 -- BITUMINOUS PAVEMENT PATCHING

516.01 -- Description

1. Bituminous pavement patching shall consist of the removal and disposal of unstable or disintegrated bituminous or concrete surfacing and/or base course and the placing and compacting of "Asphaltic Concrete, Type ___", at locations specified by the Engineer. Patching shall include the correction of faulty subgrade conditions.

516.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 516.01.

Table 516.01

Material Requirements	
<u>Applicable Materials</u>	<u>Section</u>
Asphaltic Concrete.....	1028
Performance Graded Binder.....	1029
Emulsified Asphalt.....	1031, 1032
Aggregate.....	1033

516.03 -- Equipment

1. All equipment used in pavement patching shall conform to the requirements in Sections 501 and 503.

516.04 -- Construction Methods

1. The Contractor shall patch bituminous and concrete pavement in accordance with the requirements in Section 503.

2. Each pavement patch shall be completed in the same work day.

3. The removal and disposal shall be performed in accordance with the requirements in Section 203.

4. The removed bituminous or concrete surfacing layers shall be replaced with asphaltic concrete.

5. Subgrade Repair:

a. The underlying material shall be uniformly compacted to the Engineer's satisfaction.

b. After compaction of the underlying material, a tack coat shall be applied on the vertical faces and bottom surface as described in Section 504. The rate of application shall be as directed by the Engineer.

c. If the underlying material includes an unstable base course, it shall be removed and wasted. The base course shall be replaced with asphaltic concrete.

d. If the underlying material includes unstable subgrade materials, they shall be removed and wasted or salvaged for reused back in the repair if the moisture content of these materials is adequate or can be made adequate for proper compaction, Subgrade shall be replaced as follows:

(1) Subgrade from within a repair that extend to a depth of 16 inches or less shall be replaced with asphaltic concrete.

(2) Wasted subgrade from within a repair that extends to a depth greater than 16 inches shall be replaced with material as required by

the Engineer. This material may be the salvaged soil, imported soil similar to the subgrade soils, asphaltic concrete or “granular materials for patching.”

(3) “Granular materials for patching” shall be crushed concrete, recycled asphaltic concrete, sand, gravel or crushed rock. The type and quality of these materials shall be satisfactory to the Engineer.

(4) When “granular materials for patching” are used to replace the subgrade material, the Engineer may require they be drained by day-lighting the repair excavation to the adjacent foreslope. The excavation for day-lighting shall be made in accordance with the Engineers requirement and shall be filled with the same type of “granular materials for patching” used in the repair.

6. All edges shall be vertical and straight.

7. The thickness of the layers shall be adjusted so that the required density is achieved throughout the layer. The final elevation of the patch's surface shall be approximately 1/8 inch (4 mm) above the adjacent surfacing.

516.05 -- Method of Measurement

1. a. Bituminous Pavement Patching of flexible pavement and the repair or replacement of any subgrade material authorized by the Engineer will be measured by one of the following methods based upon the depth of the patch.

(1) For patches 16-inches (40cm) deep or less, determined at the time of patching, the patching will be measured by the ton (megagram) of “Asphaltic Concrete for Patching, Type ____” required to complete the patch and repair any faulty base course or subgrade. No equipment rental will be paid for this work, and all equipment used to complete the work shall be subsidiary to the item, “Asphaltic Concrete for Patching, Type ____.”

(2) For patches more than 16 inches (40cm) deep, determined at the time of patching, the patching will be measured by the ton (megagram) of “Asphaltic Concrete for Patching, Type ____” required to complete the patch and repair any faulty subgrade that is replaced with asphaltic concrete. Additionally, the following will apply:

(i) The hours of equipment rental required to complete the patching and repair in that portion of the patch deeper than 16-inches and make any required day-light excavations will be measured by the hour of equipment rental in accordance with Section 919. Only approved equipment needed to patch and excavate the failure or make the day-light excavation is to be rented, and only the time utilized to perform the work in the region deeper than 16-inches (40 cm) is to be measured. Excluded is any equipment needed to haul asphaltic concrete, soil or “Granular Materials for Patching” to the site or haul away material for disposal.

(ii) Imported soil or “granular materials for patching” used to replace unstable subgrade materials shall be measured and paid by the cubic yard (CY).

2. a. “Asphaltic Patching of Portland Cement Concrete Pavement, Type_____” and the repair or replacement of any subgrade material authorized by the Engineer will be measured by the square yard (square meter) of completed and accepted work regardless of depth. Additionally,

the asphaltic concrete used to complete the patch will be measured for payment and included with the roadway tonnage.

b. Bituminous Pavement Patching of concrete pavement is divided into three types (see Table 516.02). The types are based on the size of the individual patches constructed in a single lane. If a damaged area spans two or more lanes, then the continuous patch will be counted as multiple patches -- one patch per lane.

Table 516.02

Asphalt Patch Sizes in Portland Cement Concrete Pavement	
Type	Size
A	5 SY (5 m ²) or less
B	Greater than 5 SY to 15 SY (5 m ² to 12.5 m ²)
C	Greater than 15 SY (12.5 m ²)

3. "Asphaltic Concrete, Type _____," "Asphaltic Concrete for Patching, Type _____," "Performance Graded Binder _____," and "Hydrated Lime for Asphalt Mixtures" used in either the patching of flexible pavement or concrete pavement will be measured for payment by the ton (megagram) in accordance with Subsection 503.05.

516.06 -- Basis of Payment

1. Pay Item	Pay Unit
Rental of Motor Grader, Fully Operated	Hour (h)
Rental of Dump Truck, Fully Operated	Hour (h)
Rental of Loader, Fully Operated	Hour (h)
Rental of Skid Loader, Fully Operated	Hour (h)
Asphaltic Concrete for Patching, Type _____	Ton (Tn) [Megagram (Mg)]
Asphalt Patching of Portland Cement Concrete Pavement, Type _____	Square Yard (SY) [Square Meter (m ²)]

2. Performance Graded Binder and asphaltic concrete used in the work of pavement patching shall be paid for in accordance with Section 503.

3. Emulsified asphalt for tack coat will be measured and paid for in accordance with Section 504.

4. If more than one type of asphaltic concrete is required, the pay item will be subdivided so the quantities of each type are documented.

5. If imported soil of "Granular Materials for Patching" are used to replace the unstable subgrade materials at a depth greater than 16 inches or to backfill day-light excavations, the pay item will be "Granular Material for Patching" measured by the cubic yard. Payment will be calculated as 0.5 times the bid price (per ton) for "Asphaltic Concrete for Patching, Type _____" in units of \$/CY.

6. Replacement of subgrade materials will be paid per hour of equipment rental.

7. Payment is full compensation for all work described in this Section.

SECTION 517 -- PRIME COAT

517.01 -- Description

1. This work shall consist of the application of asphaltic materials on bases, roadbeds or other surfaces as shown in the contract or as designated by the Engineer.

517.02 -- Material Requirements

1. Asphaltic materials for prime coat shall be the type and grade shown in the contract and shall conform to the requirements of Section 1030.

517.03 -- Construction Methods

1. The Contractor shall blade off all loose material, then sweep the surface with mechanical brooms until the surface is substantially dust free.

2. a. The Contractor shall distribute the asphaltic material at a uniform rate of 0.30 Gal/SY (1.36 L/m²).

b. The distributor shall meet the requirements of Subsection 501.02, Paragraph 5.

c. Hand sprayers may be used to coat small and irregular sections.

3. Asphaltic material shall not be applied if the ambient temperature is below 50°F (10°C).

4. The surface shall be dry before asphaltic materials are applied.

517.04 -- Method of Measurement

1. Asphaltic materials are measured by the gallon (liter) at 60°F (16°C).

517.05 -- Basis of Payment

1. Pay Item

Prime Coat Asphaltic Oil

Pay Unit

Gallon (Gal) [Liter (L)]

2. Any amount of Prime Coat asphaltic oil which is outside the specified property ranges of Table 517.01, shall be paid for at the contract unit price multiplied by the pay factor determined in Table 517.01. If the resultant pay factor for the material indicates rejection as an option, the Engineer will determine if the non-compliant material will be removed.

Table 517.01

Tolerances and Pay Factors		
Specified Property	Deviation Tolerance	Pay Factor
Residue from distillation, volume percent of sample by difference.	$\leq -1.0\%$	1.00
	-1.1% to -3.0%	0.85
	-3.1% to -5.0%	0.70
	$> -5.0\%$	0.40 or Reject
Pay Factors for Tests for all other Properties Specified* 1.00 for deviation of \pm less than or equal to 10% 0.75 for a deviation of \pm greater than 10% to less than or equal to 25% 0.40 or Reject for deviation of \pm greater than 25% * When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied to the listed criteria. Note: When more than one specified property exceeds specification tolerances, the single largest Pay Factor Reduction will be the one applied.		

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 30 days of receiving the written notification of deficiency.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Payment is full compensation for all work described in this Section.

SECTION 518 -- FABRIC REINFORCEMENT

518.01 -- Description

1. This work shall require the Contractor to furnish and place a reinforcing fabric, crack repair system on joints or cracks as shown in the contract or as directed by the Engineer.

518.02 -- Material Requirements

1. The repair fabric shall consist of fiberglass grid and shall conform to the following requirements:

Table 518.01

Mechanical Properties	
Material	Fiberglass reinforcement grid coated with an elastomeric polymer
Grid size	0.5 inch x 0.5 inch or 1.0 inch x 1.0 inch
Tensile strength across	1100 pounds / inch Minimum
Tensile strength along	550 pounds / inch Minimum
Weight	16 oz. / square yard Minimum
Roll width	4.5 feet Minimum

2. Fabric reinforcement materials approved for use are shown on the Department's Approved Products List.

518.03 -- Construction Methods

1. The fabric reinforcement shall be applied immediately before the placement of the bituminous overlay. The materials and application method shall resist shoving and lifting during placement of the bituminous overlay.

2. The Contractor shall follow the recommendations of the manufacturer in placing the fabric reinforcing system, including preparing the surface, joints, and cracks on which the system is to be applied. Substitutions involving any element of a system will not be allowed without the written approval from the manufacturer and concurrence of the Engineer.

3. Manufacturer installation instructions shall be provided to the Engineer two weeks prior to installation.

4. The fabric shall be placed on the leveling course asphaltic concrete pavement centered on the crack or joint. The fabric shall be placed at temperatures of 50°F or above. The pavement surface on which the fabric is to be placed shall be dry and free of dirt, debris and other foreign matter.

5. Immediately after placement, the fabric shall be rolled with a pneumatic roller to ensure a good bonding between the fabric and the roadway. At no time will traffic, except minimal construction traffic, be allowed on the placed fabric.

6. The application of the materials will be accepted by visual examination and satisfactory initial performance.

518.04 -- Method of Measurement

1. Fabric reinforcement repair will be measured by the total length in linear feet (meters).

518.05 -- Basis of Payment

1. Pay Item	Pay Unit
Fabric Reinforcement Crack Repair	Linear Feet (LF) [Meter (m)]

2. Payment is full compensation for all work described in this Section and all fabric reinforcement system manufacturer's requirements.

SECTION 519 -- CRACK SEALING BITUMINOUS SURFACING

519.01 -- Description

1. This work shall consist of preparing and sealing the transverse and longitudinal cracks in bituminous surfacing at the various locations shown in the contract.

519.02 -- Material Requirements

1. NE-101, NE-CR18B, NE-3405, and NE-3405LM shall include the following for ASTM D5329:

a. Sections 6.4 and 12.4 "Specimen Preparation" shall have the reference of "177 ml (6 oz.)" replaced with "3 oz."

b. Section 6 "Cone Penetration, Non-immersed" shall be superseded with the following exceptions:

(1) Section 6.5 "Procedure" is void and superseded by the following:

Place the specimen in a water bath maintained at $77 \pm 0.2^{\circ}\text{F}$ ($25 \pm 0.1^{\circ}\text{C}$) for two hours immediately before testing. Remove the specimen from the bath and dry the surface by shaking gently to remove free water from the surface of the specimen. Using the apparatus described in Section 6.3, make one determination at or near the center of the specimen. Take care to ensure the cone point is placed on a point in the specimen that is representative of the material itself, and is free of dust, water, bubbles, or other foreign material. When testing higher rubber content sealants, ensure that the point of the cone is not placed on a piece of rubber.

(2) Section 6.6 "Report" shall be amended to include "Record the value as the penetration of the specimen in dmm units."

c. Section 12 "Resilience" shall be superseded with the following exceptions:

(1) Section 12.5 "Procedure", void the sentence "Make determinations at three points equally spaced from each other and less than 13 mm (1/2 inch) from the container rim." and supersede with the sentence "Make one determination at or near the center of the tin."

(2) Section 12.6 "Report" is void.

2. Packaging

a. The sealant can be packaged in either cardboard box or wholly-meltable type containers.

b. Cardboard box containers shall be manufactured from double wall kraft board producing a minimum bursting test certification of 350 PSI (241 N/cm²) and using water-resistant adhesives. The use of metal staples or fasteners of any kind will be prohibited for closing the lids of the boxes. Tape or other like material is acceptable.

c. The sealant shall be in melttable [300°F (149°C)] polyethylene bags.

d. Wholly-meltable type containers, and any of their components, shall be fully melttable and integrational with the sealant by the time the manufacturer's minimum application temperature is reached.

e. The wholly-melted and integrated container must not adversely affect the test specifications of the sealant.

f. Each individual container shall include information regarding manufacturer, lot or batch number, type of product, minimum application temperature, and maximum heating temperature. The maximum heating temperature must be at least 20°F (11°C) higher than the minimum application temperature.

3. Sample conditioning, preparation, and heating for NE-101, NE-CR18B, NE-3405, and NE-3405LM shall be in accordance with ASTM D5167 with the following exceptions:

a. The following sentence of 8.1.2, “Also, if present, remove container liner by cutting it away”, is void and superseded by the following:

“Also, if present, as much of the polyethylene bag as possible, shall be removed by cutting it away. Wholly-meltable type container in contact with the sample section shall be left in place.”

b. The last sentence of 8.1.2 is void and superseded by the following:

The entire vertical section which has been cut shall be placed into the pot for melting.

c. The Section of 8.2.2.1 “Solid Materials” is void.

d. The Section of 8.2.3 is void and superseded by the following:

After the solid segment is added to the melter, the material shall be allowed to minimally melt to a uniform viscous state suitable for the installation of the stirrer or paddle. The sample shall then be stirred for one full hour. The oil bath temperature shall be regulated to bring the material to the maximum heating temperature within the one hour of stirring.

e. The Section of 8.2.4.1 is void and superseded by the following:

During the one full hour of stirring, check the temperature of the material at maximum 15 minute intervals using a Type K thermocouple with the calibration verified in accordance with Section 6.1.7 to ensure conformance with the specified temperature requirements. Stop the mechanical stirrer when measuring temperatures. If material temperatures ever exceed the maximum heating temperature, or ever drop below the minimum application temperature after the maximum heating temperature was reached, discard the sample and re-do the heating. Maintain appropriate records of times and temperatures to verify conformance with specification requirements.

f. The Section of 8.2.4.2 is void.

4. NE-101

a. The sealant shall be a mixture of paving grade asphalt, vulcanized recycled rubber, and polymer modifier(s) that conform to the following requirements and Specifications:

(1) The sealant shall be a pre-reacted blend of product. The sealant shall not require additional heating time for application after it has reached the manufacturer’s recommended minimum application

temperature. New material may be added to the material that has already been heated to the minimum application temperature.

(2) When heated in accordance with ASTM D5167 to the maximum heating temperature, the sealant shall meet the parameters in Table 519.01.

Table 519.01

Test	Specification
Cone Penetration, non-immersed, 77° F (25° C) (ASTM D5329)	45-70 dmm
Cone Penetration, non-immersed, 39.2° F (4°C) (ASTM D5078)	30 dmm minimum
Resilience, 77° F (25° C) (ASTM D5329)	30% minimum
Softening Point (ASTM D36)	195° F (91°C) min.
Ductility, 77° F (25° C) (ASTM D113)	30 cm. minimum
Asphalt Compatibility, 140° F (60° C), 72 hours (ASTM D5329)	Pass ⁽¹⁾
Bitumen Content (ASTM D4)	60% minimum
Tensile Adhesion (ASTM D5329)	500% minimum
Flow, 140° F (60° C), 5 hours (ASTM D5329)	3 mm. maximum
Flexibility, Mandrel Bend, 0° F (-18° C), 1" mandrel, 90 degrees, 10 sec. Sample strip size is 3" long, 1" wide, 0.125" thick. (ASTM D3111, modified)	Minimum 2 of 3 specimens shall pass.
Recycled Rubber Content (by total weight of product). Extraction by ASTM D2172, Method A	10 – 15% ⁽²⁾
<p>Notes:</p> <p>(1) There shall be no failure in adhesion, or formation of an oily exudate at the interface between the hot pour filler and the asphalt concrete specimen, nor softening or other deleterious effects on the asphaltic concrete or hot pour filler.</p> <p>(2) Due to the interlace variations of the asphalt/rubber matrix, a +/- 2% testing tolerance deviation from specification is allowable.</p>	

d. The vulcanized recycled ground rubber shall be free of wire, fabric, or other contaminating materials. The gradation shall be 100% passing the No. 8 sieve (2.36 mm) and a maximum of 5% passing the No. 200 (75 µm) sieve.

5. NE-CR18B

a. The sealant shall be a mixture of paving grade asphalt, vulcanized recycled rubber, and other additives such as polymer modifier(s), that conform to the following requirements and Specifications:

(1) The sealant shall be a pre-reacted blend of product. The sealant shall not require additional heating time for application after it has reached the manufacturer's recommended minimum application temperature. New material may be added to the material that has already been heated to the minimum application temperature.

(2) When heated in accordance with ASTM D5167 to the maximum heating temperature, the sealant shall meet the Nebraska Specifications of CR18B, as noted in Table 519.02.

Table 519.02

Test	Specification
Cone Penetration, non-immersed, 77° F (25° C) (ASTM D5329)	50 – 90 dmm
Flow, 140° F (60° C), 5 hours (ASTM D5329)	5.0 mm. max.
Resilience, 77° F (25° C) (ASTM D5329)	25 – 60%
Bond, non-immersed, -20° F (-29° C) 50% extension (1/2" specimen) (ASTM D5329)	Pass 3 cycles (ASTM D6690, Table 1, Note A)
Flexibility, Mandrel Bend, -29° F (-34° C), 1" mandrel, 90 degrees, 10 sec. Sample strip size is 3" long, 1" wide, 0.125" thick. (ASTM D3111, modified) ⁽¹⁾	Minimum 2 of 3 specimens shall pass.
Asphalt Compatibility, 140° F (60° C), 72 hours (ASTM D5329)	Pass ⁽²⁾
Recycled Rubber Content (by weight of asphaltic components). Extraction by ASTM D2172, Method A	18% Minimum ⁽³⁾
<p>Notes:</p> <p>(1) Concrete blocks will be constructed by the Department's Concrete Laboratory. The materials used are a common design in Nebraska concrete paving specifications. The design is a 47B concrete mixture as specified in Section 1002 of the NDOT Standard Specifications. The design is amended to not include flyash; all other specifications for Portland Cement Concrete apply.</p> <p>(2) There shall be no failure in adhesion, or formation of an oily exudate at the interface between the hot pour sealant and the asphalt concrete specimen, nor softening or other deleterious effects on the asphaltic concrete or hot pour sealant.</p> <p>(3) Due to the interlace variations of the asphalt/rubber matrix, a 2% testing tolerance deviation from specification is allowable.</p>	

b. The vulcanized recycled ground rubber shall be free of wire, fabric, or other contaminating materials. The gradation shall be 95-100% passing the No. 10 (2.00 mm) sieve, 35-55% passing the No. 20 (850 µm) sieve, and 0-25% passing the No. 40 (425 µm) sieve.

6. NE-3405

a. The sealant shall conform to the requirements of ASTM D6690, Type II. The material shall conform to the requirements of Table 1, with the following exceptions.

(1) The test of Bond, non-immersed, ASTM D5329, 3 specimens through 3 cycles shall be run at 0°F, (-18 °C), 100% extension.

(2) The concrete blocks will be constructed by the Department's Concrete Laboratory. The materials used are a common design in Nebraska concrete paving specifications. The design is a 47B concrete mixture as specified in Section 1002 of the NDOT Standard Specifications. The design is amended to not include fly ash; all other specifications for Portland Cement Concrete apply.

7. NE-3405LM (Low Modulus)

a. The sealant shall conform to the requirements of ASTM D6690, Type IV. The material shall conform to the requirements of Table 1, with the following exception:

b. The concrete blocks used in the test of Bond, non-immersed, ASTM D5329, will be constructed by the Department's Concrete Laboratory. The materials used are a common design in Nebraska concrete paving specifications. The design is a 47B concrete mixture as specified in Section 1002 of the Standard Specifications. The design is amended to not include flyash; all other specifications for Portland Cement Concrete apply.

8. Acceptance Requirements

a. Acceptance of the manufactured material is based on pre-approval by either on or off-site sampling. Acceptable hot pour sealant lots are listed on the Department's Approved Products List.

b. Department on-site field sampling shall be in accordance with the Department's Materials Sampling Guide.

c. Off-site (Proxy) sampling shall be in accordance with ASTM D5078.

(1) Proxy sampling shall be overseen by an outside party approved by the Department, preferably another DOT Agency. Proxy samples shall include a manufacturer's Certificate of Compliance. Proxy samples shall also include a dated signature of origin by the Representative that is not affiliated with the manufacturer, and can either be on the Certificate of Compliance, or separate letter.

(2) For convenience in both sampling and shipping samples, sample containers smaller than a manufacturer's usual production containers are allowed, as long as the sample is a minimum of 1500 grams.

(3) Samples shall be sent to the Department, or alternatively, sent to a Department approved independent laboratory for testing which will be at no cost to the Department. If a Department approved independent laboratory is used, the Department shall be notified so that concrete blocks can be sent for any required Bond testing.

519.03 -- Construction Methods

1. Preparation of Transverse and Longitudinal Cracks

a. Cracks shall be prepared as follows:

(1) Cracks 3/8 inch (10 mm) or less in width shall be widened using a router to form a reservoir which is 1/2 inch (12.5 mm) wide by 3/4 inch (20 mm) to 1 inch (25 mm) deep. The crack shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material, and moisture so that at the time the sealant is applied, the crack will be clean and dry.

(2) Cracks wider than 3/8 inch (10 mm) shall be cleaned for the entire crack depth using sandblasting, or brushing and air-blowing techniques as required to provide a crack free of all dust, dirt, loose material and moisture. It may be necessary to remove incompressibles deep in the crack by gouging or plowing.

(3) A hot air heat lance shall be used to warm the sidewalls of the crack immediately prior to placing the sealant.

b. The surface of the bituminous pavement shall be dry at the time of crack preparation and sealing operations.

c. No more than 500 linear feet (150 m) of crack preparation shall be left unsealed after the end of each working day. The Engineer will inspect any prepared crack, left unsealed at the end of each working day to determine if they need to be recleaned prior to being sealed.

2. Sealing Transverse and Longitudinal Cracks

a. When the sealant reaches the minimum application temperature, the crack shall be filled using a pressure type applicator equipped with a nozzle that will fit into the crack. The design of the pressure applicator and nozzle shall be approved by the Engineer. The crack shall be filled with sealant from the bottom up. The crack shall be slightly overfilled with sealant and squeegeed to surface level leaving a 2 to 4 inch (50 to 100 mm) width of sealant over the crack. In no case shall the temperature of the sealant fall below the minimum, or exceed the maximum recommended by the manufacturer during application.

3. Existing cracks previously routed and sealed, shall be re-routed, if applicable, and cleaned for the entire crack depth using sandblasting, or brushing and air-blowing techniques as required to provide a crack free of all dust, dirt, loose material and moisture. It may be necessary to remove incompressibles deep in the crack by gouging or plowing; reseal as above. This operation also includes previously sealed cracks that have not been routed. The Contractor is responsible for cleaning up and discarding all removed crack sealing material and debris.

519.04 -- Method of Measurement

1. The work of crack sealing bituminous surfacing will be measured for payment by the linear foot (meter) of cracks sealed.

2. Measurement shall be to the nearest foot (0.3 m), complete, in place and accepted by the Engineer.

519.05 -- Basis of Payment

1. Pay Item	Pay Unit
Crack Sealing Bituminous Surfacing	Linear Feet (LF) [Meter (m)]

2. When sealant materials comply with the Specification requirements, crack sealing shall be paid for at the contract unit price per linear foot (meter).

a. When testing of on-site sealant materials is outside of the specified property ranges, crack sealing shall be paid for at the contract unit price multiplied by the Pay Factors in Table 519.03.

Table 519.03

Pay Factor	Specified Property
1.00	Deviation of up to (+/-) 5.0%
0.95	Deviation of (+/-) 5.1% to 10.0%
0.90	Deviation of (+/-) 10.1% to 15.0%
0.80	Deviation of (+/-) 15.1% to 20.0%
0.70	Deviation of (+/-) 20.1% to 25.0%
0.40 or Reject	Deviation of 25.1% or greater

(1) When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied according to the above table.

(2) When more than one specified property exceeds specification tolerances, the single largest pay factor reduction will be the one applied.

(3) Material not meeting a Pass/Fail requirement falls under the Pay Factor of 0.40 or reject.

b. If the material is found to be out of specification, the material shall be rejected if not already used. All material out of specification, regardless of pay factor, not in place shall be rejected and removed from the site.

c. If the pay factor is less than 1.00 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material is determined by the above pay factor table.

d. Material that exhibits unacceptable field application will be rejected and removed from the approved products list. Material already used shall be removed and replaced at no cost to the Department.

3. When disputes arise in test results, the Department will select an approved independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. The Contractor shall initiate the dispute resolution in writing to the Engineer within 30 days of receiving the notification of deficiency.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Payment is full compensation for all work described in this Section and all sealant manufacturer's requirements.

SECTION 520 -- BITUMINOUS PATCHING OF CONCRETE PAVEMENT

520.01 -- Description

1. This work shall consist of repairing deteriorated joints and panels in the concrete pavement with bituminous material. The work will be performed at locations shown in the contract or designated by the Engineer. This work shall include removing and disposing of deteriorated pavement and/or existing bituminous patching material, preparation of the repair areas, and furnishing, placing, and compacting the bituminous patch material in the repair area.

520.02 -- Material Requirements

1. The patching material shall be composed of a suitable aggregate, plant-mixed with a liquid asphalt blend. The bituminous material shall be capable of coating aggregates without stripping. The patching material shall be capable of maintaining adhesive qualities in patched areas which are damp or wet at time of application.

2. Bituminous Material - The bituminous material shall consist of a liquid asphalt blend with chemical additives capable of coating wet aggregates without stripping. The binder shall be homogeneous, free from water, and shall not foam when heated to mixing temperature. The bituminous material shall meet the following requirements:

Requirement	Criteria
ASTM D-1310	Flash Point (TOC): 200°F (94°C)
AASHTO T201 or ASTM D-2170	Kinematic Viscosity at 140°F (60°C): 300-4000
AASHTO T55 or ASTM D-95	Water: 0.2% Maximum
AASHTO T78 or ASTM D-402	Distillate Test (Volume of original sample): To 437°F (225°C): None To 260° C (500° F): 0-5% To 315° C (600° F): 0-25% Residue from Distillate at 360° C (680° F): 72-95%
Residue Tests:	
AASHTO T202 or ASTM D-2171	Abs. Viscosity at 140°F (60°C): 125-425 Poise
AASHTO T49 or ASTM D-5	Penetration: 200 Minimum
AASHTO T51 or ASTM D-113	Ductility at 39°F (4°C) 1 cm/min: 100 Minimum
AASHTO T44 or ASTM D-2042	Solubility in Trichloroethylene: 99% Minimum

3. Aggregate - The aggregate shall consist of a crushed limestone complying with the following requirements:

English Sieve Size (Metric)	Percent Passing
3/8 inch (3.5 mm)	90-100
No. 4 (4.75 mm)	20-55
No. 8 (2.36 mm)	5-30
No. 16 (1.18 mm)	0-10
No. 50 (300 µm)	0-5

Requirement	Criteria
AASHTO T104 or ASTM C-88	Soundness Loss (Sodium-5 Cycles): 12.0% Max.
AASHTO T96 or ASTM C-131	Los Angeles Abrasion Loss: 40.0% Max.
AASHTO T-11 or ASTM C-117	-200 Sieve (75 µm) (By Wash): 2.0% Max.
AASHTO T-85 or ASTM C-127, 128	Absorption: 1.0%-2.5%
AASHTO T-85 or ASTM C-127, 128	Specific Gravity: 2.55-2.75 Other Deleterious Matter:
NDOT T504	Soft Pieces 3.0% Max.
NDOT T504	Coal and Lignite 1.0% Max.
NDOT T504	Shale 2.5% Max.

4. Composition of Mixture - The mixture shall consist of the bituminous material and aggregate as described above, plant-mixed in such a manner as to contain a minimum of 100 lbs. (45.4 kg) of bituminous material for each finished ton (.9 Mg).

5. Certification - The bituminous patching material will be accepted on the basis of a producer certification of the finished product. Bituminous patching materials approved for use are shown on the Department's Approved Products List as cold mix.

520.03 -- Construction Methods

1. The Engineer shall designate the areas to be repaired. If the patch area is greater than 10 sq. ft. (0.9 m²), then the Engineer must approve either a bituminous repair or a Portland cement concrete (PCC) repair. A PCC repair will be done as extra work if PCC repair is not a bid item. The deteriorated concrete shall be removed to a minimum depth of 4 inches (100 mm) or to sound concrete. The deteriorated concrete may be removed to a depth specified with a self-propelled milling machine or a 35 pound (15.9 kg) maximum jack hammer. The operation of the machine must be closely monitored to insure that the impact and vibration of the milling head will not cause damage to the slab outside of the area designated for patching. The radii at the ends of each milled area must be cut to a reasonably neat vertical face with a 15 pound (6.8 kg) chipping hammer. For areas smaller than the milling head, removal must be accomplished with a 35 pound (15.9 kg) jack hammer or other equipment approved by the Engineer.

2. After the deteriorated concrete and/or the existing bituminous patching material has been removed to the extent practical, the spalled areas at the joints or in the concrete slab shall be thoroughly cleaned.

3. After the repair area has been cleaned and dried, the bituminous patching material shall be placed using hand methods to assure complete filling of the repair areas. The repair areas shall be slightly overfilled with bituminous material and compacted to a density that is satisfactory to the Engineer. A mechanically powered hand-held tamper shall be used for the smaller areas and a steel drum vibratory roller, minimum 2.5 ton (2.3 Megagram), shall be used on the other repair areas. The layer of the bituminous material shall not be in excess of that which the equipment is capable of compacting to a uniform density throughout the layer.

4. Old concrete and/or bituminous patching material that is removed shall become the property of the Contractor and shall be removed from the project. The material shall be disposed of in accordance with Section 203.

5. The bituminous patching of the concrete pavement shall be accomplished at the same time the traffic lane is closed for concrete joint and panel repair.

6. The deteriorated concrete pavement and/or the existing bituminous patch material shall be removed and the patch completed during daylight hours in the same working day.

7. If asphaltic concrete for patching is not available when the pavement repair or joint repair work is performed, and the drop-off created by the repair is greater than one inch (25 mm), the drop-off will be feathered a minimum of three foot (900 mm) in length for each inch (25 mm) in height with a commercially available cold-mix bituminous mixture, or other suitable temporary patch material with a durable surface approved by the Engineer. The Contractor will be required to maintain normal traffic flow across these patches while they are in service. Where it has been necessary to use these "temporary patches", they will be removed, the area cleaned out, and the required permanent asphaltic concrete patch placed. The material, installation, maintenance, removal and disposal of these temporary patches will not be measured and paid for directly, but shall be considered subsidiary to the concrete pavement repair or concrete joint repair work being performed. The asphaltic concrete for the permanent patches shall be any available hot-mix bituminous mixture approved by the Engineer. The hot-mix material will be subsidiary to the items for which direct payment is provided.

520.04 -- Method of Measurement

1. a. The "Bituminous Patching" shall be measured for payment in tons (megagrams) on approved scales.

b. The scale tickets shall be prepared in duplicate. The truck driver shall carry the original scale ticket, and copy, for each load. The truck driver shall give the copy to the Engineer at the delivery point.

c. (1) The measured quantity shall be the total weight of bituminous patching shown on the scale ticket without deduction for the asphalt binder in the mixture.

(2) The Engineer shall deduct the weight of all material lost, wasted, damaged, rejected, or applied contrary to these Specifications.

2. The tonnage (mass) shall be the actual weight of the mixture including the liquid asphalt and the chemical additive.

520.05 -- Basis of Payment

1. **Pay Item**

Bituminous Patching

Pay Unit

Ton (Tn)

[Megagram (Mg)]

2. Payment is full compensation for all work described in this Section and all sealant manufacturer's requirements.

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CONCRETE PAVEMENTS**

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SECTION 601 -- GENERAL REQUIREMENTS

601.01 -- General

1. This Section describes materials, procedures and equipment that are common to items of work described in Division 600. The requirements in Section 601 are applicable to all work, unless otherwise indicated.

2. The Contractor shall protect concrete pavement from any damage including but not limited to damage due to precipitation or freezing conditions.

3. The Contractor shall replace any concrete damaged by precipitation, freezing, or other conditions at no additional cost to the Department.

4. The Contractor shall always have materials readily available to protect the surface and the edges of the concrete.

5. No section of concrete pavement will be opened to traffic without providing the Engineer adequate advance notice to inspect joints, check the pavement surface, and schedule the coring unit.

6. The method used to place concrete shall not allow the concrete materials to segregate or displace reinforcing steel. The impact of any free fall must be kept to the lowest levels consistent with efficient placement.

7. Curing compounds shall not be placed on any surface that will be bonded to another concrete surface.

8. The Department is responsible for the initial cores on all Portland cement concrete pavement.

601.02 -- Equipment

1. a. All placing and finishing equipment shall be at the job site one full NDOT work day before its intended use to allow the Engineer time to examine it.

b. On small urban projects, the equipment will be examined before the work starts. However, the equipment need not be on site 1 day before the paving.

2. Garden rakes shall not be used to handle or move concrete.

3. Equipment shall meet the requirements of Section 1002.

4. The subgrade profiling equipment shall be capable of meeting the Construction methods of Section 302. Electronically controlled profiling equipment will not be required when subsequent construction uses formed construction methods.

5. Concrete spreaders shall be self-propelled and able to spread and strike off concrete. The spreader may be an independent machine or combined with the finishing machine. Mechanically drawn strike off blades shall not be employed unless hand finishing methods are allowed. Self-propelled concrete spreaders shall be equipped with the following devices:

a. A power-driven system capable of uniformly spreading the concrete transversely without segregation.

b. An adjustable strike-off screed capable of leveling the concrete surface at the required elevation inside the forms.

c. Vibrators capable of uniformly consolidating the full depth and width of the concrete.

6. a. Concrete pavement finishing machines shall be self-propelled and capable of leveling, consolidating, and floating the concrete.

b. The finishing machine shall travel at a controlled speed such that it produces a uniform, well consolidated pavement that does not contain large voids or torn pavement.

c. All finishing machines shall finish the pavement to the required cross section.

7. All spreading and finishing equipment operating on forms shall be equipped with scrapers to keep the top of the paving form free of concrete.

8. The wheels of finishing equipment operating on previously placed pavement shall be rubber faced. Track propelled equipment should be equipped with rubber protective pads on the crawler tracks, or the tracks shall travel on cushions of wood or belting. The near edge of wheels or tracks shall not be closer than 3 inches (75 mm) from edge of pavement. Provisions must also be made to prevent the screed from damaging the edge of the existing pavement surface.

9. a. Internal vibrating equipment shall be used ahead of the finishing machine.

b. Vibrators shall not contact the side forms, dowel bars or reinforcing steel, nor transmit vibration to finishing machines or spreaders.

c. Vibrators shall consolidate the full depth and width of the concrete in a single pass so that a uniform density is achieved without mix segregation or creation of excessive surface mortar. The vibrators shall be operated only when the machine to which they are attached is moving. The vibrators shall be placed to minimize overlap vibration.

d. The Contractor shall always have a tachometer available to monitor vibrator frequency. The vibrator frequency shall be within the manufacturer's specifications not to exceed 9,000 vpm.

10. a. The Contractor shall use a 10 foot (3 m) straightedge to continuously check the concrete surface smoothness. The allowable surface tolerance is 1/8 inch (3 mm).

b. The Contractor shall use a straight steel channel [10 feet (3 m) long by 6 inches (150 mm) deep] to check the alignment of the straightedge.

c. Sufficient straightedges shall be available to maintain continuous paving operations.

11. Equipment required to install pavement joints is as follows:

a. Air compressors shall be portable and able to maintain a nozzle air pressure of 90 psi (620 kPa) or greater. Suitable traps shall maintain the compressed air free of oil and moisture.

b. Sandblasting equipment shall be of proper size and capacity to obtain the cleaning specified and shall operate at an air pressure of at least 90 psi (620 kPa). Nozzles shall be sized to the width of each joint.

c. Motor driven wire brushes shall have a stiff wire brush wheel able to clean the full depth of the joint face openings at not less than 1000 rpm. The motor and brush shall be mounted on a frame with wheels and handles to move the unit along the joints to be cleaned. Brush rotation shall move debris away from the operator.

d. Joint saws

(1) The saw shall be equipped with an adjustable guide.

(2) The joint cut shall be made with a diamond-toothed blade.

(3) The blade shall be water-cooled.

(4) Two joint saws shall always be maintained on the project.

(5) In an emergency, dry sawing is allowed with the Engineer's approval.

e. Early-cut system joint saws.

(1) The early-cut system saw may use an abrasive type cutting blade.

(2) The early-cut saw blade may be air cooled.

f. The hot-poured joint compound heater shall mechanically agitate the compound. A flame will not be allowed to contact the container surface. The melting unit shall heat the material according to the manufacturer's specifications to a pouring consistency without damaging the joint compound.

g. A pressure type joint filling machine with a mixing unit shall be used. Hand caulking guns may be used in places that are inaccessible to the pressure equipment.

SECTION 602 -- PORTLAND CEMENT CONCRETE PAVEMENT SMOOTHNESS

602.01 -- General

1. This Specification establishes a standard for Portland cement concrete pavement smoothness, and defines defective pavement smoothness. The intent of the specification is to produce a finished Portland cement concrete pavement driving surface with an International Roughness Index (IRI) no greater than 99 inches per mile.

2. Pavement smoothness will be evaluated as described in this section when the pay item "Portland Cement Concrete Smoothness Testing" is included in the contract.

3. When the pay item "Portland Cement Concrete Pavement Smoothness" is not included in the contract, the Contractor shall test the hardened concrete for surface irregularities with a non-contact inertial pavement profiler, a 10 foot (3 m) straightedge, or an approved device at the Engineers discretion. Areas showing high spots in excess of 1/8 inch (3 mm) in the 10 foot (3 m) span will be plainly marked and ground to the required profile.

602.02 -- Equipment

1. The Contractor shall furnish a non-contact inertial pavement profiler (profiler) that meets the requirements of ASTM Standard E 950, certified by the manufacturer. The profiler shall be certified by the Department that it meets the ASTM Standard E 950 requirements.

2. The profiler may be a lightweight version or a high speed version.

3. The profiler shall be equipped with a computerized system that will record, analyze, and print the test data. The profiler shall be equipped with a guide bar and a large footprint height sensor specifically designed for surface profile measurements on textured Portland cement concrete surfaces.

4. The profiler shall produce a printed pavement profile summary report. The report shall include the following information.

- a. Project number
- b. Test date
- c. Traffic lane
- d. Test direction
- e. Test path
- f. Pass number (1 for initial test; 2, 3, etc. for repeat runs)
- g. Operator's name
- h. Project stations
- i. Data filter values
- j. IRI values for each test section
- k. California profilograph emulation traces (profilograms) for each test section
- l. Bump and dip locations for each test section, as determined by California profilograph emulation

602.03 -- Certification and Independent Assurance Testing

1. The Department will calibrate and certify the Contractor's profiler annually at a test site established by the Department.

a. The profiler will be inspected for compliance with general equipment requirements, including data analysis system, guidance system, and overall condition.

b. The profiler will be calibrated for distance measurement by moving it over the described path of a premeasured test distance to determine its distance calibration factor.

c. The profiler will be checked for vertical measurement accuracy by performing the height measurement calibration procedure described in Section 6 of AASHTO R 056, Certification of Inertial Profiling Systems.

d. The profiler will be checked for overall performance by operating it over the described path of a premeasured pavement test section at its normal operating speed.

e. Distance measurement indicated by the profiler shall be within 0.2% tolerance of the actual premeasured test section distance. To ensure accurate distance measurement during test runs, the air pressure of the distance measurement tire must always be maintained at the same pressure.

f. The IRI reported by the profiler for the test section shall be within 10.0% tolerance of the IRI reported by a Department profiler for the same test section.

g. A dated and signed decal will be placed on the profiler to certify its acceptability for use on Department pavement construction projects.

2. The Department will certify the Contractor's profiler operator at least every 5 years. The operator may be certified by presenting certification from another state highway agency or by completing certification training conducted by the Department.

3. The Department will perform Independent Assurance tests for the Contractor's profilers and operators at least once per construction season. Independent Assurance testing will be conducted at a randomly selected time on an active construction project. The criteria for the test will be similar to those used for certification.

602.04 -- Profilograph Test Procedures

1. The Contractor shall perform all pavement smoothness specification tests with a Department certified profiler.

2. The Engineer will furnish a report form to the Contractor identifying all required test sections.

a. The pavement surface will be divided into lane-width segments that end at a bridge, railroad crossing, or other designated termini.

b. The lane-width segments will be further divided into individual 528 feet (200 m) long test sections, in the direction of project stationing. The last test section in a segment is usually shorter than 528 feet (200 m).

c. If a test section is less than 300 feet (100 m) long, it will be combined with the preceding 528 feet (200 m) long test section for analysis.

3. The Contractor's certified profiler operator shall perform smoothness specification tests in the Engineer's presence.

4. Smoothness testing shall be performed during normal daylight working hours unless otherwise approved by the Engineer.

5. The profiler operator shall perform pavement smoothness measurements in the right-hand or left-hand wheel path of all driving lanes and shall be performed in the direction of traffic, as directed by the Engineer, including climbing and fly-by lanes. The wheel path is the path followed by the right or left wheels of a truck or car traveling in the center of a traffic lane. It is assumed to be 3 feet from the left or right lane lines. In urban areas, where inlet block-outs or manholes are in the right- or left-hand wheel path, the pavement smoothness measurements shall be made in a location determined by the Engineer.

6. The Contractor shall remove all objects and foreign material from the pavement surface before testing, including any extra run-in or run-out lengths required for the profiler.

7. The profiler operator shall guide the profiler along the specified wheel path of each traffic lane at a constant speed and directional path throughout the length of pavement being tested. The speed of the profiler must be within the speed range recommended by the manufacturer. Sudden changes in speed or direction during a test run will disqualify that test, and a new test must be performed.

8. A lateral location indicator shall be used to align the profiler in the required test path during testing. Pavement edges, longitudinal joints or longitudinal pavement markings may be used as reference lines.

9. Before testing, the profiler operator shall perform routine check procedures of the measurement system as recommended by the manufacturer. To ensure consistent distance measurement, the profiler operator shall also check and adjust the distance recording wheel tire pressure several times a day.

10. All station references on the profiler reports shall be actual project stations. Stations shall be accurately noted on any printed profiles at least every 100 feet (25 m). The distance measured by the profiler shall compare within 0.2% of the actual distance tested, as determined using project stationing, for all testing and retesting runs. Test runs that do not compare within 0.2% will disqualify that test. New tests must be performed for all disqualified tests, following calibration of the distance measuring system

11. Immediately after completion of the tests, the profiler operator and the Engineer shall sign and date any printed reports and profiles to verify their authenticity. The signed prints then immediately become the property of the Department. Failure to do so will disqualify the tests. The test shall be re-run by the Contractor at no additional expense to the Department. Upon completion of the project, the data files shall be given to the Engineer in a Pro-VAL-compatible file.

12. The Engineer will perform or schedule verification tests on at least 10% of the lane miles of pavement surface, with a Department profiler. This verification testing will be performed in conjunction with the Contractor's profile testing. The Contractor's IRI results shall be within 10% of the Departments IRI results.

13. If the verification test, Independent Assurance tests, or other observations indicate that the Contractor's procedures or results are not acceptable and/or accurate, the Engineer may do any or all of the following:

- a. Require the Contractor to calibrate the profiler and re-run the tests on some or all previous projects in the current construction season.
- b. Disqualify the Contractor's equipment or operator.
- c. Perform the tests for part, or all, of the project with a profiler owned by the Department, and charge the Contractor \$500.00 per lane mile for all testing done by the Department.

14. The following areas of pavement shall be excluded from the IRI requirements.

a. Pavement on horizontal curves having a centerline radius of curvature of less than 1,000 feet (300 m) and pavement within the superelevation transition of such curves.

b. Pavement within 50 feet (15 m) of a transverse joint that separates the pavement from an approach slab to a bridge deck or existing pavement not constructed under the contract.

c. Pavement for truck weigh stations, rest areas, acceleration/ deceleration lanes, and interchange ramps and loops.

d. Pavement within 50 feet (15 m) of railroad crossing and associated transitions.

e. Pavement with a posted speed limit of 45 miles per hour or less.

f. Mandated blockouts for access at intersections and driveways including 50 feet (15 m) on either side.

g. Pavement that would require handwork by normal industry practices.

h. Additional exceptions shown on the summary sheet in the plans.

15. Excluded pavement sections shall be measured for bumps and dips by the Contractor with a profiler or a 10 foot (3m) straight edge. If the profiler is used, the bump or surface deviation shall not exceed 0.30 inch (7.6 mm) in 25 feet. The deviation of the surface shall not exceed 1/8 inch (3 mm) if a 10 foot (3 m) straight edge is used.

602.05 -- Evaluation

1. The Contractor shall determine the IRI and number of correctable bumps and dips for each test section, record the information on the report form, and provide a copy of the report, along with the corresponding printed reports and profiles, to the Engineer.

a. The International Roughness Index (IRI) shall be calculated by the profiler software using the quarter-car simulation. IRI shall be reported in units of inches per mile.

b. Correctable bumps shall be separately identified by the profiler software in a summary report using the California profilograph emulation. Bumps will appear as high points on the printed profile, and correspond to high points on the pavement surface. Correctable bumps are vertical deviations on the pavement surface that exceed 0.30 inch (7.6 mm) in height above a base line span of 25 feet (7.62 m).

c. Correctable dips shall be separately identified by the profiler software in a summary report using the California profilograph emulation. Dips will appear as low points on the printed profile, and correspond to low points on the pavement surface. Correctable dips are vertical deviations on the pavement surface that exceed 0.30 inch in depth below a base line span of 25 feet.

602.06 -- Pavement Surface Correction

1. The Contractor shall locate and perform all required pavement surface corrective work, with the approval of and in the presence of, the Engineer. Corrective work may also be required for any combination of bumps, dips, or other roughness that, in the opinion of the Engineer, produces an objectionable ride. The Contractor may also locate and perform voluntary corrective work as described in Paragraphs 2.b. and 2.c. of this Subsection.

a. Corrective work shall be accomplished by diamond grinding or by removal and replacement, at no cost to the Department.

b. Diamond grinding equipment used for surface correction shall be power driven, self-propelled units specifically designed to grind and texture pavements. The cutting head shall be at least 36 inches (0.9 m) wide and consist of many diamond blades with spacers. The Engineer may approve equipment with a narrower width for irregular and confined areas which will not accommodate larger equipment and for bumps of limited number and area.

c. The grinding shall be performed so that the cement aggregate bond will not be broken.

d. The Contractor shall re-test all corrected test sections with the profiler.

2. All bumps and dips, as defined in Subsection 602.05, Paragraph 1.b. and 1.c., shall be corrected until they are at or below the 0.30 inch (7.6 mm) limit. All dips shall be corrected by diamond grinding on either or both sides of the dip.

a. When the initial IRI of a test section is 99 in/mi or less, mandatory bump and dip correction is the only corrective work allowed for that section.

b. When the IRI of a test section exceeds 99 in/mi, the Contractor may perform voluntary corrective work in that section, in addition to mandatory bump and dip correction work.

c. When the IRI of a test section exceeds 124 in/mi, mandatory corrective work shall be performed to reduce the IRI of that section to a value of 124 in/mi or less. The Contractor may perform voluntary corrective work in that section, in addition to mandatory work.

d. Dip correction by diamond grinding shall not reduce the pavement thickness to less than the required plan thickness minus 1/4 inch.

3. When pavement removal and replacement is used for correction, the Contractor shall furnish the replacement material and construction at no cost to the Department.

a. All replacement material shall meet the original specifications for the material removed.

b. Removal and replacement shall be for the full lane width for a distance determined by the Engineer.

c. Replacement material must meet the same smoothness requirements as the removed pavement.

602.07 -- Traffic Control

1. The Contractor shall provide all traffic control for smoothness testing and corrective work at no cost to the Department.

602.08 -- Method of Measurement

1. The unit price of the accepted quantity of Portland concrete pavement in each profilograph test section shall be adjusted according to the schedule in Table 602.01, subject to the limitations in Paragraphs 2, 3, and 4 of this Subsection. Pavement sections excluded from this smoothness specification shall not qualify for incentive pay.

Table 602.01

Payment Adjustment Schedule	
IRI Inches per Lane Mile (mm per lane Kilometer)	Percent of Contract Prices
0 to 43 (0 to 63)	106
Greater than 43 to 56 (63 to 126)	104
Greater than 56 to 68 (126 to 189)	102
Greater than 68 to 99 (189 to 347)	100
Greater than 99 to 105 (347 to 379)	97
Greater than 105 to 111 (379 to 410)	94
Greater than 111 to 117 (410 to 442)	92
Greater than 117 to 124 (442 to 473)	90
Greater than 124 (473)	Corrective work required

2. When the initial IRI of a test section is 99 in/mi (347 mm/km) or less, that value shall determine the percent of incentive pay for the section, except that any mandatory correction work (bumps or dips) performed in

that section may increase the percent of pay up to the 106% level indicated in Table 602.01.

3. When the initial IRI of a test section is greater than 99 in/mi (347 mm/km), mandatory or voluntary corrective work performed in that section may increase the percent of pay up to the 100% level indicated in Table 602.01.

4. When the initial IRI of a test section is greater than 124 in/mi (473 mm/km), mandatory and voluntary corrective work performed in that section may increase the percent of pay up to the 100% level indicated in Table 602.01.

602.09 -- Basis of Payment

1. The overall pay factor for the accepted quantity of Portland cement concrete pavement in all profile test sections shall be determined according to the formula in Table 602.02.

Table 602.02

Pay Factor Formula
$PF = \frac{A(1.06) + B(1.04) + C(1.02) + D(1.00) + E(0.97) + F(0.94) + G(0.92) + H(0.90)}{A + B + C + D + E + F + G + H}$
<p>Where:</p> <p>A = Length of pavement with an IRI of 0 to 43 inches per mile (0 to 63 mm/km)</p> <p>B = Length of pavement with an IRI greater than 43 to 56 inches per mile (63 to 126 mm/km)</p> <p>C = Length of pavement with an IRI greater than 56 to 68 inches per mile (126 to 189 mm/km)</p> <p>D = Length of pavement with an IRI greater than 68 to 99 inches per mile (189 to 347 mm/km)</p> <p>E = Length of pavement with an IRI greater than 99 to 105 inches per mile (347 to 379 mm/km)</p> <p>F = Length of pavement with an IRI greater than 105 to 111 inches per mile (379 to 410 mm/km)</p> <p>G = Length of pavement with an IRI greater than 111 to 117 inches per mile (410 to 442 mm/km)</p> <p>H = Length of pavement with an IRI greater than 117 to 124 inches per mile (442 to 473 mm/km)</p>

2. The work of smoothness testing shall be paid for at the lump sum contract unit price. This price shall be full compensation for all smoothness testing as set forth in this Specification.

SECTION 603 -- CONCRETE PAVEMENT

603.01 -- Description

1. This work shall consist of furnishing all materials and constructing Portland cement concrete pavements, approach slabs, and headers. They are to be constructed on a prepared subgrade, modified subgrade or foundation course.

603.02 -- Material Requirements

1. The concrete class for pavements, headers and bridge approach slabs shall be as specified in the contract.

2. All materials shall be furnished by the Contractor and shall conform to the requirements of the Sections shown in Table 603.01.

Table 603.01

Material Requirements	
<u>Applicable Materials</u>	<u>Section</u>
Fly Ash	1008
Admixtures	1007
Curing Materials	1010, 1011, 1012, 1013
Aggregates	1033
Deformed Metal Joint Material	1027
Dowel Bars	1022
Joint Sealing Filler.....	1014
Portland Cement Concrete	1002
Preformed Joint Filler.....	1015
Preformed Polychloroprene Elastomeric Joint Seals.....	1016
Reinforcing Steel.....	1020, 1021, 1024
Tie Bars	1020
Water	1005

603.03 -- Construction Methods

1. General Preparation:

a. The Contractor shall prepare the subgrade as described in Section 302 or the contract.

b. The foundation course shall be constructed in accordance with the requirements of Section 307 or in the contract.

c. In no case shall concrete be placed upon an unstable or frozen subgrade or foundation course.

2. Slip-Form Preparation:

a. Grade control shall be maintained by the Contractor.

(1) Conventional Stringline shall be installed utilizing the construction staking provided by the Department or by the Contractor if Contractor Staking is required.

(2) Stringless machine grade control may be utilized, provided that the Contractor prepares a digital terrain model (DTM) to a system specifically designed to control the paving equipment. The Contractor shall provide elevations from the DTM at key locations selected by the Engineer,

such as but not limited to, inlets, bridge approaches, intersections, and superelevations.

3. Fixed Form Preparation:

a. Form depth shall be equal to the pavement thickness. Wood or metal forms of the proper radii shall be used for curves having radii of less than 100 feet (30 m).

b. The forms shall be neatly and tightly joined, and then securely pinned and staked to line and grade.

4. General Placing Concrete:

a. The concrete shall be spread to the required depth and cross section, consolidated, leveled, and finished to the grade shown in the contract.

b. The base material shall be uniformly moistened prior to concrete placement as directed by the Engineer.

c. To place concrete at night, the Contractor must request permission from the Engineer 24 hours in advance of placement.

d. Operations shall not be started until the ascending ambient air temperature reaches 40°F (5°C) or when a forecasted descending temperature is expected to fall below 40°F (5°C) during placement. Mixing and placing operations shall be discontinued when the descending ambient air temperature reaches 40°F (5°C).

e. Placement authorized for ambient air temperatures below 40°F (5°C) shall be as described in Subsection 704.03. Any concrete damaged by freezing shall be rejected.

f. Portland cement concrete shall be handled and placed with the following maximum limits:

(1) Concrete shall be consolidated, leveled, and finished within 30 minutes of it being placed on the grade.

(2) Concrete shall not be kept in non-agitating trucks (i.e., dump trucks) more than 30 minutes.

(3) Concrete shall not be kept in an agitating truck more than 90 minutes.

(4) A transverse construction joint shall be installed whenever work stops for more than 30 minutes. However, no section's length shall be less than 10 feet (3 m).

g. Cracks which form in the concrete pavement panels between joints shall be replaced or repaired as directed by the Engineer. No payment will be made for this work.

h. The Contractor may use a machine to place the longitudinal tie bars in lieu of tie bar pins shown in the contract. It must be located in the paving train so as to place tie bars prior to the placement of the wire mesh on reinforced concrete pavement, or prior to the passage of the first finishing machine on non-reinforced concrete pavement.

i. Finished concrete shall be of uniform density with no segregation, honeycombing, or large voids.

5. Slip-Form Placing Concrete:

a. All concrete shall be consolidated by internal vibration with transverse vibrating units or a series of longitudinal vibrating units.

b. The concrete float finisher shall be directly attached to the paver.

6. Doweled Concrete Pavement

a. Dowel bars shall be placed at mid-depth of the slab, parallel to the finished surface of the slab, and parallel to the centerline of the roadway.

b. Dowel bars may be placed by use of either baskets or mechanical inserters.

c. The dowel bars shall be placed within a tolerance of 1/4 inch (6 mm) in both the horizontal and vertical planes. The Engineer may elect to dig into the plastic concrete to verify dowel bar orientation and location. The subsequent hole shall be repaired by the Contractor at no additional expense to the Department.

d. Dowel bars for transverse joints furnished in approved assemblies shall be suitable for the joint layout as shown in the contract. The assemblies shall be dipped in an asphaltic bond breaker found on the Approved Products List prior to delivery to the work site.

(1) When basket assemblies are used, the baskets shall be placed at all transverse joints where doweled concrete is required, and shall be securely pinned to the grade to prevent any movement during the paving operation. Pins shall be placed at a maximum distance of three feet (1 m) apart and shall be a minimum of 12 inches (300 mm) in length. All lateral support braces shall not be cut after the baskets are secured and prior to placing the concrete.

(2) Assemblies that are damaged prior to placement shall not be used. Assemblies damaged after placement shall be replaced prior to paving.

e. Transverse Joints for doweled concrete pavement shall be constructed perpendicular to the roadway on 16 foot 6 inch (5 m) centers.

f. For areas with pavement widening, dowel baskets shall be placed in all transverse joints which are 6 feet (1.8 m) or wider.

g. Transverse cracks which form in the concrete pavement panels between load transfer joints shall be replaced or repaired as directed by the Engineer. No payment will be made for this work.

7. Placing Reinforcing Steel:

a. Welded steel wire fabric shall be installed on a level and consolidated layer of concrete whose top surface is at the elevation specified for the reinforcing metal.

(1) Welded steel wire fabric shall be lapped at least 1 foot (300 mm).

(2) The welded steel wire fabric shall be tied together at all laps.

(3) The spacing between the ties of longitudinal laps shall not exceed 2 feet (600 mm).

(4) The transverse laps shall be tied with a minimum of 3 ties per lane width.

(5) Any portion of the bottom layer of concrete that has been placed more than 30 minutes without being covered with the top layer shall be rejected.

b. Placing Tie Bars:

(1) The tie bars shall be placed as shown in the plans and in Table 603.02.

Table 603.02

TIE BARS FOR LONGITUDINAL JOINTS		
Slab Thickness	Bar Size*	Bar Spacing
5" (125 mm)	#4 (#13)	24" (610 mm)
6-10" (150-250 mm)	#5 (#16)	33" (840 mm)
More Than 10" (250 mm)	#6 (#19)	33" (840 mm)

*#5 bars will be used in place of #6 bent bars that must be straightened.

(2) The contractor may use a machine or jig to place tie bars in lieu of tie bar pins.

(i) The machine or jig shall be attached to and operated only when the paver to which it is attached is moving.

(ii) The machine or jig shall result in placement of tie bars in one quick, continuous movement resulting in maximum contact of plastic concrete around the bar with no void created behind the bar.

(iii) Hand placement of tie bars shall not be allowed except in emergencies to complete the day's concrete placement.

(iv) All tie bars, regardless of placement method, shall attain a minimum 12,000 lb pullout strength once the concrete reaches a minimum 3500 psi compressive strength. NDOT may perform pullout testing for verification at any time.

(3) Tie bar spacing may vary ± 4 inches (± 100 mm) from the nominal spacing shown. The number of tie bars per 16 feet 6 inch (5 m) panel shall remain constant.

(4) No tie bar shall be installed closer than 1/2 the tie bar spacing to a transverse joint.

c. When adjacent pavement lanes are constructed separately, tie bars placed at key-type longitudinal joints may have a 90 degree bend at the center of the bar to facilitate placement.

(1) The tie bars shall be bent to a position that is at least 45 degrees to the longitudinal joint.

(2) The free end of the bar shall be at least 6 inches (150 mm) horizontally from the dowel bar at the transverse joint.

(3) Bars that are loose in their socket must be replaced.

(4) All bars that crack or break off shall be replaced by installing tie bars as described in Section 909. Cracked or broken bars shall be replaced at no additional cost to the Department.

(5) All deformed tie bars shall be epoxy coated. Epoxy that is damaged by straightening bars to a 45° angle does not need to be repaired.

8. Finishing Concrete Pavement:

a. The concrete shall be placed, struck off, screeded and consolidated and finished to the specified finished grade.

(1) The concrete-finishing machine shall be power driven and of the transverse-screed type. The finishing machine shall be equipped with two oscillating type transverse screeds. The front screed shall be used for striking off excess concrete to exact grade and crown. The rear screed shall be used for finishing and smoothing. All screeds shall be constructed of steel, capable of being adjusted to the specified cross section and shall be of such rigidity as to produce the specified crown and cross section. Both the machine and the screeds shall have variable speeds and be independently controlled.

(2) Hand methods may be used to finish concrete on narrow or variable width sections where mechanical methods are impractical.

(i) After the concrete has been deposited and spread, it shall be vibrated until the concrete is thoroughly consolidated, then struck-off to a uniform height above the specified finished grade. It shall then be shaped with heavy vibrating screeds to the described cross section.

(ii) If normal vibration is found inadequate to thoroughly consolidate the plastic concrete within and around the dowel basket assemblies, adjustments to the material and/or operations shall be made.

b. The addition of water to the surface of the concrete to assist in finishing operations is not allowed except for unavoidable delays or unusual drying conditions. Fogging the concrete surface may be required to aid finishing. The fog shall be applied as a mist by means of an approved "orchard" sprayer.

(1) If it becomes necessary to fog the surface to complete the concrete finishing, all placing operations shall be immediately stopped until the finishers catch up to a point where fogging for finishing is no longer required.

(2) An evaporation retardant may be used in addition to fogging. It shall be applied according to the manufacturer's specifications with approval by the Engineer.

c. The longitudinal surface shall be made smooth and true to the profile with a 10 foot (3 m) straightedge.

(1) Straightedges shall be set parallel to centerline and shall be lapped one-half their length in each successive position. High areas shall be removed, depressions filled with fresh concrete, and the concrete consolidated with hand floats.

(2) Straightedge testing shall be continued as necessary until all irregularities have been satisfactorily corrected.

d. Pavement that will not be tined shall be textured by dragging a wet burlap, carpet, or canvas belt over the full width of the surface in a longitudinal direction.

(1) A wetted drag used directly behind a slip form paver is allowed.

(2) Dampening of this drag material will be accomplished through a uniform, fogging spray pattern. The addition of water to the drag shall not produce unsatisfactory conditions such as puddling, dripping, or excessive paste on the surface.

(3) The drag shall be suspended from a mandrel, or similar device, to insure a uniform texture.

(4) The drag shall be lifted from the surface of the concrete pavement when the paving train is not in motion for 30 minutes or more and carefully reset before resuming the dragging operations.

(5) Drags shall be rinsed or washed as necessary to obtain a uniform surface. Drags that cannot be cleaned shall be replaced.

(6) After the final drag finish, hand-formed or machine-formed joints shall be prepared and the concrete over the joints carefully removed. The edges of the pavement along the side forms and joints shall be rounded with an edging tool.

9. Tined Finish.

a. When required by the contract or when the posted speed is 40 mph or greater; the Contractor shall tine texture the concrete pavement surface using the following methods:

(1) Paving shall be tined with a single, full lane width device.

(2) The tines shall be of such dimensions as to produce grooves parallel to the centerline of the road approximately 1/8 inch (3 mm) wide and 1/8 inch (3 mm) deep spaced at 3/4 inch (19 mm) on center. A 2 inch (50 mm) to 3 inch (75 mm) wide strip of pavement surface shall be protected from surface grooving for the length of and centered along the longitudinal joint.

(3) The tining device shall be mechanically operated and shall cover the full pavement width in a single pass at a uniform speed and depth centered on the longitudinal joint. Longitudinal tining shall be accomplished by equipment with horizontal and vertical string line controls to ensure straight grooves.

(4) Hand tining will be allowed on irregular areas or areas inaccessible to the tining machine. A tine rake shall be used for hand tining. The use of a corrugated bull float or other device that creates a smooth finish between the grooves will not be permitted.

b. Pavement texture damaged or pavements not textured to the specified requirements shall be textured only after the concrete has attained its designed strength. The texturing shall be done with diamond grinding equipment specifically designed to grind and texture concrete pavements. The cutting head shall be at least 36 inches (915 mm) wide and capable of producing the depth and spacing indicated above. This work shall be performed at no additional cost to the Department.

10. Protection:

a. Protection shall be required when concrete is being placed and the ambient air temperature is expected to drop below 35° F (2°C) within 72 hours. The Contractor shall supply min/max thermometers at 200 ft intervals at no additional cost to the Department. The Contractor shall spread straw, hay, or other suitable blanketing material over the pavement to a sufficient depth to keep the concrete from freezing. The blanket material shall be covered with a layer of burlap or plastic sheeting, weighted or anchored to prevent the wind from displacing the insulation. The protection shall be maintained for 10 days or until opening strength is obtained, whichever occurs first.

11. General Curing

a. Curing aids (liquid membrane, films, sheet, or fabric) shall be installed before plastic shrinkage cracking, "hair-checking", develops.

b. If the rate of evaporation approaches 0.2 lb/SF/h (1.0 kg/m²/h), the Contractor must notify the Engineer regarding the additional actions that will be taken to prevent plastic shrinkage cracking. The rate of evaporation shall be obtained by using the nomograph in Figure 706.01.

c. The Contractor shall cure concrete pavement by one of the following methods:

(1) Curing with liquid membrane-forming compounds:

(i) The pavement shall be covered with curing compound within 45 minutes after the pass of the paving machine.

(ii) After the final finishing operations, the concrete pavement surface, curbs, and edges with or without tie bars shall be covered with a continuous uniform coating of white-pigmented curing compound as described in Section 1012.

(a) Curing compounds shall not be placed on any surface that will be bonded to another concrete surface except for slip-formed pavement. All surfaces of slip-formed pavement shall receive a coat of curing compound.

(b) The curing compound shall be applied in 2 applications. The second application shall be made a minimum of 10 feet behind the first application.

(c) The total rate of combined applications shall be at a minimum of 1 Gal/100 SF (0.4 L/m²) [0.5 Gal/100 SF (0.2 L/m²) each application] of surface area for tined surfaces or 1 Gal/150 SF (0.3 L/m²) of surface area for all other finishes.

(d) With form paving, the sides of the pavement slab shall be covered with the curing compound within 30 minutes after removal of the forms.

(ii) A self-propelled mechanical power sprayer shall be used to apply the curing compound to the concrete pavement. Hand-powered spraying equipment may be employed in an emergency and on narrow or variable width sections where the use of a mechanical power sprayer is impractical.

(a) The mechanical power sprayer shall not ride on the uncured pavement surface.

(b) The power sprayer shall be able to cover the entire lane width and thoroughly atomize the curing-compound.

(c) If the mechanical power sprayer produces an unsatisfactory result, such as puddles, dripping, or non-uniform application, the paving operation shall be suspended until appropriate changes have been made.

(d) The sprayer shall be equipped with a hood to prevent uncontrolled dispersal by the wind.

(iii) Damaged curing compound coatings, such as may result during the joint sawing operations, shall be recoated without delay using the same application rate originally described. Recoating shall be performed at no additional cost to the Department.

(2) Curing with white opaque polyethylene film or white burlap-polyethylene sheets:

(i) As soon as practical after the final finishing operations, the top surface of the pavement shall be covered with a white opaque polyethylene film or white burlap-polyethylene sheeting conforming to the requirements of Section 1010. Placement of the film or sheeting shall be done to avoid damaging the concrete surface.

(ii) The film or sheeting shall be placed on the concrete pavement in conformance with the following:

(a) The weight of the rolls of film or sheeting shall be kept off the concrete while placing the material.

(b) The material shall cover all exposed horizontal and vertical pavement surfaces.

(c) Film or sheeting shall be lapped at least 18 inches (450 mm). The laps shall have a satisfactory anchor placed on them to form a closed joint.

(d) The Contractor shall secure the sheeting and/or film so that moisture is held inside the covering to facilitate curing.

(e) Any tears or holes in the film or sheeting must be repaired immediately by cementing patches over the openings.

(f) Film or sheeting may be used more than once, provided that it is kept in serviceable condition by proper repairs, and provided also that it will maintain a watertight covering during the curing period.

(g) The concrete pavement must be kept covered with film or sheeting, properly sealed, for 72 consecutive hours following the placing of the concrete except that, the film or sheeting may be temporarily removed so that joints may be sawed. While the pavement is uncovered, it shall be kept wet by sprinkling with water.

(iii) Any joints or seams in a roll of burlap-polyethylene sheeting shall be double sewn.

(iv) Joints and seams in polyethylene film or sheeting shall have a minimum lap of 18 inches (450 mm), and sheeting shall be securely cemented together.

(v) All joints and seams shall be sufficiently durable to prevent separation during the curing period.

(3) Curing with wet burlap:

(i) As soon as practical after the final finishing operations, burlap shall be carefully placed on the concrete and kept moist. Placement of burlap shall be done to avoid damaging the concrete surface.

(ii) The burlap shall conform to the requirements of Section 1011 and shall be of sufficient length to cover all exposed surfaces, including the vertical edges of the slab.

(iii) At exposed vertical edges of the slabs, earth shall be banked so that the top width of the berm shall be at least 6 inches (150 mm).

(iv) The burlap shall be kept continuously saturated with water for at least 72 hours following the placing of the concrete, except that the burlap may be temporarily removed so that the joints may be sawed. While the pavement is uncovered, it shall be kept wet by sprinkling with water. Concrete operations shall be suspended when water is not available to cure the concrete.

12. Joint Construction Procedures:

a. (1) Joints shall be constructed to the dimensions shown in the contract or when "early-cut" type sawing of the joint, the cut shall be the depth recommended by the manufacturer. Curbed sections must be cut with a saw equipped with a diamond tipped blade.

(2) Initial sawing shall begin when the concrete can support the weight of the saw and sawing does not create raveling. Sawing must be completed before random cracking occurs.

(3) Joints over dowels shall not deviate from their intended location by more than 5% of the described spacing.

(4) Doweled joints shall not deviate more than 1 inch (25 mm) from the center of the dowel's length.

(5) Each transverse joint shall be cut to the described depth in one continuous pass.

(6) Any panels that contain random cracking will be considered unacceptable. The Engineer will decide whether to replace or repair the panel. The Contractor shall replace or repair these panels at the direction of the Engineer at no cost to the Department. A 20% deduction will be assessed on any repaired panel. Any panel that is replaced will not be assessed a 20% deduction.

(7) Joints at gutters or integral curbs shall be cut to the proper depths to prevent random cracking.

b. Panels with spalls shall be repaired as directed by the Engineer.

c. The Contractor shall prepare and seal joints according to the manufacturer's recommendations.

(1) Before sealing, the joint wall (not the bottom of joint) surfaces shall be sandblasted or water-blasted to remove all dirt, curing compound residue, laitance, and any other foreign material. The Engineer may require additional measures, such as resawing, if the blasting techniques are ineffective. After sandblasting, the entire joint shall be cleaned with compressed air having a minimum pressure of 90 psi (620 kPa). The compressed air shall be free of oil, water, and other contaminants. The joints shall be dry at the time of sealing.

(2) Transverse joints in Portland cement concrete pavements shall be sealed so that the joint is filled to approximately 1/4 inch to 5/8 inch (6 to 12 mm) below the top of the joint with an approved hot poured sealant.

(i) All overflow material shall be removed from the surface of the pavement.

(ii) If adhesion is not satisfactory, the material will be rejected, removed and replaced at no additional cost to the Department.

(3) The Contractor shall give the Engineer one copy of the hot pour manufacturer's sealing recommendations two weeks prior to commencing work.

13. Surface Tests:

a. The Contractor shall check all concrete pavement for smoothness as described in Section 602.

14. Integral Curbs

a. The Contractor shall construct integral curbs as shown in the contract. This curb shall be placed within 30 minutes after the slab has been placed and finished. That part of the pavement that will be attached to the integral curb shall be cleaned of all laitance and roughened to assure a good bond.

b. The Contractor may install the integral curb as a separate operation.

(1) The Contractor shall install tie bars of the size and at the spacing shown in the contract.

(2) The pavement upon which the curb is to be placed shall be finished with a rough texture.

c. The concrete for the integral curb shall be of the same class as that used in the concrete slab. All contraction or expansion joints in the pavement shall be continuous through the integral curb.

15. Opening Pavement to Traffic:

a. No section of concrete pavement shall be opened to traffic until approval has been given by the Engineer.

b. The time for opening pavement will be based on the length of time the pavement is in place and/or on the compressive strength of the concrete as determined by cores taken from the pavement.

c. The Contractor's forces may be allowed on the concrete pavement when the concrete has reached a minimum age of 14 days or when the concrete has reached a compressive strength of 3,000 psi (21 MPa) when tested in accordance with ASTM C 39.

d. With the approval of the Engineer, the Contractor may elect to increase the early strength of the concrete by adding cement and/or reducing the water/cement ratio. The pavement may then be opened to traffic provided it has attained a compressive strength of 3500 psi (24 MPa). The concrete in the area where the early strength is required shall be paid for at the bid price.

e. When requested by the Contractor or the Department, the maturity method may be used to determine pavement compressive strength. The maturity method will be performed in accordance with NDOT C 1074 and in lieu of Subsection 603.03, Paragraph 15.c. and d. to determine the strength of concrete pavement for the purpose of early opening to traffic. Requests by the Contractor for use of the maturity method shall be on a project basis and shall be made in writing to the Engineer.

603.04 -- Method of Measurement

1. Concrete pavement is measured by the square yard (meter).
2. Concrete for pavement approaches is measured by the cubic yard (meter).
3. Reinforcing steel for concrete pavement approaches is measured by the pound (kilogram).
4. "Portland Cement Concrete Pavement Smoothness Testing" is measured according to the procedure in Section 602.
5. Headers are measured by the cubic yard (meter) of concrete used.
6. If the concrete pavement includes a beveled edge, the concrete pavement will be measured to the outside edge of the beveled edge. The work required to form the beveled edge will be considered subsidiary to the concrete pavement being placed.

603.05 -- Basis of Payment

1. Pay Item	Pay Unit
____ inch (mm) Doweled Concrete Pavement _____	Square Yard (SY) [Square Meter (m ²)]
____ inch (mm) Concrete Pavement _____	Square Yard (SY) [Square Meter (m ²)]
____ inch (mm) Reinforced Concrete Pavement _____	Square Yard (SY) [Square Meter (m ²)]
Concrete for Pavement Approaches _____	Cubic Yard (CY) [Cubic Meter (m ³)]
Epoxy Coated Reinforcing Steel for Pavement Approaches	Pound (lb.) [kilogram (kg)]
Portland Cement Concrete Smoothness Testing	Lump Sum (LS)
Concrete for Headers, Class _____	Cubic Yard (CY) [Cubic Meter (m ³)]

2. Payment will be based on the quantities shown in the contract unless changes are approved by the Engineer.

3. Paving Units and Coring Program

a. Cores will be collected from paving units for the evaluation of compressive strength and thickness. Cores will be located randomly within each paving unit. Additional cores (special cores) for strength verification, thickness deficiency delineation or other anomalies may be taken at the discretion of the Engineer. These cores may be used in acceptance decisions.

b. (1) The paved area shall be divided into units. Each unit will be considered separately. Units are 750 linear feet (230 m) of pavement for each separately placed width, or width of each class of concrete whether or not placed separately starting at the beginning of the pavement.

(2) The last unit for the width under consideration shall be 750 feet (230 m) plus any fractional part of 750 feet (230 m) remaining.

(3) When the length of a separately placed width is less than 750 feet (230 m), the length of the unit shall be the actual length.

(4) A separately placed width is the width between field constructed longitudinal joints, between a longitudinal construction joint and the edge, or between two pavement edges. A separately placed width may include more than one pay item of concrete, such as doweled and non-doweled.

(5) Bridges and approach slabs shall be considered as exceptions to the unit's length.

(6) In cases of separately placed intersections or blockouts, the normal width of pavement on either side shall be considered as continuing through in the same manner as would be applicable if the section under consideration had been placed continuously through the section.

4. Compressive Strength Cores

a. A pay factor will be applied to each unit based on the compressive strength of 1 core per unit tested in accordance with ASTM C 39. The Department will test concrete cores with a minimum age of 28 days. The Contractor will have the option to obtain two additional cores, at no cost to the Department, for any unit core that fails to have the required minimum compressive strength provided:

(1) The cores shall be obtained in accordance with ASTM C 42 and tested within seven (7) days of being notified of the strength deficiency, under the supervision of the Engineer.

(2) The cores shall be cut within 6 inches of the original unit core in the longitudinal direction.

(3) The results of all three cores sampled at the location will be averaged for the final compressive strength calculation and pay factor.

b. When the primary designated core is deficient in thickness by more than 0.25 inch (6 mm), an additional core will be taken within 1 foot (300 mm) longitudinally of the primary core. The additional core can be used for compressive strength testing.

c. The pay factors are shown in Table 603.03.

Table 603.03

Concrete Strength Pay Factor	
Percent of Required Concrete Compressive Strength	Pay Factor
Greater than 99.9	100
Greater than 98.5 to 99.9	99.75
Greater than 97.5 to 98.5	99.50
Greater than 96.0 to 97.5	99
Greater than 94.0 to 96.0	98
Greater than 92.0 to 94.0	97
Greater than 90.0 to 92.0	94
Greater than 88.0 to 90.0	90
Greater than 86.0 to 88.0	86
Greater than 84.0 to 86.0	81
Greater than 82.0 to 84.0	76
Greater than 80.0 to 82.0	70
Less than 80.0	See Paragraph 4.e of this Subsection

d. The pay factors for blockouts, intersections, and pavements not covered by coring shall be determined from the compressive strengths of their cylinders. If the concrete cylinders' compressive strengths are less than 2,000 psi (14 MPa) at 7 days, then the Engineer may require the concrete to be removed and replaced.

e. The Engineer will evaluate the concrete's expected use and may allow concrete with a compressive strength of less than 80% of the required strength (after 28 days) to be left in place and paid for at 40% of the bid price or may require the unit to be removed and replaced.

5. Thickness Cores

a. Pavement shall be constructed to the minimum thickness shown in the contract. A pay factor shown in Table 603.04 will be applied to each unit based on the average thickness of cores tested in accordance with ASTM C 174.

b. At the option of the Engineer cores may not be required from irregular areas, blockouts, intersections, with widths less than 8 feet (2.4 m) or from an entire contract involving less than 5,000 square yards (4200 m²) of pavement.

c. The thickness of a core shall be determined by averaging the measurement of three caliper readings taken at 3 equidistant points on the core.

(1) If the unit core taken is not deficient by more than 0.25 inch (6 mm) from plan thickness, full payment will be made and no additional cores will be required.

(2) If the unit core is deficient by more than 0.25 inch (6 mm), 2 additional cores will be taken in the same unit. Whenever possible, the distance between cores should be approximately one third of the unit length.

(3) The average thickness of the 3 cores will then be determined. If the average thickness of these 3 cores is not deficient by more than 0.25 inch (6 mm), full payment will be made.

(4) If the average thickness of the cores is deficient by more than 0.25 inch (6 mm) but not more than 0.50 inch (12.5 mm) an adjusted unit price will be paid in accordance with Table 603.04. Cores deficient by more than 0.50 inch (12.5 mm) will be treated as described in Subection 603.05 5.d.

(5) When calculating the average thickness of the pavement unit, measurements greater than contract thickness will be considered contract thickness.

(6) Exploratory cores for determining limits of deficiencies of more than 0.50 inch (12.5 mm) or special cores will not be used in determining average thickness.

(7) The area deficient in thickness by more than 0.50 inch (12.5 mm) will be deducted from the total area of the unit and pay for the remainder of the unit will be based on Table 603.04.

Table 603.04

Payment Deductions Based on Deficient Pavement Thickness	
English Average Thickness Deficiency (Metric)	Percent of Contract Unit Price
0 to 0.25 inch (0 to 6 mm)	100
Greater than 0.25 to 0.30 inch (6 to 7.6 mm)	85
Greater than 0.30 to 0.35 inch (7.6 to 8.9 mm)	80
Greater than 0.35 to 0.40 inch (8.9 to 10.2 mm)	75
Greater than 0.40 to 0.45 inch (10.2 to 11.4 mm)	70
Greater than 0.45 to 0.50 inch (11.4 to 12.5 mm)	65
Greater than 0.50 inch (12.5 mm)	Remove and Replace*
* When the thickness of the pavement is deficient by more than 0.50 inch (12.5 mm), the Engineer will evaluate the pavement's expected use and may allow it to be left in place at 40% pay.	

d. Remove and Replace Determination Procedure

(1) When the measurement of any core is less than plan thickness by more than 0.50 inch (12.5 mm), the method to establish the limits of the 0.50 inch (12.5 mm) deficient section will be determined by taking exploratory cores in the following manner.

(2) Cores will be taken 5 feet (1.5 m) either side of the deficient core's locations on a line parallel to the centerline of the pavement.

(3) If both cores are within the 0.50 inch (12.5 mm) tolerance, no additional cores will be taken for this individual zone of deficiency.

(4) If either or both of these cores are not within the 0.50 inch (12.5 mm) tolerance, additional cores will be cut on either side of the original

deficient core on a line parallel to the centerline of the pavement. These additional cores shall be taken 25.0 feet (7.6 m) from the original core and then consecutive cores will be cut at 40 foot (15 m) intervals until a thickness within the 0.50 inch (12.5 mm) tolerance is found in both directions.

(5) On either side of the original short core, the procedure will be to take a core approximately halfway between the first core that comes within the 0.50 inch (12.5 mm) tolerance and the nearest core over 0.50 inch (12.5 mm) deficient.

(6) This procedure will be repeated until the location (plus or minus 5 feet) (1.5 m) at which the pavement comes within the 0.50 inch (12.5 mm) tolerance is located.

(7) Once the limits are located, payment will be made as defined in Table 603.04 for deficiencies greater than 0.50 inch (12.5 mm).

6. Cement Content Deduction:

a. The cement content deduction is applicable to concrete pavement under the following conditions:

(1) Batching equipment is determined to be faulty during concrete paving operations.

(2) Concrete pavement is constructed under a QC/QA specification.

b. Cement content, as a percentage by weight of the specified concrete (regardless of its intended use) shall be determined as described by ASTM C 138.

c. (1) If the average of 10 consecutive cement content tests is less than 100% of the specified weight, then a deduction shall be made as described in Table 603.05.

(2) The amount of placed concrete that is to have its payment adjusted by the cement content deduction pay factor shall include all concrete represented by the 10 consecutive tests.

d. (1) If the average cement content percentage for 10 consecutive tests is 100% or more of the specified weight and any individual test is less than 97%, then a deduction is made as described in Table 603.06.

(2) The amount of placed concrete that is to have its payment adjusted by the cement content deduction pay factor shall include all concrete that is placed between the test just prior to the low percentage test and the first test following the low percentage test that is at or above 97%.

Table 603.05

PCC Concrete Deduction for Cement Content (Average of Ten Consecutive Tests)	
Average Cement Content – By Weight	PCC Concrete Pay Factor
100 or greater	1.00
Less than 100 to 99.7	0.98
Less than 99.7 to 99.5	0.95
Less than 99.5 to 99.2	0.85
Less than 99.2 to 99.0	0.85
Less than 99.0 to 98.5	0.70
Less than 98.5 to 98.0	0.625
Less than 98.0 to 97.5	0.550
Less than 97.5 to 97.0	0.475
Less than 97.0	Remove and Replace*
* The Engineer may elect to leave concrete in place and pay only 40% of bid price.	

Table 603.06

PCC Concrete Deduction for Cement Content (Individual Test)	
Cement Content Percentage (by weight)	PCC Concrete Pay Factor
100 to 97	1.00
Less than 97.0 to 96.5	0.98
Less than 96.5 to 96.0	0.95
Less than 96.0 to 95.0	0.88
Less than 95.0 to 94.0	0.76
Less than 94.0 to 93.0	0.64
Less than 93.0 to 92.0	0.52
Less than 92	Remove and Replace*
* The Engineer may elect to leave concrete in place and pay only 40% of bid price.	

7. No additional payment over the contract unit bid price will be made for any pavement, which has an average thickness greater than shown in the contract.

8. The preparation of the subgrade under the pavement approaches shall not be measured and paid for directly but shall be considered subsidiary to the concrete pavement.

9. Direct payment will not be made for integral curbs. They shall be considered as subsidiary to concrete pavement.

10. Furnishing and placing required reinforcement and dowel bars shall not be paid for directly but will be considered as subsidiary to concrete pavement.

11. Water incidental to the concrete placement shall be considered subsidiary to concrete pavement.

12. If varying types and thicknesses of concrete are required, the pay item will be subdivided so that the quantities of the various types and thicknesses will be identified.

13. Securing and tying reinforcing bars will not be paid for directly but shall be considered subsidiary to the items of work for which direct payment is made.

14. Payment is full compensation for all work described in this Section.

SECTION 604 -- CONCRETE BASE COURSE

604.01 -- Description

1. This work shall consist of furnishing all materials and constructing a base course composed of Portland cement concrete. It shall be constructed on a prepared subgrade or foundation course as shown in the contract.

604.02 -- Material Requirements

1. The base course concrete shall be Class 47B-3,000 (47B-20)
2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 604.01.

Table 604.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Joint Sealing Filler	1014
Preformed Joint Filler.....	1015
Reinforcing Steel	1020, 1021, 1024
Deformed Metal Joint Material.....	1027
Curing Materials.....	1010, 1011, 1012, 1013
Dowel Bars	1022
Aggregates	1033
Admixtures.....	1007
Water.....	1005

604.03 -- Equipment

1. The equipment used and the calibration responsibility shall be as described in Sections 601 and 603.

604.04 -- Construction Methods

1. The Contractor shall prepare the subgrade and foundation course as described in Sections 301, 302, 303, 305, and 307.

2. Concrete base course shall be constructed in accordance with the pertinent sections of Section 603.

3. The surface of the concrete base course shall be tested for smoothness in both the transverse and longitudinal directions with a 10 foot (3 m) straightedge. The maximum allowable variation is 1/4 inch (6 mm). Base course not meeting this requirement will be evaluated by the Engineer and may be subject to corrective diamond grinding or other remedy.

4. a. When a bituminous or asphaltic concrete surface is to be placed on the base course, a bituminous liquid curing compound conforming to the requirements of Section 1013 shall be applied.

b. The rate of application shall be determined from the results of moisture retention tests, except that the rate of application shall never be less than 1 Gal/200 SF (2 L/m²) of surface area.

c. In the event that the cure coating is damaged within 72 hours after being applied, the affected areas shall be recoated without delay at the same rate described for the original application.

5. a. The base course may be opened for hauling and placing the wearing or surface course after the concrete has cured 14 days or after

7 days with the pavement having developed a compressive strength of 3,000 psi (20 MPa) when tested in accordance with ASTM C 39.

b. The Engineer shall be given 48 hour notice before any vehicles are allowed on the pavement.

6. The Contractor shall clean and seal all cracks and joints in the base course with approved joint sealer if the wearing or surface course is not placed during the same construction season as the base course. This work is subsidiary to the Concrete Base Course.

604.05 -- Method of Measurement

- 1. Concrete base course is measured by the square yard (meter).

604.06 -- Basis of Payment

1. Pay Item	Pay Unit
_____ Concrete Base Course; _____	Square Yard (SY) [Square Meter (m ²)]

2. Deductions for strength deficiencies will be computed as described in Section 603.

3. Welded steel wire fabric reinforcing used in the concrete base course will not be paid for directly but shall be considered subsidiary to concrete base course.

4. Furnishing and placing the required reinforcement and dowel bars in the concrete base course will not be paid for directly but will be considered subsidiary to the concrete base course.

5. If varying types or thicknesses of concrete are used, the pay item will be subdivided to show the quantities of each variation.

6. a. The 28-day compressive strength of each day's production unit will be determined from cylinder strength tests.

b. Payment shall be reduced by the amount described in Table 603.03.

c. (1) If the first 28 day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department and under the supervision of the Engineer. The Department will take immediate custody of the cores at the time of sampling. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(2) Cores shall be taken and tested within seven (7) days of being notified of the strength deficiency.

(3) The Engineer will select the location where the cores will be taken within each day's production unit.

7. Payment is full compensation for all requirements described in this Section.

SECTION 605 -- CONCRETE PAVEMENT REPAIR

605.01 -- Description

1. This work shall consist of repairing Portland cement concrete pavement at the locations shown in the contract or as designated by the Engineer. The work shall include removing deteriorated concrete, disposing of the old concrete, preparation of the repair area, and furnishing, placing, finishing, and curing the concrete.

2. Concrete pavement repairs are grouped into 3 types based on the surface area of the patch (see Table 605.01). If a concrete repair extends across more than one lane, the repairs in each lane will be counted as a separate repair.

Table 605.01

PCC Pavement Repair Groups	
<u>Type</u>	<u>Size</u> <u>Square Yards or m²</u>
A	Less than 5
B	5 to 15
C	More than 15

3. Full width concrete pavement repairs shall be a minimum of 4 feet (1.2 m) in length.

4. Removal of concrete for partial depth pavement repair shall be to the depth necessary to reach sound concrete. The minimum depth of removal shall be 3 inches (75 mm), or as shown in the contract.

5. Full depth pavement repair shall be constructed on a prepared subgrade or foundation course as described in the contract. The thickness of the new concrete pavement will be as shown in the contract, or 2 inches thicker than the adjacent pavement, if not shown in the contract.

6. a. When performing concrete pavement repairs on 2-lane roadways, the Contractor shall have all lanes open to traffic before sunset and at times when the Contractor is not working. Where the pavement has been removed and the Contractor is unable to complete the required patching in time for the concrete to obtain the full curing time required prior to opening the section of the road to traffic, the excavation shall be filled with a commercially available cold-mix bituminous mixture, or other suitable temporary patch material with a durable surface. The Contractor will be required to maintain traffic flow across these patches while they are in service. When it is necessary to use a temporary patch, the patch shall be removed, and the required permanent patch placed, within 48 hours unless otherwise directed by the Engineer. The temporary patches will be at no cost to the Department.

b. When performing concrete pavement repairs on multi-lane highways, the Contractor may have one lane closed while performing the repair work. Repairs shall not be left open overnight. Where the pavement has been removed, and the Contractor is unable to complete the required patch before sunset, the Contractor shall fill the excavated area with either: (1) the appropriate patching concrete material for curing overnight, or (2) a suitable material with a durable surface. The material, installation, removal and disposal of these temporary patches will not be measured and paid for

directly, but shall be considered subsidiary to the concrete joint and pavement repair work being performed.

605.02 -- Material Requirements

1. a. Repairs shall be made with Class PR1-3500 (PR1-25 MPa) or Class PR3-3500 (PR3-25 MPa) concrete.

b. Repairs shall be made with Class 47B-3500 (47B-25 MPa) or Class 47B-HE-3500 (47B-HE-25 MPa), if the contract allows for lane closures or detours to accommodate the extended curing period.

2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 605.02.

Table 605.02

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Aggregates	1033
Fly Ash.....	1008
Curing Compounds (Without Asphalt Overlay)	1012
Curing Compounds (With Asphalt Overlay)	1013
Joint Sealing Filler	1014
Admixtures.....	1007
Water.....	1005
Epoxy Compounds & Adhesives.....	1018

605.03 -- Equipment

1. A mobile mixer conforming to the requirements of Section 1002 may be used.

2. Adequate hand tools shall be provided, including an internal vibrator.

3. Screeds, either mechanical or hand operated, shall be used to finish the concrete except for small patches and curb repair. The screeds shall be either a vibrating or roller type screed specifically designed for striking off concrete.

4. Internal vibrators shall meet the requirements of Section 601.

5. Drills for dowels or tie bars, shall be capable of drilling the appropriate sized hole parallel to the surface of the concrete and the longitudinal centerline within 1/8 inch.

605.04 -- Construction Methods

1. Removals General Requirements

a. The Contractor shall remove the concrete pavement and curbs, if applicable without damaging the adjacent concrete pavement and curbs.

b. The Contractor shall remove and dispose of all old pavement, reinforcing steel, and all other materials.

(1) The repair section shall be removed with minimum disturbance of the underlying foundation course. Any loosened foundation course material shall be removed and replaced with concrete.

c. If reinforcing fabric is encountered, it shall not be replaced.

d. The Contractor shall cut around the perimeter of the repair area as shown in the contract.

(1) All repairs shall be cut so the edges are parallel or perpendicular to the traveled way.

(2) Curb repairs shall be cut a minimum of 2 inches (50 mm) in depth with a diamond saw and breaking back the remaining thickness to form vertical edges on the existing concrete.

(3) Saw over-cuts shall be kept to a minimum.

e. The Contractor shall use care to prevent damage to the concrete to remain in place. Repair of unnecessary damage will be at no cost to the Department.

f. When tie bars in longitudinal joints are damaged during concrete removal, they shall be replaced by the Contractor at no additional cost to the Department with reinforcing bars [No. 5 (16 mm in diameter) bars that are 18 inches (450 mm) in length]. The new tie bars shall be installed into holes drilled in the existing concrete and secured in place with a non-shrink grout or epoxy on the Department's Approved Products List.

2. Preparation

a. General

(1) The repair sections shall be removed to the lines designated by the Engineer, including reinforcement that interferes with the operations.

(2) The wheel-type cutter shall be operated to produce minimum disturbance of the foundation course material, with no encroachment of the cut into the concrete of the adjoining lane.

(3) "Foundation Course Replacement" consists of removing and disposing of foundation course (i.e., bituminous, cement treated, crushed concrete, granular) or subgrade below the concrete pavement, which excludes the additional 2 inch (50 mm) of removal, as shown in the contract.

(i) When the Engineer determines that the foundation course and/or subgrade needs replacing, the Contractor shall remove and dispose of the foundation course and/or subgrade, prepare the subgrade, and replace the materials with the same type of material.

(4) The Contractor shall compact the subgrade or foundation course under full depth patches to the maximum density achievable.

(5) A bond breaker shall be used as shown in the contract.

(6) The subgrade or foundation course shall be uniformly wetted before placing the concrete. Ponding or puddling shall be prohibited.

(7) Where the repair area is not bordered by existing concrete pavement, a form shall be used as the pavement edge to provide the same surface elevation and edge alignment as the existing pavement. The form shall be supported or braced in position to prevent movement during the placement and finishing of the concrete. Forms for concrete pavement repair shall conform to the requirements of Subsection 603.03.

b. Preparation full depth with dowels or tie bars

(1) Removal shall extend across the existing joint a minimum of 2 feet (600 mm) into the adjacent panel in doweled concrete.

(2) Dowel bars or tie bars shall be anchored into the faces of the existing concrete as designated in the contract.

(3) The dowel bar holes shall be drilled at the same plane \pm 1/8 inch and at the spacing shown in the contract.

(4) The tie bar holes may be drilled independently.

(5) The drilled holes shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material and moisture.

(6) After cleaning and prior to dowel or tie bar insertion, an application of grout or Type IV, Grade 3 epoxy shall be made at the back of the hole. The grout or epoxy shall be from the Approved Products List. Twist the dowel or tie bar one full turn during insertion to completely surround it with the grout or epoxy. Retention disks shall be placed on the bars as designated in the contract. The furnishing and installation of dowel and tie bars will not be paid for directly but shall be considered subsidiary to the concrete pavement or joint repair work being performed.

(7) When matching transverse joints on repairs that span existing joints, the dowel baskets shall be placed parallel to the joint, and the dowel bars shall be parallel to centerline.

c. Preparation partial depth

(1) For partial depth repairs, the Contractor shall cut and chip the pavement edges with a 15 pound (6.8 kg) maximum chipping hammer to form reasonably neat vertical surfaces.

(2) All surfaces, including the bottom, of the partial depth concrete repairs shall be free from loose concrete, sand, and other debris and shall be maintained in a dry and clean condition.

(3) A bonding agent shall be applied to all cleaned and dried surfaces.

(i) The bonding agent shall be a Type IV, Grade 2 Epoxy Adhesive on the Approved Products List.

(ii) The bonding agent shall be applied to all surfaces, including the bottom. The vertical faces of the transverse joints, longitudinal joints, or cracks exposed in the repair shall not be coated with the bonding agent.

3. Placing and Finishing

a. The Contractor shall furnish and place the concrete. The concrete shall be handled and consolidated so there will be no separation of the aggregate and the mortar.

b. An internal vibrator shall be used to consolidate the concrete.

c. A vibrating screed shall be used on a full depth concrete repair that is 5 feet or wider, to finish the concrete to the final elevation.

d. The concrete shall be floated with a magnesium bull float and then given a drag finish with wet burlap, carpet, or canvas in a direction

parallel to the traffic flow. If the surface is not to receive an overlay or smoothness grinding, it shall be tined to match the existing surface.

4. Joints

a. The Contractor shall create joints in full depth repairs as shown in the contract.

b. When pavement and joint repairs will not be overlaid, all sawcuts, transverse joints, and longitudinal joints shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material and moisture, and sealed with hot pour joint sealant.

c. Random cracks which develop in the new concrete repair that will not be overlaid with asphaltic concrete shall be removed or repaired as directed by the Engineer.

d. Joints shall not be sealed until after any corrective work or Diamond Grinding and Texturing Concrete Pavement is completed. Formed joint wells that are destroyed shall be re-constructed, and joints of insufficient depth shall be deepened prior to sealing.

5. Curing

a. The Contractor shall apply curing compound to all concrete pavement repairs. The cure compound shall be applied immediately after each patch is completed.

(1) When pavement and joint repairs are overlaid with asphaltic concrete, the curing method shall be with tack coat. An approved asphalt emulsion or bituminous based compound may be used with approval of the Engineer.

(2) White pigmented curing compound shall be used when the repair will be the wearing surface. The application rate shall be 1 Gal/150 SF (0.4 L/m²).

b. Class PR1-3500 (PR1-25) or PR3-3500 (PR3-25) concrete pavement repairs shall be covered with polyethylene film and then insulation board or insulated blankets immediately after the curing compound has been applied.

(1) The insulation board and insulated blankets shall have an R-value (thermal resistance) equal to or greater than 5 ft²-hr-°F/BTU [1.0 m²(°C/W)].

(2) Insulation and polyethylene film shall be maintained until concrete reaches opening strength.

c. Class PR1-3500 (PR1-25 MPa) or PR3-3500 (PR3-25 MPa) concrete pavement repairs shall not be opened to traffic until the compressive strength reaches 3500 psi (25 MPa). This will be determined by use of Maturity Method or cylinders, at the discretion of the Engineer. Table 605.03 is a guide to the minimum time the PR-3500 concrete will reach a compressive strength of 3,500 psi.

Table 605.03

(Class PR1-3500 [25 Mpa] and PR3-3500 [25 Mpa])	
Minimum Ambient Air Temperature [°F (°C)]	(Hours)
Below 41 (5° C)	12
41 – 60 (5°-16°C)	8
Above 60 (16°C)	4

(1) Concrete shall not be placed when ambient air temperatures are expected to drop below 40 °F (4° C) during the cure period.

(2) Class PR3 Concrete shall be used for all concrete repairs if the repaired areas must be opened to traffic within 24 hours, except that Class PR1 Concrete may be used provided the minimum required strength can be attained within the allotted time.

(3) Strength measurements for the opening and the 24-hour pay strengths of the PR1 and PR3 Concrete may be performed using the Maturity Method or cylinders, at the discretion of the Engineer.

d. Class 47B-3500 (47B-25 MPa) or Class 47B-HE-3500 (47B-HE-25 MPa) concrete pavement repairs shall not be opened to traffic until the compressive strength reaches 3,500 psi (25 MPa) as determined by the Maturity Method or cylinders, at the discretion of the Engineer. Table 605.04 is a guide to the minimum time the 47B-3500 concrete will reach a compressive strength of 3,500 psi.

(1) Concrete shall not be placed when ambient air temperature is expected to drop below 40°F (4°C) during the cure period.

Table 605.04

(Class 47B-3500 25 MPa)	
Minimum Ambient Air Temperature [°F (°C)]	(Hours)
Below 41 (5° C)	120
41 – 60 (5°-16°C)	72
Above 60 (16°C)	48

6. Smoothness

a. The pavement elevation of repair areas shall be corrected in a manner that eliminates dips or bumps. Dips and bumps are defined as having a 1/8 inch or greater deviation using an approved 10 foot straightedge. If the repair will be the wearing surface, the correction shall be diamond grinding or replacement. If the repair will be overlaid, the correction shall be milling, diamond grinding or replacement. The condition of the adjacent pavement shall be considered when evaluating the 1/8 inch deviation requirement.

7. a. Disturbed or damaged areas in the existing surfaced shoulder resulting from the repair operation shall be repaired by the Contractor at no additional cost to the Department.

b. The perimeter of the damaged areas of the surfaced shoulders shall be sawed prior to removing.

c. The shoulder shall be repaired with the same material as the existing shoulder or as directed by the Engineer.

605.05 -- Method of Measurement

1. a. The quantity of each type of concrete pavement repair and joint repair are measured in cubic yards (meters) of pavement replaced in each separate lane.

b. Concrete pavement repairs that adjoin full depth repair areas of varying widths in the same traffic lane which are situated such that the removals of the areas may be accomplished concurrently, shall be considered as a single repair. The total area of the adjoining areas shall be combined to determine the repair type as shown in Table 605.01.

c. Joint repairs in excess of 9 feet in length will be paid for as the appropriate pavement repair item.

d. The quantity of curb repair is measured in linear feet.

2. "Foundation Course Replacement" will be measured by the cubic yard of foundation course replaced.

605.06 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete Curb Repair	Linear Feet (LF) [Meter (m)]
Concrete Pavement, ____ Joint Repair	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type A, Full Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type B, Full Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type C, Full Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type A, Partial Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type B, Partial Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Pavement Repair, Type C, Partial Depth	Cubic Yard (CY) [Cubic Meter (m ³)]
Foundation Course Replacement	Cubic Yard (CY) [Cubic Meter (m ³)]

2. When the Engineer directs that partial depth concrete pavement repairs be constructed with a thickness greater than what is shown in the contract, an adjustment will be made to provide compensation for the work. The adjustment will be as follows:

$\text{Adjusted Unit Price} = \text{Bid Price} \times \frac{(\text{Actual Thickness Placed})}{(\text{Thickness shown in the contract})}$
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3. a. The 24-hour compressive strength shall be used to determine pay factor deductions for all PR type concrete in accordance with Table 603.03.

b. The 28-day compressive strength of each day's production will be determined from cylinder strength tests for all 47B type concrete.

(1) Payment shall be reduced by the amount described in Table 603.03.

(2) For 47B concrete, if the 28 day strength fails, the Contractor has the option to take 3 core samples at no additional cost to the Department. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(i) Cores must be taken within 45 days from the date the concrete was poured.

(ii) The Engineer shall select the site where the cores will be taken.

4. "Foundation Course Replacement" will be paid for at the contract unit price per cubic yard for the item "Foundation Course Replacement". This price shall be full compensation for removing and disposing of the old foundation course, preparation of the subgrade, furnishing and placing the replacement concrete, and for all labor, equipment, tools and incidentals necessary to complete the work.

5. The sealing of all random cracks or joints will not be measured and paid for directly but shall be considered subsidiary to the joint or pavement repair work being performed.

6. Payment is full compensation for all work described in this Section.

SECTION 606 -- CONCRETE CURB AND CONCRETE GUTTER

606.01 -- Description

1. The Contractor shall furnish all materials and construct concrete curb, combination concrete curb and gutter, and concrete gutter as described in the contract. This Section shall not include integral curb that is covered under Section 603.

606.02 -- Material Requirements

1. The concrete Class shall be specified in the contract.
2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 606.01.

Table 606.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Joint Sealing Filler	1014
Preformed Joint Filler	1015
Reinforcing Steel	1020, 1021, 1024
Deformed Metal Joint Material.....	1027
Curing Materials	1010, 1011, 1012, 1013
Aggregates	1033
Admixtures	1007
Water	1005

606.03 -- Construction Methods

1.
 - a. The Contractor shall prepare the curb and gutter subgrades by excavating or filling with suitable material to the required depth below the finished surface in accordance with the dimensions shown in the contract.
 - b. All soft and yielding or other unsuitable material shall be removed and replaced with suitable material.
 - c. The material shall be compacted thoroughly by tamping or rolling and finished to a firm, smooth surface.
 - d. If necessary, water shall be added by sprinkling to facilitate compaction.
 - e. Concrete shall be deposited upon a thoroughly moistened subgrade. Ponding or puddling shall be prohibited.
2.
 - a. Forms shall be metal, straight, free from warp, and of sufficient strength to resist the pressure of the concrete and vibration.
 - b. Wood forms or curved metal forms shall be used for curves having a radius of less than 100 feet (30 m).
 - c. Forms shall be used for both the inside and outside faces of the curb and gutter.
 - d. All forms shall be thoroughly cleaned and oiled before concrete is placed against them. Forms that have become worn, bent, or broken shall not be used.
 - e. The forms shall be neatly and tightly joined and then securely pinned and staked to line and grade.

- 3. Slip-form techniques are acceptable.
- 4. The concrete in curbs and/or gutters shall be deposited full depth in one operation and shall be consolidated immediately after being placed with an internal vibrator.
- 5. a. The Contractor shall finish the exposed surfaces with a wooden or cork hand float.
 b. The Contractor shall finish concrete gutters in accordance with the requirements of Subsection 603.03.
 c. The edges of the curb face and backs are to be rounded in accordance with the details shown in the contract.
- 6. a. Contraction joints are to be opened with a double edger while the concrete is still plastic.
 b. Prefomed joint filler shall be placed at locations and in accordance with the details shown in the contract and double-edged while the concrete is plastic.
- 7. Forms may be removed 12 hours after the concrete has been placed. All honeycomb areas or small defects shall be properly pointed with mortar (1 part cement and 2 parts sand) or an approved grout.
- 8. When the inside or outside face of the curb and gutter forms a joint with other surfacing, all surplus concrete shall be removed from the face.
- 9. The Contractor shall cure concrete by one of the methods described for curing concrete pavement in Subsection 603.03.

606.04 -- Method of Measurement

- 1. The quantity of curb and combination curb and gutter will be measured in linear feet (meter).
- 2. The quantity of concrete gutter will be measured in square yards (square meters).

606.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete ____ Curb Type ____	Linear Foot (LF) [Meter (m)]
Concrete ____ Curb ____	Linear Foot (LF) [Meter (m)]
Concrete ____ Island Curb ____	Linear Foot (LF) [Meter (m)]
Concrete ____ Median Curb ____	Linear Foot (LF) [Meter (m)]
Concrete ____ Barrier Curb ____	Linear Foot (LF) [Meter (m)]
Combination Concrete ____ Curb and Gutter ____	Linear Foot (LF) [Meter (m)]
Concrete ____ Gutter	Square Yards (SY) [Square Meter (m ²)]

2. a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.

b. Payment shall be reduced by the amount described in Table 603.03.

c. (1) If the 28 day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department and under the supervision of the Engineer. The Department will take immediate custody of the cores at the time of sampling. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(2) Cores must be taken and tested within seven (7) days of being notified of the strength deficiency.

(3) The Engineer shall select the site where the cores will be taken.

3. Payment is full compensation for all work described in this Section.

**SECTION 607 -- CONCRETE SIDEWALKS, BIKEWAYS, AND
MEDIAN SURFACING**

607.01 -- Description

1. The Contractor shall furnish all materials and construct sidewalks, curb ramps, bikeways, and median surfacing of Portland cement concrete on a prepared subgrade as described in the contract.

607.02 -- Material Requirements

1. The concrete Class will be specified in the contract.
2. Fill for medians shall be sand, millings, crushed concrete or other suitable material approved by the Engineer.
3. Approved detectable warning panels are shown on the Department's Approved Products List.
4. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 607.01.

Table 607.01

Material Requirements	
Applicable Materials	Section
Concrete.....	1002
Fly Ash	1008
Aggregate.....	1033
Preformed Joint Filler	1015
Steel Bars for Concrete Reinforcement.....	1020

607.03 -- Construction Methods

1. Sidewalks, curb ramps, and bikeways shall be constructed as shown in the contract.
2.
 - a. The Contractor shall prepare the subgrade by excavating or filling to the elevation described in the contract.
 - b. The subgrade shall be thoroughly compacted to insure stability.
 - c. In fills, the subgrade shall be made at least 1 foot (300 mm) wider on each side of the required bikeway and/or sidewalk width.
 - d. Concrete shall be deposited upon a thoroughly moistened subgrade. Ponding or puddling shall be prohibited.
 - e. Sand fill, when required, shall be uniformly compacted to facilitate placing the concrete median surfacing.
3.
 - a. Forms shall be wood or metal and of a depth equivalent to the design thickness of concrete shown in the contract.
 - b. Forms shall be straight and able to support the concrete pressure without any deformation.
 - c. The forms shall be securely staked, braced, held firmly to the required line and grade, and sufficiently tight to prevent leakage of mortar.
 - d. All forms shall be thoroughly cleaned and oiled before the concrete is placed against them.

e. Slip-form methods described in Subsection 603.03 may also be used.

4. a. The Contractor shall deposit concrete on the prepared subgrade so the concrete will not segregate.

b. The concrete shall be deposited for the full thickness of the slab in one operation and shall be consolidated. Excess concrete shall be screeded off level with the forms.

c. After consolidation, the surface shall be struck off to the required grade and cross section.

d. (1) The surface of sidewalks and medians shall be floated to produce a smooth surface free from irregularities and voids.

(2) All edges and joints shall be rounded to a radius of 1/4 inch (6 mm).

(3) The surface shall then be brushed to slightly roughen the surface and remove the finishing tool marks.

e. (1) Surfaces of sidewalks shall have joints marked off in square areas not less than 1.0 square yard (0.8 m²) nor more than 4.0 square yards (3.3 m²). Bikeways shall have joints marked off in squares equal their width. The joints shall be cut at least 1/3 of the slab thickness, then edged on both sides of the cut.

(2) Surfaces of median surfacing shall be jointed in accordance with the details and at the locations shown in the contract.

(3) Holes for sign posts shall be formed in the median surfacing in accordance with the contract.

(4) Expansion joints shall be placed as shown in the contract.

5. Detectable warning panels shall be installed on curb ramps at the locations and in accordance with the details shown in the contract.

6. After the concrete has set, the side forms shall be removed and the spaces on both sides backfilled with moist earth. The backfill shall be graded and then compacted level with the walk surface.

7. The Contractor shall cure the concrete by one of the methods described for curing concrete pavement in Subsection 603.03.

607.04 -- Method of Measurement

1. The area of concrete sidewalks, bikeways, curb ramps, and median surfacing shall be measured in square yards (square meters).

2. Curb ramp areas shall be included in the sidewalk quantity.

3. The item "Detectable Warning Panel" shall be measured by the square foot.

607.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete _____ Sidewalks	Square Yards (SY) [Square Meters (m ²)]
_____ inch Concrete _____ Bikeways	Square Yards (SY) [Square Meters (m ²)]
Concrete _____ Median Surfacing	Square Yards (SY) [Square Meters (m ²)]
Detectable Warning Panel	Square Foot (SF) [Square Meter (m ²)]

2. Sand fill, when shown in the contract, will not be measured for payment but shall be considered subsidiary to the items of work for which direct payment is made.

3. In the event that more than one type or thickness of sidewalk or median surfacing is shown in the contract, an appropriate designation will be added to the pay item to differentiate the type or dimensions required.

4. Preparation of subgrade including necessary excavation and embankment for sidewalks, median surfacing, and bikeways shall not be paid for directly but shall be considered subsidiary to the construction of the sidewalk, bikeway, or median surfacing.

5. a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.

b. Payment shall be reduced by the amount described in Table 603.03.

c. (1) If the 28-day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department and under the supervision of the Engineer. The Department will take immediate custody of the cores at the time of sampling. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(2) Cores shall be taken and tested within seven (7) days of being notified of the strength deficiency.

(3) The Engineer will select the site where the cores will be taken.

6. Payment for the item "Detectable Warning Panel" shall be considered full compensation for all work required to furnish and install the detectable warning panels.

7. Payment is full compensation for all work described in this Section.

SECTION 608 -- CONCRETE ISLAND NOSE

608.01 -- Description

1. The Contractor shall prepare the subgrade, furnish all materials, and construct concrete island noses as described in the contract.

608.02 -- Material Requirements

- 1. The concrete Class shall be specified in the contract.
- 2. All materials furnished by the Contractor shall conform to the requirements in Table 608.01.

Table 608.01

Material Requirements	
Applicable Materials	Section
Concrete.....	1002
Preformed Joint Filler	1015
Reinforcing Steel	1020, 1022, 1023

608.03 -- Construction Methods

- 1. Construction shall be as described in Subsection 603.03.

608.04 -- Method of Measurement

- 1. Concrete island noses constructed on other than new pavement slabs will be measured by the each. The concrete island noses will not be measured on new pavement.
- 2. Removal of pavement for the placement of concrete island nose will be measured in square yards (square meters).

608.05 -- Basis of Payment

- | | |
|----------------------------|-----------------|
| 1. Pay Item | Pay Unit |
| Concrete _____ Island Nose | Each (ea) |

- 2. Removal of pavement and surfacing will be paid for in accordance with Section 203.
- 3. Island noses constructed on new pavement slabs will be subsidiary to the pavement.
- 4. a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.
- b. Payment will be reduced by the amount described in Table 603.03.

- c. (1) If the 28 day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department, and under the supervision of the Engineer. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

- (2) Cores shall be taken and tested within seven (7) days of being notified of the strength deficiency.

- (3) The Engineer will select the site where the cores will be taken.

- 5. Payment is full compensation for all work described in this Section.

SECTION 609 -- CONCRETE DRIVEWAYS

609.01 -- Description

1. The Contractor shall prepare the subgrade, furnish all materials, and construct a concrete driveway as shown in the contract.

609.02 -- Material Requirements

1. The concrete Class will be specified in the contract.
2. All materials furnished by the Contractor shall conform to the requirements in Table 609.01.

Table 609.01

Material Requirements	
Applicable Materials	Section
Concrete	1002
Preformed Joint Filler.....	1015

609.03 -- Construction Methods

1. The subgrade shall be prepared in accordance with the requirements of Sections 302 or 303, whichever is applicable.
2. The forms shall be constructed in accordance with the requirements of Subsection 603.03.
3.
 - a. The Contractor shall place the concrete on the prepared subgrade so there will be no segregation of the concrete.
 - b. The concrete shall be finished in accordance with the requirements of Subsection 603.03.
 - c. Concrete driveways shall be protected and cured by one of the methods described for curing concrete pavement in Subsection 603.03.
4. Surfaces of driveways shall be jointed in accordance with the details and at the locations shown in the contract.
5. Preformed joint filler shall be placed at locations and in accordance with the details shown in the contract. At each joint, both sides shall be edge finished while the concrete is plastic.
6. When required, integral curb shall be constructed in accordance with the requirements of Subsection 603.03.

609.04 -- Method of Measurement

1. Preparation of the subgrade will be measured in accordance with Sections 302 or 303, whichever is applicable.
2. Concrete driveways will be measured for payment by the square yard (square meters).

609.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete _____ Driveway	Square Yard (SY) [Square Meter (m ²)]

2. Preparation of the subgrade will be paid for in accordance with Sections 302 or 303, whichever is applicable.

3. If more than one thickness of driveway is shown in the contract, an appropriate designation will be added to the pay item to differentiate the thickness required.

4. a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.

b. Payment will be reduced by the amount described in Table 603.03.

c. (1) If the 28-day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department, and under the supervision of the Engineer. The Department will take immediate custody of the cores at the time of sampling. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(2) Cores shall be taken and tested within seven (7) days of being notified of the strength deficiency.

(3) The Engineer will select the site where the cores will be taken.

5. Payment is full compensation for all work described in this Section.

SECTION 610 -- CONCRETE MEDIAN BARRIERS

610.01 -- Description

1. The Contractor shall furnish all materials, construct, and install cast-in-place concrete median barriers and cast-in-place concrete median barrier ends and transition sections in accordance with the details shown in the contract.

610.02 -- Material Requirements

1. The concrete Class will be specified in the contract.
2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 610.01.

Table 610.01

Material Requirements	
Applicable Materials	Section
Concrete.....	1002
Reinforcing Steel.....	1020
Dowel Bars.....	1022

610.03 -- Construction Methods

1. Construction of the concrete median barrier shall conform to the applicable provisions of Sections 704 to 707.
2.
 - a. The surface finish of the median barrier shall be a rubbed finish in accordance with Subsection 704.03 if shown in the contract.
 - b. Each individual section of concrete median barrier shall have a uniform color and texture.
3. All forms shall be metal except for end and transition sections.

610.04 -- Method of Measurement

1. "Concrete _____ Median Barrier, Type _____" will be measured by the linear foot (meter). "Concrete _____ Median Barrier End Section, Type _____" and "Concrete _____ Median Barrier Transition Section, Type _____" will be measured by the each.

610.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete _____ Median Barrier, Type _____	Linear Foot (LF) [Meter (m)]
Concrete _____ Median Barrier End Section, Type _____	Each (ea)
Concrete _____ Median Barrier Transition Section, Type _____	Each (ea)

2.
 - a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.
 - b. Payment shall be reduced by the amount described in Table 603.03.

c. (1) If the 28-day compressive strength fails, the Contractor has the option to take 3 core samples, at no additional cost to the Department, and under the supervision of the Engineer. The Department will take immediate custody of the cores at the time of sampling. The average compressive strength of these cores will be used to determine the actual 28-day compressive strength of each day's production.

(2) Cores shall be taken and tested within seven (7) days of being notified of the strength deficiency.

(3) The Engineer will select the site where the cores will be taken.

3. Payment is full compensation for all work described in this Section.

SECTION 611 -- SEALING CRACKS

611.01 -- Description

1. This work shall consist of preparation and sealing of cracks, located in Portland cement concrete roadway.

611.02 -- Material Requirements

1. The cracks shall be sealed with a hot-poured type joint sealing filler which conforms to the requirements of Section 1014.

611.03 -- Construction Methods

1. Preparation of Cracks:

a. New cracks 1/4 inch (7 mm) and over in width shall be filled with crack sealing filler. Old cracks shall have all existing crack sealing filler or other foreign material removed by sandblasting or other methods that provide a clean and dry surface for the full depth of the crack.

b. The location of the cracks to be sealed will be designated by the Engineer.

2. Sealing Cracks:

a. The Contractor shall furnish the Engineer, the manufacturer's recommendations for mixing, application, and temperature restrictions of the hot pour sealer seven days prior to work beginning. These recommendations shall be strictly followed. In no case shall the temperature of the hot pour sealer exceed the maximum heating temperature recommended by the manufacturer. The hot pour sealer temperature shall not fall below the minimum application temperature recommended by the manufacturer during the application process.

b. When the minimum application temperature of the hot pour sealer is attained, the cracks shall be filled as shown in the contract through the use of a pressure type applicator equipped with a nozzle which will fit into the cracks.

c. The cracks shall be filled full depth as shown in the contract to 1/4 inch to 5/8 inch (7mm to 16mm) below the pavement surface.

d. Material spilled on surfaces of the pavement adjacent to the crack shall be cleaned away by the Contractor at no additional cost to the Department.

e. Cracks shall not be sealed until after any corrective work or Diamond Grinding and Texturing Concrete Pavement is completed.

611.04 -- Method of Measurement

1. Sealing cracks will be measured for payment by the linear foot (meter) of cracks sealed, measured to the nearest foot (meter) of sealed cracks, complete, in place and accepted by the Engineer.

611.05 -- Basis of Payment

1. Pay Item	Pay Unit
Sealing Cracks	Linear Feet (LF) [Meter (m)]

2. When sealant materials comply with the Specification requirement, crack sealing shall be paid for at the contract unit price per linear foot (meter).

a. When test results of on-site sealant materials is outside of the specified property ranges, crack sealing shall be paid for at the contract unit price multiplied by the Pay Factors in Table 611.01.

Table 611.01

Pay Factor*	Specified Property
1.00	Deviation of up to (+/-) 5.0%
0.95	Deviation of (+/-) 5.1% to 10.0%
0.90	Deviation of (+/-) 10.1% to 15.0%
0.80	Deviation of (+/-) 15.1% to 20.0%
0.70	Deviation of (+/-) 20.1% to 25.0%
0.40 or Reject	Deviation of 25.1% or greater

(1) When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied according to the above table.

(2) When more than one specified property exceeds specification tolerances, the largest pay factor reduction will be applied.

(3) Material not meeting a Pass/Fail requirement falls under the Pay Factor of 0.40 or reject.

b. If the material is found to be out of specification, the material shall be rejected if not already used. All material out of specification, regardless of pay factor, not in place, will be rejected and shall be removed from the site.

c. If the pay factor is less than 1.00 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material is determined by Table 611.01.

d. Material that exhibits unacceptable field application will be rejected and removed from the approved products list. Material already used shall be removed and replaced at no cost to the Department.

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. Should the Contractor request referee testing, it shall be submitted in writing to the Department within 30 days of receiving the notification of deficiency.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Payment is full compensation for all work described in this Section and all sealant manufacturer's requirements.

SECTION 612 -- SEALING JOINTS

612.01 -- Description

1. This work shall consist of the preparation and sealing of transverse and longitudinal joints and joints around existing concrete repairs in the concrete roadway.

612.02 -- Material Requirements

1. The joints shall be sealed with hot-poured type joint sealing filler which conforms to the requirements of Section 1014.

612.03 -- Construction Methods

1. Preparation of Joints

a. All joints shall be prepared by removing old joint sealing filler or other foreign material by diamond-blade sawing or other suitable method which will produce acceptable results. Details of the joints are shown in the contract. If the method of removing the old joint sealing filler creates a slurry, the joint shall be flushed with water to remove the slurry.

b. Immediately prior to sealing, the joints shall be sandblasted to remove any loose joint sealing filler or other foreign material remaining in the joint or adhering to internal surfaces of the joint after the initial preparation. The joints shall be dry and clean at the time of sealing.

2. Sealing Joints

a. The Contractor shall furnish the Engineer, the manufacturer's recommendations for mixing, application and temperature restrictions 7 days prior to work beginning. These recommendations shall be strictly followed. For hot pour material, in no case shall the sealing filler temperature exceed the maximum recommended by the manufacturer.

b. The joints shall be filled full depth as shown in the contract to 1/4 inch to 5/8 inch (3mm to 6mm) below the pavement surface. When proper pouring consistency is attained, the joints shall be filled as shown in the contract through the use of a pressure type applicator equipped with a nozzle which will fit into the joints.

c. Material spilled on surfaces of the pavement adjacent to the joint or overfilling the joint will be cleaned away by the Contractor at no additional cost to the Department.

d. Joints shall not be sealed until after any corrective work or Diamond Grinding and Texturing Concrete Pavement is completed. Formed joint wells that are destroyed shall be re-constructed, and joints of insufficient depth shall be deepened prior to sealing.

612.04 -- Method of Measurement

1. Sealing joints will be measured for payment by the linear foot (meter) of joints sealed, measured to the nearest foot (meter) as sealed, complete, in place and accepted by the Engineer.

2. "Sealing Concrete Repair Joints" is for those existing repairs that do not abut transverse and longitudinal joints. The work "Sealing Concrete Repair Joints" that abut existing transverse and longitudinal joints is included in the quantity of "Sealing Joints", as shown in the contract.

612.05 -- Basis of Payment

1. Pay Item	Pay Unit
Sealing Joints	Linear Foot (LF) [Meter (m)]
Sealing Concrete Repair Joints	Linear Foot (LF) [Meter (m)]

2. When sealant materials comply with the Specification requirement, joint sealing shall be paid for at the contract unit price per linear foot (meter).

a. When testing results of on-site materials is outside of the specified property ranges, joint sealing shall be paid for at the contract unit price multiplied by the Pay Factor table below.

b. If the material is found to be out of specification, the material shall be rejected if not already used.

c. If the pay factor is less than 1.00 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material is determined by the Table 612.01.

Table 612.01

Pay Factor*	Specified Property
1.00	Deviation of up to (+/-) 5.0%
0.95	Deviation of (+/-) 5.1% to 10.0%
0.90	Deviation of (+/-) 10.1% to 15.0%
0.80	Deviation of (+/-) 15.1% to 20.0%
0.70	Deviation of (+/-) 20.1% to 25.0%
0.40 or Reject	Deviation of 25.1% or greater

* When the specification requirement is stated as a percentage, the test result deviation from the specification will be divided by the specification value. The resulting deviation percentage is then applied according to Table 612.01.

* When more than one specified property exceeds specification tolerances, the largest pay factor reduction will be applied.

* Material not meeting a Pass/Fail requirement falls under the Pay Factor of 0.40 or reject.

d. Material that exhibits unacceptable field application will be rejected and removed from the Department’s Approved Products List. Material already used shall be removed and replaced at no cost to the Department.

3. When disputes arise in test results, the Department will select an independent laboratory for referee testing on the remainder of the sample. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing.

a. Only the Contractor can initiate dispute resolution, and request referee testing. The Contractor shall initiate the dispute resolution in writing to the Engineer within 30 days of receiving the notification of deficiency.

b. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specifications or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

4. Payment is full compensation for all work described in this Section.

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SECTION 701 -- GENERAL REQUIREMENTS

701.01 -- Description

1. This Section describes procedures and equipment that are common to a variety of structures as described in Division 700.

701.02 -- General Procedures

1. The Contractor shall excavate and place shoring as necessary to insure safe access to work areas.

2. Concrete Proportioning:

a. Concrete shall be proportioned, mixed and delivered under inspection of the Engineer.

b. A copy of the concrete load tickets shall accompany each load to the placement site and be available to the Engineer. Acceptance of the concrete at the placement site will be partially based upon verification that the concrete is of the proper class and has been delivered within the specified time limits.

c. Loads which are not accompanied by such tickets, which do not arrive in satisfactory condition, or which do not arrive within the specified time limits shall be rejected.

3. When unsuitable material is encountered, it shall be removed. Excavation will continue until the unsuitable material is removed or until the Engineer halts excavation.

4. When a concrete bottom seal course is required due to unforeseen conditions, the excavation shall be sufficient to allow for placement of the seal under the structure.

5. The Contractor shall not excavate within 5 feet (1.5 m) of any cast-in-place concrete deadman or grade beam tie rod anchor except for the limits of tie rod trenches and granular backfill as shown in the granular backfill details.

6. Concrete Placement and Consolidation:

a. Concrete shall be placed and consolidated in its final position with the utmost care.

b. The method used to place concrete shall not allow the concrete materials to segregate or displace reinforcing steel.

c. The impact of any free fall shall be kept to the lowest levels consistent with efficient placement.

d. The maximum free fall placement distance shall be 5 feet (1.5 m).

e. The use of vibrators to move concrete shall be prohibited.

7. The Contractor shall backfill bridge abutments, wingwalls, and retaining walls concurrently on all sides.

8. Cofferdams:

a. Cofferdams shall be substantially watertight. The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and inspection of forms.

b. Cofferdams shall be constructed so as to protect recently placed concrete from damage from a sudden rising of water and to prevent damage to the foundation by erosion.

c. No timber bracing shall be left in cofferdams or cribs. No bracing shall be incorporated into the structure's concrete.

d. Cofferdams shall be removed by the Contractor after the completion of the substructure.

9. Blocks and bracing shall be removed with the forms, and in no case shall any portion of the forms be left in the concrete.

10. Water jetting is not authorized for excavating or backfilling around structures.

701.03 -- Equipment

1. On bridge decks, jackhammers are restricted to those lighter than the 60 lb. (30 Kg) class.

2. Jackhammers or chipping tools shall not be operated at angles greater than 45 degrees from the deck surface.

SECTION 702 -- EXCAVATION FOR STRUCTURES

702.01 -- Description

1. Bridges and the steel/concrete structures specified in Division 700 may require excavation as part of their construction, and this excavation is distinguished from the roadway excavation specified in Section 200. This work shall consist of all excavation for the following:

- a. Bridge foundations:
 - (1) Abutments.
 - (2) Piers.
 - (3) Bents.
- b. Concrete seals.
- c. All culverts.
- d. Structural plate pipe.
- e. Headwalls and wingwalls.
- f. Retaining, MSE and Modular Block walls.
- g. Steps.
- h. Any and all other structures described in Division 700 or shown in the contract.

2. This work shall include the removal of any obstructions within the excavation limits shown in the contract. It shall include all necessary bailing, draining, pumping, sheathing, and the construction of cofferdams or temporary cribs and their subsequent removal. The work shall also include backfilling, compacting, and the disposal of any excess material obtained from such excavation.

3. All excavation shall be performed in compliance with current OSHA standards.

702.02 -- Material Requirements

1. Backfill materials shall be approved by the Engineer.

2. "Granular Backfill" meeting the requirements specified in Subsection 1033.02, Paragraphs 1., 2., and 3. or 6. and the requirements in Tables 1033.02A, 1033.03A or 1033.06 will be acceptable. "Clay lump" and "mortar-making" properties do not apply.

702.03 -- Construction Methods

1. Substructure Excavations:

a. The Contractor shall excavate a volume large enough to contain the structure and its forms and provide access to set, strike, and inspect the work (18 inch (450 mm) lateral spacing is generally adequate access).

b. Footings on soil:

(1) If water is encountered, the Contractor shall dewater the excavation.

(2) The water level shall then be maintained at an elevation below the base of the excavation until after the concrete has been placed and set for at least 5 hours.

(3) If water percolates through the base of the excavation in spite of dewatering efforts, then:

(i) The Contractor shall place a watertight seal course in the bottom of the excavation. This will be considered extra work.

(ii) The Contractor shall prevent seepage through the cofferdam's walls. Such seepage shall not be justification for the placement of a watertight seal course except as noted in Paragraph 1.b.(3) of this Subsection.

(4) If unsuitable soil is encountered at the elevation established for the bottom of the excavation, the excavation shall be continued to a width and depth designated by the Engineer. The unsuitable material shall be disposed as directed by the Engineer. The additional volumes excavated shall be replaced with compacted approved granular material, crushed rock or crushed concrete meeting the gradation requirements of Subsection 702.02 paragraph 2. The material shall be compacted to optimal stiffness as defined by a deflection target value established by the Engineer.

c. Footings on rock:

(1) Spread footings which are supported by bed rock shall be founded on horizontal surfaces cut at least 6 inches (150 mm) into the rock.

(2) The entire bottom surface of the footing shall be in contact with the rock.

(3) Footings shall be constructed to the elevations shown in the contract.

(i) If the rock is not a hard, solid, and a continuous stratum, then the excavation shall be continued until rock which will furnish the required support is found.

(ii) If a satisfactory foundation is found more than 3 feet (1 m) above, or if a satisfactory foundation is not found within 2 feet (600 mm) below the elevation shown in the contract, the work shall be suspended.

(iii) The Department will reevaluate the design before work resumes.

(4) All footings on rock will be inspected by the Geotechnical Unit before concrete is placed.

2. Excavating for Pipe and Pipe-Arch Culverts:

a. Pipe and Pipe-Arch Culverts constructed on soil:

(1) The trench width at its bottom shall be at least 36 inches (1 m) wider than the width of the pipe.

(2) All backfill will be placed as described in Paragraph 3. of this Subsection.

(3) Bedding, described as shaping the trench to the pipe's diameter, including recesses for connections, shall be required for all pipe with a diameter greater than 2 feet (600 mm). Bedding shall include shaping the trench to not less than 10% of the total culvert height.

b. Pipe and Pipe-Arch Culverts constructed on rock:

(1) When rock, cobbles, or boulders are encountered in the bottom of a culvert excavation, the rock shall be excavated to not less than 6 inches (150 mm) below the lower surface of the culvert and replaced with proper bedding material.

(2) No part of a culvert shall rest directly in contact with rock.

c. Unsuitable soil encountered at the bottom of pipe trenches shall be excavated, disposed as directed by the Engineer, and replaced with compacted approved granular material, crushed rock or crushed concrete meeting the gradation requirements of Subsection 702.02 paragraph 2.; the material shall be compacted to optimal stiffness as defined by a deflection target value established by the Engineer.

3. Backfilling:

a. All structures shall be backfilled in accordance with the following requirements:

(1) "Granular Backfill" limits are identified in the contract.

(2) Backfilling shall not damage any part of the structure.

(3) Backfill shall be placed in layers approximately 6 inches (150 mm) thick.

(4) Backfill layers shall be compacted to optimal stiffness as defined by a deflection target value established by the Engineer .

(5) Backfilling shall not be started against any structure until the concrete develops a compressive strength of at least 70% of the design compressive strength.

(6) Backfilling culverts, abutments, wingwalls, and piers shall progress concurrently on all sides.

(7) Backfilling of retaining walls and abutments is limited to the top of berm elevation until the superstructure is in place.

(8) All form boards or other obstructions shall be removed from drain or weep holes and any other structure before backfilling.

(9) When the area to be backfilled has standing water, the area shall be drained or pumped until dry. Saturated unstable material shall be removed from the base.

(i) If a suitable draining or pumping procedure cannot produce a dry area, an approved granular material shall be deposited to an elevation above the water level.

(10) The Contractor shall use all available suitable backfill material before obtaining borrow.

(11) The Contractor shall protect backfill from washing away or other erosion until the contract is complete and accepted by the Engineer.

(12) Backfill for areas which provide support for any subsequent surface or base course, which includes the area directly below the pavement section of the bridge approach slab, shall be constructed in

accordance with the requirements of Subsection 205.03 for Class III embankment and meet the compaction criteria in Table 702.01.

Table 702.01

Structure Backfill Requirements			
Soil Type	Depth Below Finish Grade	Moisture Requirements	
		Minimum	Maximum
Silt-Clay	Upper 40 in (1 m)	Opt. -3%	Opt. +3%
Silt-Clay	Depths > 40 in (1 m)	**	Opt. +2%
Granular	All Depths	**	**

** Moisture content as necessary to obtain stiffness.

b. Only suitable material shall be used for backfill.

(1) Materials such as frozen soil, logs, stumps, sod, weeds, or other organic matter shall not be used.

(2) The Engineer may approve the use of large stones more than 12 inches (300 mm) in diameter if all voids between the large stones are filled with compacted soil.

(3) Shales and other materials that break down during compaction shall not be used.

c. Granular Fill:

(1) "Granular Backfill" limits are identified in the contract.

(2) Underneath the approach slab sections excavated by the Contractor, the interior of all abutments and wingwalls and tie rod trenches shall be backfilled with granular backfill.

d. Temporary shoring:

(1) In lieu of excavating to construct the abutment substructure and then backfilling to the limits shown on the granular backfill detail, the Contractor may utilize other methods to achieve a minimum of 3 1/2 feet (1.1 m) of clear excavation from the inside abutment and wing faces.

(2) If this option is elected, the 3 1/2 feet (1.1 m) wide void shall be backfilled with "Granular Backfill" from the bottom of the void to the bottom of the approach slab; and a minimum depth of 1 foot (300 mm) of granular backfill shall be placed and compacted under the remaining approach slab section.

e. Backfilling bridges:

(1) The Contractor shall complete the backfill at bridges to the elevation shown in the contract. The backfilled surface shall be a smooth continuation of the surrounding ground.

(2) The Contractor shall compact backfill around bridge abutments, wingwalls, piers adjacent to railroad tracks, piers in the toe of embankment slopes, piers for grade separations, culverts, inlets, sewers, and all other structures shown in the contract.

(3) When tie rods are required, the abutment and wing backfill shall be placed and compacted to an elevation matching the planned tie rod elevations. The tie rods shall then be installed and the backfilling operation continued. The contractor may trench the tie rods after the abutment and

wing backfill. If the tie rods are trenched after the abutment and wing backfill, the tie rods shall be backfilled with granular material.

(4) The volume to be compacted adjacent to bridges shall be the entire embankment between the faces of the abutment walls and vertical planes 10 feet (3 m) outside and parallel to the ends of the floor.

(5) The entire area between the wings of box culverts and bridges shall be compacted.

(6) Abutments shall not be backfilled to the full height until the superstructure (except bridge slabs) has been placed.

f. Backfilling culverts:

(1) The Contractor shall place and compact embankments near pipe and box culverts in accordance with the requirements of Subsection 205.03 for the class of embankment and type of compaction shown in the contract.

(2) The area beneath and adjacent to pipe and pipe-arch culverts shall be backfilled carefully to insure the specified stiffness is achieved. Backfill shall be placed concurrently in equal lifts on both sides of the culvert.

(3) When the full embankment over a pipe culvert is not immediately placed, the embankment shall be constructed to the elevation of the original surrounding ground surfaces or at least to the midpoint of the culvert's vertical height (or to the elevation of the widest dimension of a pipe-arch culvert), with berm tops 2 feet (0.6 m) wide and with 1 vertical to 2 horizontal slopes away from the culvert. When the full embankment over a box culvert is not immediately placed, the embankment around the foundations shall be backfilled to at least the elevation of the original surrounding ground surfaces, but no lower than the top of the foundations. If necessary, additional excavation for backfill or embankment shall be required for this work.

(4) Backfill for traffic:

(i) Culverts having 2 feet or more depth of excavation, within 15 feet of traveled way shall be backfilled to 15 feet minimum from the edge of the traveled way prior to removing traffic control. Backfill for traffic shall be to the final grade or to the limits shown in Figure 702.01. Additional excavation for culverts may be required.

(ii) The Engineer may also determine that it is necessary or desirable to allow vehicles (construction or otherwise) to travel over a pipe or box culvert. The volume to be compacted adjacent to the pipe or box culvert shall be that between vertical planes located 5 feet (1.5 m) outside of and parallel to the neat lines of the pipe or barrel at its maximum horizontal dimension and a 1 vertical to 6 horizontal slope to natural ground line. Compacted soil shall be placed to a depth at least 3 feet (1 m) above the top of the box or pipe and to the grade of the existing adjacent shoulder slope on extensions. The remaining length of the pipe or box culvert shall be filled in accordance to pipe culverts in 702.03 Paragraph 3.f.(3).

(iii) After the pipe is laid or as soon as the box culvert concrete reaches 3000 psi compressive strength, the Contractor shall complete the backfill within 10 calendar days.

(iv) Failure to complete the backfill within 10 calendar days shall be cause for the assessment of liquidated damages in the amount of \$500 per working day until the backfill is completed. "Completion of the backfill" shall be defined as the time when all of the required material has been placed, compacted, and shaped.

(v) The Engineer may extend the 10 calendar days because of weather and soil conditions.

(vi) The assessment of all liquidated damages described in Section 702 shall be in addition to any applicable liquidated damages assessed in accordance with Subsection 108.08.

4. Excess Material Disposal:

a. The Contractor shall waste at the site or remove any excess material as approved by the Engineer.

b. No material shall be placed so as to permanently obstruct the flow of waterways except as shown in the contract.

5. Unsuitable material which in the opinion of the Engineer cannot be utilized in the fill shall be removed from the project and disposed at an approved site.

702.04 -- Method of Measurement

1. a. Excavation for individual bridge piers, bents, and abutments is not a field measured quantity. The pay item is a Lump Sum.

b. Tie rod excavation is included in the bridge abutment excavation.

c. In the event that a bridge is constructed with a change in plans or with a change in the location, the payment may be recomputed.

2. Excavation for pipe culverts, headwalls, and box culverts is measured by the cubic yard (cubic meter). The quantity of excavation is computed by the Department using Figure 702.01 and the following limits described below:

EXCAVATION PAYMENT LIMITS

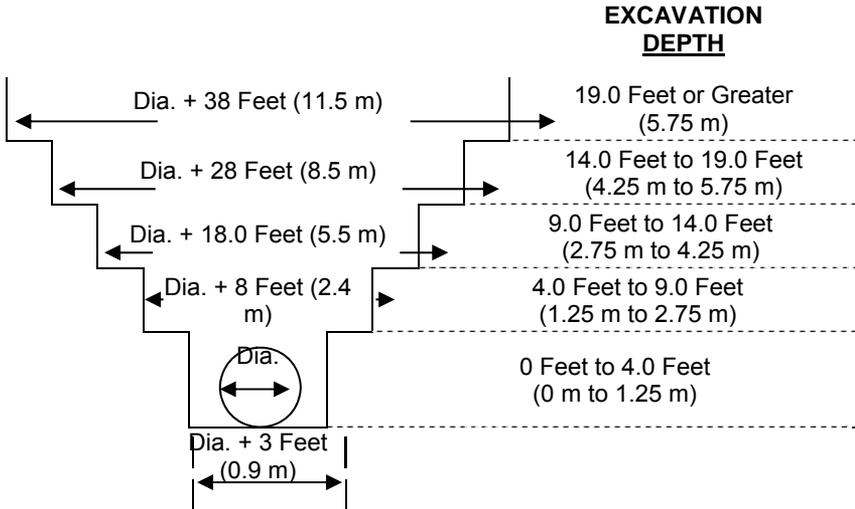


Figure 702.01

a. The upper limits will be the new channel section elevations, when shown in the contract, or the ground elevations, when a new channel section is not shown in the contract.

b. The horizontal limits to be used in computing the quantity of excavation will be as follows:

(1) Concrete Footings. Vertical planes 18 inches (450 mm) outside of and parallel to the limits of the footings.

(2) Headwalls. Vertical planes 18 inches (450 mm) outside of and parallel to the limits of the headwalls.

(3) Pipe Culverts. Vertical planes parallel to the centerline of the pipe culverts separated by a distance equal to the nominal inside diameter of the pipe, plus 36 inches (900 mm), and vertical planes 18 inches (450 mm) beyond the ends of the culvert.

(4) Pipe-Arches. Vertical planes parallel to the centerline of the pipe-arch separated by a distance equal to the maximum nominal inside clear span dimension of the pipe-arch, plus 36 inches (900 mm), and vertical planes 18 inches (450 mm) beyond the ends of the culvert.

c. The lower limits to be used in computing the quantity of excavation will be as follows:

(i) Concrete Footings. The bottom of the footings or the lower limits of unsuitable material removed at the direction of the Engineer.

(ii) Headwalls. The bottom of the headwalls.

(iii) Pipe and Pipe-Arch Culverts. The flowline elevation of the culvert or to the lower limits of unsuitable material removed at the direction of the Engineer.

d. In addition to the above, the nominal volume, based on neat dimensions, for the portion of the curtain or cutoff wall below the bottom of the concrete footings will also be included for payment for box culvert excavation.

e. (1) Overlapping excavation volumes will be measured and deducted from the pay volumes so that a volume is only paid for once.

(2) The overlap of removal excavation volume with an excavation volume required to construct new work will be deducted by subtracting the overlapping removal excavation volume from the new work excavation volume.

f. The excavation associated with the preparation of a structure or the removal of a structure shall be included in the quantity of excavation for pipe culverts and headwalls or excavation for box culverts when the structure is within the limits of excavation for the culvert or its headwalls.

g. Deductions will be made for the volume of any intersecting structure, except for pipe or pipe-arch culverts, when the intersecting structure has a cross sectioned area of more than 16 square feet (1.5 m²) within the limits of culvert excavation as shown in Figure 702.02.

DEDUCTION LIMITS

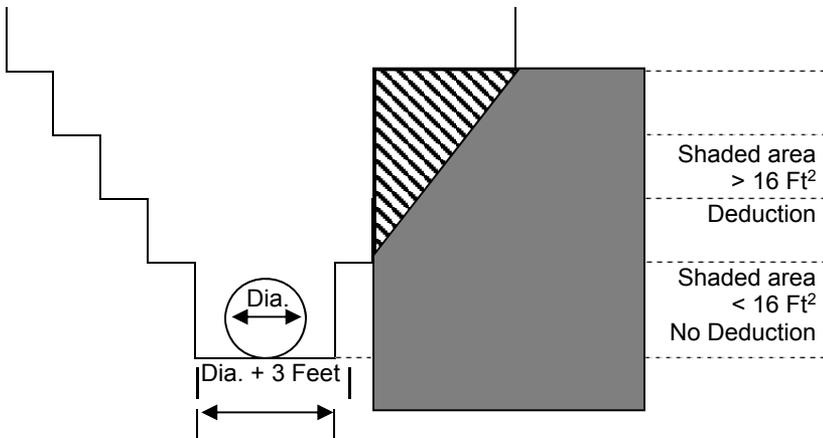


Figure 702.02

h. When excavation depths exceed 4 feet (1.2 m), an additional horizontal allowance will be computed on the basis of Figure 702.01. The slope of trench walls shall be approximately 1 foot (300 mm) rise to 1 foot (300 mm) run.

i. The excavation limits may vary due to the bedding requirements shown in the contract. The quantity of excavation will be computed on the basis of Figure 702.01.

j. The limits in figures 702.01 and 702.02 are for measurement purposes only. Any changes in the excavation limits for the Contractor's operations or that which is necessary to meet any safety requirement will not be cause for recalculation of the established quantity.

3. When the contract or special provisions require a culvert to be built with shoring or sheet piling, then Figure 702.01 will be superseded by the location of the shoring and the sheet piling when determining the authorized volume of excavation for culverts and pipes.

4. a. When additional material is required for backfilling or for the construction of embankments as described in these Specifications, the quantity to be paid for will be the volume of the material actually removed measured in cubic yards (cubic meters) in its original position.

b. When it is impracticable to measure the volume of material actually removed in its original position, the quantity to be paid will be 1.4 times the volume of placed embankment (cubic yards) (cubic meters). Payment will not be made for any surplus material placed outside the specified limits.

5. a. When unsuitable soil beyond the excavation payment limits at a Pipe Culvert, Pipe-Arch Culvert, Headwall, or Box Culvert is removed and replaced, the pay volume of soil removed shall be 2 times the actual volume removed as Excavation for Pipe, Pipe-Arch, Culverts, and Headwalls.

b. When unsuitable soil beyond the excavation for abutments, piers and bents will be paid for as extra work.

6. a. "Granular Backfill" for bridges shall be the quantity shown in the contract.

b. The quantity for "Granular Backfill" shown in the contract is computed in cubic yards (cubic meters) based on the lines and grades shown in the "Granular Backfill" details. In the event that a bridge is constructed with a change in contract or with a change in the location, the payment may be re-determined.

c. Deductions will not be made in the quantity of "Granular Backfill" when the Contractor elects to use a sheet pile wall to construct the abutment substructure in lieu of excavation.

7. When it is necessary to remove unforeseen obstacles at the direction of the Engineer and additional granular backfill is required, the removal and the additional "Granular Backfill" will be paid for as "extra work."

8. a. Backfill required by paragraph 3.f.(3) and 3.f.(4) of Subsection 702.03 is measured and paid for as "Excavation for Pipe, Pipe-Arch Culverts and Headwalls" or "Excavation for Box Culverts".

b. Backfill beyond the berm limits in paragraph 3.f.(3) and 3.f.(4) of Subsection 702.03 is paid for under the pay item for the remainder of the surrounding embankment.

9. The Contractor shall use all suitable excavated material from a structure for the backfill. The Contractor shall dry the material that exceeds the maximum moisture requirements. If the material exceeds the maximum moisture requirements during excavation and the volume exceeds 200 cubic yards (cubic meters), the drying of the material in excess of 200 cubic yards (Cubic meters) will be paid for as "extra work".

702.05 -- Basis of Payment

1. Pay Item	Pay Unit
Abutment _____ Excavation	Lump Sum (LS)
Pier _____ Excavation	Lump Sum (LS)
Bent _____ Excavation	Lump Sum (LS)
Granular Backfill	Cubic Yard (CY) [Cubic Meter (m ³)]
Excavation for Pipe, Pipe-Arch Culverts, and Headwalls	Cubic Yard (CY) [Cubic Meter (m ³)]
Sheet Pile Excavation	Cubic Yard (CY) [Cubic Meter (m ³)]
Excavation for Box Culverts	Cubic Yard (CY) [Cubic Meter (m ³)]

2. No direct payment will be made for furnishing, placing, and removing cofferdams or cribs. This work shall be considered subsidiary to the item requiring the cofferdam or crib.

3. Removal of unforeseen obstacles which are unknown to both the Department and the Contractor at the time of receiving bids, and which, in the opinion of the Engineer, will be detrimental to the work of Excavation for Structures shall be "extra work", except as noted in Subsection 104.06.

4. a. Direct payment will not be made for the following work which shall be considered as being subsidiary to the associated structure pay item:

- (1) Stepping slopes.
- (2) Placing or removing cofferdams and cribs.
- (3) Dewatering.
- (4) Backfilling or compacting.
- (5) Water used to facilitate compaction.
- (6) Drainage provisions at drains or weep holes.
- (7) The work involved in "bedding" pipes in trenches.
- (8) Sheeting and shoring.
- (9) Gravel, crushed rock, or other fill material (except as

allowed in Paragraph 6. of this Subsection).

5. Box and pipe culvert excavation shall be the quantity shown in the contract.

a. The quantity will be increased by the amount of unsuitable material excavation calculated in Section 702.04 Para. 5.

b. The quantity will be recomputed when the completed structure differs from the contract because of one or more of the following changed conditions:

- (1) An increase or decrease in length of more than 10 feet (3 m).

8. a. When compacted approved granular material, crushed rock or crushed concrete is placed for a structure foundation, payment will be "Granular Backfill".

(1) When "Granular Backfill" is not included in the Bid Proposal Schedule of Items and is the required backfill material to replace unsuitable material approved by the Engineer for removal, then the unit price for the replacement granular backfill shall be a negotiated unit price.

(2) Each day, the Engineer and the Contractor shall compare their records of unsuitable material removed and reconcile any differences.

b. Gravel or crushed rock will not be paid for as "extra work" when placed at the bottom of a foundation if the material is not required structurally and is being provided solely as a good working platform for the Contractor.

9. When it is necessary to lower the elevations of bridge foundation beds, the additional excavation will be measured for payment as "extra work".

10. The quantities of unsuitable material excavated beyond the excavation limits shown in the contract and removed at the direction of the Engineer will be paid as "extra work."

11. Deductions will not be made in the price paid for excavation when satisfactory foundation beds for spread footings are found at elevations within 36 inches (900 mm) above the elevations shown in the contract; however, when it is necessary to lower the elevations of these foundation beds or to remove unsuitable material as directed by the Engineer, the additional excavation will be paid for as "extra work".

12. Payment is full compensation for all work described in this Section.

SECTION 703 -- PILES AND PILE DRIVING

703.01 -- Description

1. This work shall consist of furnishing, driving, cutting, and extending all bearing and sheet piles. They shall be driven or placed in accordance with the requirements of these Specifications at the locations, elevation, penetration, and bearing shown in the contract.

2. Only one type of concrete piling may be used in any one structure. Before construction begins, the Contractor shall advise the Engineer in writing which type is to be furnished at each structure.

703.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 703.01.

Table 703.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Reinforcing Steel.....	1020, 1023, 1024
Epoxy Coated Reinforcing Steel	1021
Structural Steel (Bearing Piles).....	1045
Steel Sheet Piles and Sheet Pile Corners.....	1056
Sheet Zinc.....	1053
Sheet Aluminum.....	1054
Precast Piles.....	705

2. Steel Piling:

- a. Pipe pile shall meet the requirements in ASTM A 252, Grade 2.
- b. Sheet pile and sheet pile corners shall meet the requirements in ASTM A 328/A 328M.
- c. "H" pile shall meet the requirements in ASTM A 6/A 6M.

3. Pre-Cast Piling:

- a. Pre-cast concrete piling shall meet the requirements in Section 705.

4. Cast-In-Place Concrete Piles:

- a. Piles shall be constructed in accordance with the details shown in the contract.

- b. Materials:

- (1) The class of concrete used in cast-in-place concrete piles shall be as shown in the contract. Maximum slump for concrete used in cast-in-place piling shall be 6 inches (150 mm).

- (2) When the contract allows for the use of more than one class of concrete, the Contractor shall advise the Engineer, in writing, of the class of concrete to be used 14 days before the date of beginning the concrete work.

- (3) No change shall be made in the concrete class without written permission of the Engineer.

- (4) Reinforcement shall be furnished, handled, stored, and placed in accordance with the requirements of Section 707.

(5) Pile shells for cast-in-place concrete bearing piles shall be metal shells of the type, size, and gauge indicated in the contract.

c. Concrete Placement:

(1) After driving and before the placing of any concrete, the Engineer shall examine each shell throughout its entire length. If any shell is broken or otherwise defective, the Contractor shall remove and replace the shell or abandon the defective shell and drive a new shell. The Engineer will choose the location of the new shell.

(2) All shells for cast-in-place concrete piles supporting bents, piers, or abutments shall be fully driven before any pile in that unit is filled with concrete.

(3) Water inside the shells shall be removed before the concrete is placed.

(4) Concrete shall be placed in accordance with the requirements of Section 705.

(5) Concrete shall be placed continuously and shall be vibrated only in the areas which contain reinforcing steel.

(6) The shells shall be overfilled, the surplus concrete struck-off, and the top surface finished to a uniform, even texture.

5. Order requirements:

a. The Contractor shall furnish piles for each structure in accordance with the itemized list in the contract showing the number and lengths of all piles required.

b. The Contractor may, without additional compensation, increase the lengths given in order to suit the Contractor's method of operation.

c. Heat numbers shall be clearly visible on each pile.

d. Prefabricated pile points shall conform to the requirements of ASTM A27 Grade 70-36. A list of approved manufacturers of prefabricated pile points are on the Department's Approved Products List.

6. Downgraded or salvaged piles are not to be used.

7. Storing and Handling Piling:

a. Piles shall be stored on suitable skids or platforms. Piles shall be kept free from accumulations of dirt, oil, or other foreign matter.

b. If the Contractor uses bearing piles or sheet piles for falsework, trackways, or any other purpose than shown in the contract, such use will be at his/her own risk and any damaged piles shall be rejected for use as material in the permanent structure.

703.03 -- Construction Methods

1. Preparation for Driving Piles:

a. The Hammer Data sheet shall be required for the wave equation analysis. (The wave equation is a computer program that analyzes the hammer-pile system.) The Contractor shall submit a completed data sheet for each hammer to be used, to the Engineer, at least 21 days before its use. The Engineer will notify the Contractor, within 10 days of the receipt

of the hammer data, as to whether or not the hammer is acceptable. A typical Hammer Data sheet is shown in Figure 703.01.

b. The wave equation analysis may indicate that the hammer system may not be able to drive the pile to minimum penetration without damage to the pile. In this case, the Contractor shall modify the hammer system and submit a new Hammer Data sheet to the Engineer. The new data will be analyzed to determine if the modifications to the hammer system are adequate to allow the pile to be driven to minimum penetration without damage.

c. Hammers shall not be replaced or changed unless authorized by the Engineer. The Contractor shall submit a new Hammer Data sheet if hammers are changed.

d. The Contractor shall complete foundation pile pit excavations before driving the piles. After the piles are driven, all loose and displaced material shall be removed, leaving a smooth solid bed to serve as a concrete form.

e. The Engineer will use a saximeter to measure the height of the fall of the ram on a single acting diesel hammer. If a saximeter is not available, the Contractor, when using a single-acting diesel hammer, shall be required to have a measuring rod rigidly fixed to the hammer which will indicate the ram stroke in feet (meters). The measuring rod shall be divided into 3 inch (75 mm) increments and shall be readable from the ground.

(1) The Contractor may provide a saximeter for the Department's use.

f. The Contractor, when using a double-acting diesel hammer, shall furnish an appropriate gauge and chart to measure the bounce chamber pressure and resulting hammer output. The gauge shall be readable from the ground.

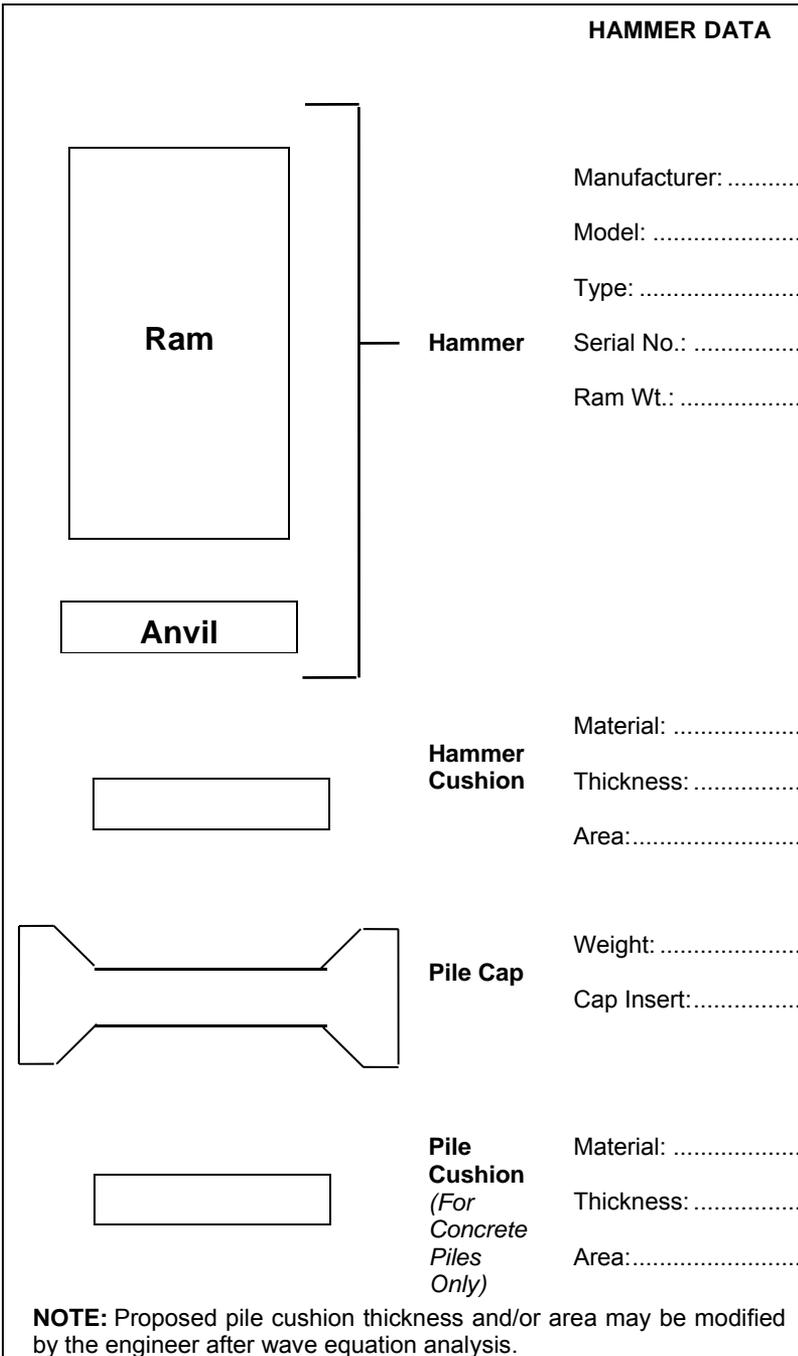
g. Cushioning Material:

(1) Wood or steel cable shall not be allowed for use as a hammer cushion.

(2) Wood can be used as a pile cushion.

(3) If fresh cushioning material has been inserted over the head of the pile, the penetration measurements for the purpose of determining the final bearing values shall not be made until at least 10 blows are struck.

j. Piles shall not be driven without the use of a closely fitting cap or driving head. This cap or driving head shall be of such design as to distribute the blow of the hammer throughout the cross section of the pile.



NOTE: Proposed pile cushion thickness and/or area may be modified by the engineer after wave equation analysis.

Figure 703.01

k. Full length piles shall be used where practical. Optional field splices will be allowed for steel "H" piling, pipe piling, and cast-in-place pile shells as follows:

(1) One optional field splice will be allowed on piling more than 40 feet (12.2 m) long and less than 80 feet (24.4 m) long. Two optional field splices will be allowed for piling over 80 feet (24.4 m) long and less than 120 feet (36.6 m) long. Three optional field splices will be allowed for piling over 120 feet (36.6 m) long. The method of splicing shall be as shown in the contract.

(2) Prefabricated pile splices of an approved type and source will be allowed for use on steel "H" piling, pipe piling, and cast-in-place pile shells. The splices shall be attached and welded in place in accordance with the manufacturer's recommendations.

(3) Preidentified splices shall be made before driving the pile, and the shortest side of the splice will be placed in the ground first.

l. Except where piles are driven through water, the use of a follower pile will not be allowed.

m. Welding:

(1) All welding to be done on steel piles shall be in accordance with the contract and the applicable requirements of Section 708 in the Standard Specifications. Welder qualification certification is required and must be submitted to the Bridge Fabrication Manager for approval prior to any welding. All field welding on steel piles shall be done in the SMAW process using electrode E7018.

(2) Welders shall be experienced in pile welding.

2. Pile Driving Methods:

a. Concrete and Steel Bearing Pile:

(1) Concrete and steel bearing piling shall be driven with a steam, air, or diesel hammer developing a manufacturer's rated energy such that when all known values are substituted in the applicable dynamic formula, "P" (bearing capacity in kips) shall be not less than 125% of the required design bearing when an "S" (penetration rate) of 0.05 inch (1 mm) per blow is assumed. In no case shall a power hammer have a ram weight of less than 2,000 pounds (900 kg) nor develop a manufacturer's rated energy of less than 8 Ft.-Tons (20 KJ).

(2) Water or air jets may be used to assist in driving the piling.

(3) Concrete and steel bearing piles may be driven with a gravity hammer for the first half of the pile's penetration below ground provided that the bearing of the driven pile does not exceed one-third of the design bearing.

(4) Steel pipe, "H" pile, and cast-in-place piling may be driven with a vibratory hammer for the first half of the driven length.

b. Steel Sheet Pile:

(1) Steel sheet piling shall be driven with a steam hammer, air hammer, diesel hammer, vibratory hammer, gravity hammer, or a combination of water or air jets and hammer.

(2) Steel sheet piles shall not be driven without the use of a closely fitting cap or driving head. This cap or driving head shall be of such design as to distribute the blow of the hammer throughout the cross section of the pile.

c. When gravity hammers are allowed the following requirements will apply:

(1) The minimum weight of gravity hammers which may be used for driving shells for cast-in-place concrete, pipe piles, and steel bearing piles shall be as shown in Table 703.02.

Table 703.02

Minimum Gravity Hammer Weight	
Design Bearing Capacity of Pile in Kips (kN)	Gravity Hammer Weight in Pounds (kg)
16 – 24 (70-105).....	2,000 (900)
More than 24 – 30 (105-135).....	2,500 (1100)
More than 30 – 44 (135-195).....	2,800 (1250)
More than 44 – 56 (195-250).....	3,000 (1350)
More than 56 – 74 (250-330).....	3,500 (1600)
More than 74 – 100 (330-445).....	4,000 (1800)

(2) The weight of the gravity hammer for driving precast concrete bearing piles shall not be less than 30% of the weight of the pile and never less than 2,000 pounds (900 kg).

(3) The fall of gravity hammers shall be operated so as to avoid damage to the piles.

d. Leads:

(1) No pile shall be driven without the use of leads. Pile driver leads shall be designed to afford free movement of the hammer and shall support the pile and hammer in proper position during driving. The stroke of the hammer shall be accurately in line with the axis of the pile. Leads, pile, and hammer shall be held in proper vertical or battered alignment to place the piles within the tolerances allowed.

(2) Swinging leads may be used with steam, air, or diesel hammers if the results obtained meet all requirements of these Specifications.

(3) Pile driver leads used with gravity hammers shall be guyed, braced, or fixed.

e. When water or air jets are used, the number of jets and the volume and pressure at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration.

f. Augured Holes:

(1) The Contractor has the option of starting piling in augured holes.

(2) Augured hole length shall not exceed 30% of the below-ground length of the pile.

(3) Augured hole diameters shall not be more than 2 inches (50 mm) larger than the pile.

3. Tolerance for Bearing and Sheet Piles:

a. Piles shall be driven to the depth and bearing shown in the contract or to "practical refusal", whichever occurs first.

b. Piles shall be driven plumb or to the batter indicated in the contract. Piles that do not meet the following criteria shall be rejected.

(1) No variation greater than 1/4 inch per foot (6mm per 300 mm) (2%) from vertical or the batter line indicated shall be allowed.

(2) In no case shall the top of a bearing pile be out of line more than 3 inches (75 mm).

(3) The tops of sheet piles shall not be out of position by more than 2 inches (50 mm).

(4) Adjacent sheets shall not be out of line with each other by more than 0.4 inch (10 mm).

c. (1) Broken, split, or misplaced piles shall be withdrawn and properly replaced; or, with the permission of the Engineer, a second pile may be driven in place thereof.

(2) Piles driven below cutoff grade shall be withdrawn and replaced with new piles.

d. Should the driving of any pile cause previously driven piles to rise, the Contractor shall drive them back to their described elevations.

4. Determination of Bearing Capacity:

a. The Engineer will compute the bearing capacity of every pile.

b. The Engineer will compute the bearing capacity of at least 1 pile in each substructure (i.e., bent, abutment, or pier) at 5 foot (1.5 m) penetration intervals.

c. The Contractor shall drive piles continuously.

(1) When the driving has been interrupted for more than 2 hours, the pile shall be driven at least 12 inches (300 mm) before the determination of the bearing value is made.

(2) Should the 2 hour interruption occur when the piling is within 12 inches (300 mm) of cutoff, then the bearing capacity shall be taken in the last 10 blows just before reaching cutoff elevation.

(3) An explanatory note should be included on the pile driving report when the pile was driven less than 12 inches (300 mm) or when less than 10 blows were averaged for the bearing capacity due to an unforeseen interruption.

(4) Driving the pile at least 12 inches (300 mm) is to determine the uniformity of bearing capacity between piling and is not intended to determine a setup factor.

(5) The head of the pile shall not have any broomed or crushed fibers.

(6) The pile penetration shall be quick and at uniform rate.

(7) Deviations or problems shall be noted by the Engineer on the driving report.

d. The bearing capacity of piles shall be computed from one of the following formulas:

Dynamic Formulas (English)

$P = \frac{3.5 WH}{S+0.35}$	x	$\frac{W}{W+M}$	For gravity hammers.
$P = \frac{3.5 E}{S+0.1}$	x	$\frac{W}{W+M}$	For steam hammers.
$P = \frac{3.5 E}{S+0.1}$	x	$\frac{W}{W+M}$	For driving steel, steel shell and pipe piles with diesel hammers.
$P = \frac{1.6 E}{S+0.1}$			For driving mandrel driven pile shells.
$P = \frac{7.0 E}{S+0.1}$	x	$\frac{W}{W+M}$	For driving concrete bearing pile with diesel hammers.

Where:

- P = the bearing capacity, in tons
 W = the weight of the ram, in tons
 M = the weight of the pile and driving cap, in tons
 S = the average penetration, in inches of the last 10 blows.
 H = the height of fall of the ram, in feet (less twice the height of bounce for gravity and steam hammers)
 E = the energy per blow in foot-tons
 For double-acting steam hammers, E = W x H.

For diesel hammers, the value of E in foot-tons shall be in accordance with Manufactures recommendations.

Unless permitted by the Department's Geotechnical Section, all piles driven with hammers other than single-acting diesel hammers shall be tested with the Pile Driving Analyzer to verify capacity.

Dynamic Formulas (Metric)

$P = \frac{2.9 WH}{S+9.0}$	x	$\frac{W}{W+M}$	For gravity hammers.
$P = \frac{290 E}{S+2.5}$	x	$\frac{W}{W+M}$	For steam hammers.
$P = \frac{250 E}{S+2.5}$	x	$\frac{W}{W+M}$	For driving steel, steel shell, and pipe piles with diesel hammers
$P = \frac{130 E}{S+2.5}$			For driving mandrel driven pile shells.
$P = \frac{580 E}{S+2.5}$	x	$\frac{W}{W+M}$	For driving concrete bearing pile with diesel hammers.

Where:

- P = the bearing capacity, in kN.
 - W = the mass of the ram, in kN.
 - M = the mass of the pile and driving cap kN.
 - S = the average penetration, in millimeters of the last 10 blows.
 - H = the height of fall of the ram, meters (less twice the height of bounce for gravity and steam hammers)
 - E = the energy per blow in meter-kilogram.
For double-acting steam hammers, E = W x H.
- For diesel hammers, the value of E in kilojoules shall be in accordance with Manufactures recommendations.
Unless permitted by the Department’s Geotechnical Section, all piles driven with hammers other than single-acting diesel hammers shall be tested with the Pile Driving Analyzer to verify capacity.

(1) For bridges with design live load “HL-93”:

Dynamic Formulas (English)

Diesel Hammers:

$P = \frac{4.0 E}{S+0.5}$ For all piles driven from the top with a single-acting diesel hammers (English)

Where:

- P = the bearing capacity, in kips
 - S = the average penetration per blow, in inches of the last 10 blows
 - E = the energy per blow in foot-kips (English) or meter-kilogram (Metric).
For single-acting diesel hammers, E = W x H
 - w = the weight of the ram, in kips
 - H = the height of fall of the ram, in feet (less twice the height of bounce for gravity and steam hammers)
- Unless permitted by the Department’s Geotechnical Section, all piles driven with hammers other than single-acting diesel hammers shall be tested with the Pile Driving Analyzer to verify capacity.

e. When using double-acting diesel hammers, the hammer energy shall be read from the bounce chamber pressure gauge and computed from the bearing chart. The hammer energy used to compute pile bearing shall not exceed the manufacturer's energy rating.

f. If piling driven to the described depth fails to obtain the required bearing capacity, the Engineer will temporarily suspend driving.

(1) The Engineer will reevaluate pile requirements and notify the Contractor of proposed revisions within 2 NDOT work days from the time driving was suspended.

g. Soil-Setup Factor:

(1) In certain silt, clay, or very fine sand soils, the initial bearing computed by the formulas in this Section may not accurately represent the long-term bearing capacity of the pile. In such cases, the Engineer will request data to calculate soil-setup factors.

(2) Whenever a setup factor is to be established for a group (i.e., abutment and wings, grade beam, bent, or pier), 2 representative piles shall be driven to within 2 feet (600 mm) of the cutoff elevation shown in the contract and the bearing shall be computed on the basis of the average penetration of the last 10 blows, this will be considered the bearing achieved at the End of Original Drive (EOD). The piles will then be allowed to rest undisturbed for 36 hours. In the case of twin bridges, each shall be considered a separate bridge for the determination of soil setup factors.

(3) Soil-Setup Determination:

(i) After 36 hours have elapsed, the hammer shall be warmed up on the first Pile. This pile shall be driven to cutoff elevation. The bearing of the first Pile is not reliable if the hammer is not warmed up.

(ii) The hammer shall then be placed on the second Pile and the bearing computed on the basis of the average penetration of the first 10 blows. This pile shall be driven to cutoff and the bearing also computed on the basis of the average penetration of the last 10 blows required to bring the pile to cutoff elevation.

(iii) The bearing capacity computed on the basis of the first 10 blows shall be reported to the Engineer, and the Engineer will determine a setup factor. This factor may then be used to increase the computed bearing of the other piles in the group.

(iv) The soil-setup factor shall be determined by a ratio of two computed bearing loads for the same pile. The computed bearing load determined for the first 10 blows after a piling that has rested undisturbed for a minimum of 36 hours is bearing achieved at the Beginning of Restrike (BOR) as determined in paragraph (3) (ii). The soil-setup factor is the ratio of the BOR divided by the EOD as determined in paragraph (2).

(4) The Engineer may monitor the pile driving during the set up determination with the Pile Driving Analyzer. The Engineer shall prepare the pile for dynamic testing, and the Contractor shall attach and detach the gauges.

5. Test Piles:

a. Test Piles shall be driven at the locations shown in the contract. The Contractor shall give the Engineer a 7 day notice as to when he/she proposes to drive each test pile. The Engineer will monitor each test pile with a Pile Driving Analyzer.

b. When the pile order lengths are indicated as "tentative" in the contract, the final order lengths will be based on results obtained from the test pile driving.

- c. The Department will provide the Pile Driving Analyzer and gauges.
- d. The test piles shall be restruck a minimum of 36 hours after initial driving to determine a soil-setup factor. Restrucking shall be subsidiary to the test pile. The restruck will be monitored with the Pile Driving Analyzer.
- e. The Contractor shall bolt two accelerometers and two strain transducers to the pile before driving is started. The holes or anchors for the accelerometers and strain transducers will be predrilled by Department personnel while the pile is still on the ground.
- f. The Contractor may be required to stop the hammer for wave speed determination after the first few blows.
- g. The Contractor shall drive the pile until the transducers are near the ground surface or as directed by the Engineer, at which time the Contractor shall stop the hammer and remove the accelerometers and strain transducers.
- h. The Contractor shall continue driving the pile to cutoff elevation or as directed by the Engineer.
- i. The time delay occurring when driving a pile monitored by the Pile Driving Analyzer will normally range from 30 to 60 minutes.
- j. The test pile shall be incorporated into the foundation and become a load bearing pile.
- k. The Engineer will provide final order lengths to the Contractor within 3 NDOT work days after the test pile is driven.
- l. Test piles and the service piles shall be driven with the same hammer for each structure.

6. Practical Refusal:

- a. "Practical refusal" occurs when the actual bearing capacity is 2.0 times the Design Pile Bearing.
- b. If a pile is at "practical refusal", driving shall be suspended. When "practical refusal" is reached before the pile has been driven to the specified minimum depth, the Engineer may require the Contractor to supplement the equipment with an adequate jetting system. By this means, the Contractor shall loosen the pile and continue to drive to the specified depth.

c. The Engineer may require predrilling through the material that is causing premature refusal for subsequent piling.

7. Elevation of Piles and Cutoff:

- a. Piles shall be driven to the specified depth and cut off at the elevation shown in the contract. The entire order length may be driven if the pile top is not damaged.
- b. Prestressed concrete piling shall be cut off to the shape specified.
 - (i) A saw cut, to the depth of the prestressing strands, shall be made at cutoff elevation around the perimeter of the pile.

(ii) After the saw cut is completed, a chipping tool shall be used to expose the prestressing strands for burning.

(iii) The Contractor shall remove the excess portion of the concrete pile after cutting the prestressing strands.

(iv) The Contractor shall remove and replace piles that have been broken or damaged.

8. Extensions, Splices, Build-Ups, and Overdriving of Precast Concrete Pile:

a. The Engineer shall approve all extensions, build-ups, or splices on concrete piles. When authorized, they shall be made as follows:

(1) After driving is completed, the concrete at the end of the pile shall be cut away leaving the reinforcing bars exposed for 20 inches (500 mm).

(2) The cut of the concrete shall be perpendicular to the axis of the pile.

(3) Additional bars of the same size and number as original bars, together with spiral reinforcing, shall then be fastened securely to the projecting steel and the necessary formwork placed. Formwork shall be built to prevent leakage along the pile.

(4) The concrete shall be of the same mix as that used in the original pile.

(5) Just before placing concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of mortar (1 part cement and 2 parts fine aggregate for concrete).

(6) The forms shall remain in place until test cylinders made during the progress of the work and subjected to the same curing conditions have attained a compressive strength of at least 2,000 psi (14 MPa).

b. A driving splice may be constructed instead of a build-up splice. The steel sleeve shall be fitted over the top of the driven pile, and a length of the same type of piling shall be placed in the top section of the sleeve. The piling shall be seated together by short blows with the hammer before full driving forces are applied. The allowable length of the extension will be determined by the Engineer.

9. Prefabricated Cast Steel Pile Points:

a. Piles requiring prefabricated pile point protection are shown in the contract.

b. The piles shall be cut off to provide a good fit with the prefabricated point.

c. Flanges shall be beveled 0.3 inch (8 mm) to prepare for the attaching welds, and the points shall be attached to the pile by an 0.3 inch (8 mm) (minimum) single bevel groove weld across the full width of the pile flanges.

10. Painting:

a. Exposed surfaces of all piles above finished ground line or stream shall be painted.

b. Steel bearing piles, steel pile shells, pipe piles, and steel sheet piles shall be painted in accordance with the requirements of Section 709.

703.04 -- Method of Measurement

1. The unit of measurement for bearing piling will be the linear foot (meter). The quantity shall be the authorized length of piles in the completed structure.

2. Sheet piling will be measured for payment by the square foot (square meter). The area is obtained by multiplying the length of the sheets driven by the manufacturer's nominal driving width of each sheet.

The quantity paid will be the authorized square feet (square meter) of sheet piling in the completed structure.

3. "Test Pile" are measured by the each.

4. A pile allowance is not authorized for quantities greater than those ordered by the Engineer or for piles subsidiary to other items of work (i.e., test piles).

5. All cutoff material shall become the property of the Contractor and shall be disposed of in a manner satisfactory to the Engineer.

703.05 -- Basis of Payment

1. Pay Item	Pay Unit
Test Pile _____	Each (ea)
Concrete _____ Piling	Linear Foot (LF) [Meter (m)]
Pipe Piling	Linear Foot (LF) [Meter (m)]
_____ inch x _____ lb Steel Piling	Linear Foot (LF) [Meter (m)]
Steel Sheet Piling	Square Foot (SF) [Square Meter (m ²)]
Static Pile Load Test	Each (ea)

2. a. (1) Provided that the Contractor furnishes the Engineer signed purchase orders for bearing and sheet piling, authorized "cutoff" of bearing and sheet piling shall be made at the invoice price per linear foot (meter) of piling.

(2) The signed purchase orders shall be furnished at the pre-construction conference.

b. In those cases where signed purchase orders for bearing and sheet piling are not furnished at the pre-construction conference, authorized "cutoff" of bearing and sheet piling shall be made at 60% of the piling's contract unit price.

c. No payment is made for "cutoff" beyond the order length.

d. When bearing or sheet pile are authorized for cutoff and are suitable for use as spliced material for the same purpose on the project, the length of material subsequently driven as service piling shall be deducted

from the payment for cutoff. No piece of piling can qualify for more than one measurement as pay cutoff.

3. Splices ordered by the Engineer shall be paid for at 5 times the unit bid price (2 times the unit bid price for Metric projects) for HP steel piling, pipe piling, and cast-in-place piling; and at 20 times the unit bid price (7 times the unit bid price for Metric projects) for driving and build-up splices for precast/prestressed concrete piling.

4. Separate payment, at the contract unit price, is provided for piling extensions needed to reach cutoff elevation, bearing capacity, and/or practical refusal.

5. Unless a soil-setup is specified on the contract, all pile soil-setup factors ordered by the Engineer will be paid for at a rate of \$750.00 each. Multiple soil-setup factors taken for any one group and within one hour of each other will be considered one soil-setup factor, and payment will be a total of \$750.00.

6. The work performed by the Contractor in conjunction with the use of the Department's Pile Driving Analyzer shall be considered subsidiary to the piling.

7. Overdriving:

a. A pile is overdriven when the Engineer determines that the pile must be driven deeper than the specified depth and no extension to the order length is necessary.

b. Overdriving length is paid for at 40% of the contract unit price of the piling.

c. Payment length shall be the difference between the original cutoff elevation and the actual elevation of the top of the pile in-place in the structure.

d. Additional concrete required, due to the void from the precast concrete piles, will be paid at the invoice price.

8. Furnishing and attaching cast steel pile points will not be paid for directly but shall be considered subsidiary to the piling.

9. Pile jetting or augering is a Contractor's option and shall be performed at no additional cost to the Department.

10. Optional field splices are subsidiary to the pile payment.

11. The pile used in the pay item "Test Pile _____" is subsidiary to this pay item.

12. The Contractor shall replace and redrive broken or damaged cast-in-place concrete pile shells at no additional cost to the Department.

13. The Contractor shall remove and replace piles that are broken or damaged at no additional cost to the Department.

14. No payment will be made for broken piles or piles that are ordered and are not used.

15. Payment is full compensation for all work described in this Section.

SECTION 704 -- CONCRETE CONSTRUCTION

704.01 -- Description

1. This work shall consist of falsework and form construction and the handling, placing, curing, and finishing of concrete for bridges, box culverts, arch culverts, headwalls, concrete seals, retaining walls and steps, foundations, substructures, and miscellaneous structures. All work shall be done in accordance with these Specifications and the contract.

2. Also included in this Section is all work necessary to adapt existing structures for extension or reconstruction.

704.02 -- Material Requirements

1. The class of concrete shall be shown in the contract or specified in the special provisions.

2. When the contract or special provisions allow the use of more than one class of concrete, the Contractor shall advise the Engineer of the class of concrete to be used before the date of beginning of concrete construction on any project. No change shall be made in the class of concrete during the progress of the work without the written permission of the Engineer.

3. Materials shall conform to the requirements in Table 704.01.

Table 704.01

Material Requirements	
Applicable Materials	Section
Anchor Bolts	1057, 1058
Curing Materials.....	1010, 1011, 1012
Deformed Metal Center Joints and Metal Keyway	1027
Dowel Bars	1022
Galvanized Hardware	1059
Joint Sealing Filler.....	1014
Paint and Paint Materials	1077
Portland Cement Concrete	1002
Preformed Joint Filler.....	1015
Reinforcing Steel.....	1020, 1023, 1024
Epoxy Coated Reinforcing Steel	1021
Structural Steel	708

704.03 -- Construction Methods

1. The Contractor shall construct concrete structures as described in the contract. All concrete rails on bridges and approach slabs shall be cast-in-place. Slip-forming will not be permitted for concrete rails on bridges and approach slabs.

2. Foundation Preparation:

a. Foundation excavations shall be as dry as practicable before concrete is placed.

b. In the event that the Contractor is required to excavate for spread footings to depths greater than those shown in the contract, the Engineer will redesign the structure's outline and reinforcement and provide the Contractor the appropriate revised plans.

3. Rock Anchors for Spread Footings:

a. The Contractor shall anchor spread footings resting on rock with reinforcing bars of the size, length, and number shown in the contract.

b. In rock, the reinforcing hole diameters shall be at least 2 times the bar diameters and shall be drilled to the depth indicated in the contract.

c. The bars shall be centered in the holes and grouted in place.

d. The grout shall be composed of 1 part cement and 2 parts sand and shall be placed by a method which will insure that the hole is completely filled with grout.

e. Reinforcing bar holes need not be pumped out when grouting the bars if the method that is used for placing the grout does not cause grout mix segregation.

4. Concrete Seal Course:

a. When shown in the contract or when conditions are encountered which render it impossible or impracticable to dewater the foundation bed in a satisfactory manner before and during the concrete placement, the Contractor shall be required to construct a concrete foundation seal course below the elevation of the footing of such dimensions as may be necessary.

b. Concrete for such seal course shall conform to the requirements for concrete placed in still water as described in Paragraph 11. of this Subsection.

c. When the seal course has been in place for at least 72 hours after completing the final placement, the cofferdam shall be cleared of water. The seal shall be capable of excluding water from below so that the balance of the structure may be completed.

d. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through the fresh concrete.

e. No pumping will be allowed while placing the concrete, or for 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other effective means.

5. Falsework:

a. The Contractor is responsible for the falsework and its design. The falsework shall be designed and sealed by a Professional Engineer registered in Nebraska.

b. The Contractor shall submit falsework plans when they are required by the contract, special provisions or for the following construction requirements:

(1) Support of plastic concrete for concrete slab bridges with spans greater than 50 feet (15 m) in length.

(2) Support of girders or other large structural elements when falsework is used.

(3) Concrete deck cantilevers more than 6 feet (1.8 m) beyond the exterior girder.

c. Falsework design submittals shall meet the following criteria:

(1) Detailed falsework plans shall be submitted to the Department, in triplicate, and for information only. The supporting calculations or evidence of adequacy are also required by the Department.

(2) Falsework plans and calculations shall bear the seal of a Professional Engineer registered in Nebraska.

(3) The design of the falsework shall meet the requirements in AASHTO's *Standard Specifications for Highway Bridges* and the *Guide Design Specification for Bridge Temporary Works*.

(4) The falsework plans must be submitted to the Department prior to erection of any falsework elements.

(5) The Department's request for falsework plans and calculations will in no way constitute review and approval, and the Contractor shall be solely responsible for the falsework and its design.

d. All falsework shall be designed and constructed to support the loads without appreciable settlement or deformation. The Contractor shall construct all falsework according to the falsework plans submitted.

e. (1) Falsework may be supported by pilings which shall be spaced, driven, and removed in a manner satisfactory to the Engineer.

(2) Falsework may also be supported by beams hung from the bridge's permanent substructure with the written approval of the Engineer. The Contractor shall repair any damage at no cost to the Department.

(3) Falsework for highway grade separation structure may be supported by mudsills if they are large enough to provide necessary support of the load.

(4) All falsework shall be removed after the structure is complete.

f. Falsework construction shall not begin until the contractor has complied with the conditions in Section 704.03 5.c.

g. Falsework shall be set up to produce a finished structure at the elevations and grades indicated in the contract. The Contractor shall consider and compensate for deflections that the method of construction creates.

h. Materials for falsework may be either new or used. All materials are subject to inspection by the Engineer to determine if they are suitable for their intended use. All materials which the Engineer determines to be damaged, defective, or otherwise unsuitable for use will be rejected.

i. Falsework and falsework supports shall be protected against impact and the effects of vibration by placement of barriers or limiting the access of construction equipment.

j. All falsework piles in the stream channel shall be pulled when no longer needed.

6. Forms:

a. Formwork shall be constructed in accordance with the current *AASHTO Guide Design Specification for Bridge Temporary Works*.

b. Forms for concrete shall conform to the dimensions, lines, and grades shown in the contract. They shall be substantial, unyielding, and constructed mortar tight. They shall be sufficiently rigid to prevent distortion due to pressures of concrete, vibration, and other loads incidental to the construction operations.

c. Form Materials:

(1) Aluminum or other materials that react adversely with the concrete shall not be used in the forms.

(2) Form liners shall be made of plywood, water-resistant composition board, or other approved material. Only one type of liner shall be used throughout the structure. Liners shall be a uniform size and as large as practical. Joints shall be tight and smoothly cut.

(3) Forms for 42 inch bridge rails shall be made of steel. Wood forms that are commercially manufactured to the specific shape of the 42 inch rail may be permitted. Forms shall be capable of producing a uniform surface, texture and appearance equal to that obtained by using steel panels in good condition.

d. Form Design:

(1) Concrete for exposed surfaces shall be cast against form panels or surfaces capable of producing a uniform surface, texture, and appearance at least equal to that obtained by using plywood form panels of good condition.

(2) Forms not capable of producing such a surface shall be lined.

(3) Adjacent panels shall be oriented and aligned so that the joints and grain give a continuous, uniform appearance.

(4) Forms shall be filleted or chamfered approximately 3/4 inch (19 mm) at all exposed corners.

(5) Forms shall be set and maintained true to the line designated without the use of temporary internal bracing.

(6) Form surfaces shall be treated with a nonstaining form oil or other approved material. No material which will adhere to or discolor the concrete shall be used.

(7) Metal ties or anchorages within the forms shall be designed to allow their removal to a depth of at least 1/2 inch (13 mm) from the face without damaging the concrete.

(8) Tie and anchorage cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in color.

(9) Protruding ends of plastic ties shall be removed flush with the concrete surface.

(10) When a monolithic layer cannot be completed in one operation, it shall be terminated in a vertical bulkhead.

e. Successive Pours:

(1) Twelve hours after placing concrete, the reinforcing steel and form work for the succeeding pours may be set on the curing concrete.

(2) It is recognized that for the forming to proceed, it will be necessary to remove the wet burlap from the specific areas where the forming will take place. The exposed area shall be kept to an absolute minimum and shall be kept damp.

(3) Reinforcing steel and form work for bridge curbs and bridge rails shall not be placed until after the 10-day wet curing.

f. Girder Bridge Deck Forms:

(1) Forms for concrete floor slabs on steel or precast concrete girders or beams shall be hung from adequate metal hangers.

(2) Forms shall be adjustable to vary the slab thickness.

(3) Forms shall be of such substantial design that no measurable settlement of forms occurs when the concrete deck is placed.

(4) Tack welding of form hangers or other miscellaneous hardware to the flanges of girders is prohibited.

g. Steel stay-in-place forms will be allowed for concrete floor slabs on steel or precast concrete "I" girders. Stay-in-place forms shall be used for interior areas only, where the forms are supported on both sides by girders. Stay-in-place forms must be adjustable to maintain proper slab thickness and shall be designed so no measurable settlement of forms occurs when the concrete deck is poured. Stay-in-place form support systems must be designed so as to maintain a minimum 1/2 inch (12 mm) clearance between the form support and the bridge deck reinforcing steel. Removable forms must be used outside of the exterior girders.

(1) The form corrugations shall be filled with polystyrene strips to prevent excess slab dead load.

(2) The Contractor shall submit four copies of the stay-in-place form design plans and computations to the Engineer prior to construction. These plans and computations are for information only. The Contractor is responsible for the performance of the stay-in-place forms.

(3) Steel stay-in-place form material shall conform to the requirements of ASTM A 653/A 653M Coating Designation G615/Z500.

(4) The stay-in-place forms will not be measured and paid for directly but shall be considered subsidiary to the item Class 47BD-_____ Concrete for Bridges.

7. Removal of Forms and Falsework:

a. Falsework and forms shall not be removed without the approval of the Engineer.

b. Forms:

(1) Forms shall not be removed until the concrete has sufficient strength to prevent damage to the concrete.

(2) Forms not supporting the dead weight of the concrete shall remain in place for a minimum of 24 hours, exclusive of time which the air temperature is below 40 °F unless external heating is used.

(i) Forms for bridge barrier rail may be removed after 12 hours, exclusive of time which the air temperature is below 40 °F unless external heating is used.

(ii) Forms for vertical surfaces requiring a rubbed finish may be removed after 12 hours.

(3) Forms supporting the dead weight of the concrete shall remain in place in accordance with the requirements for falsework.

c. Falsework:

(1) Falsework for bridges:

(i) Falsework and supporting forms shall not be removed until the concrete has reached 70% of the required compressive strength.

(ii) Falsework and supporting forms shall remain in place for a minimum of 5 days after the pour, with the following exceptions:

(a) Supporting forms for open rails shall remain in place for a minimum of 3 days.

(b) Supporting forms for overhangs less than 8 inches shall remain in place a minimum of 24 hours.

(iii) In the absence of compressive strength test, falsework and supporting forms shall remain in place 10 days, exclusive of the time during which the temperature is below 40°F unless external heating is used.

(2) Falsework for box culverts:

(i) Falsework and supporting forms shall not be removed until the top slab has reached 70% the design compressive strength.

(ii) In the absence of compressive strength test, falsework for top slabs shall remain in place 7 days, exclusive of the time during which the temperature is below 40°F unless external heating is used.

(3) Supports shall be removed gradually so as to allow the concrete to support its own weight uniformly.

(i) Falsework supports shall be released near the center of the span and progress toward the end supports.

(ii) All falsework piles shall be removed in accordance with the requirements of Subsection 203.02, Paragraph 13.

8. Reinforcing steel shall be placed as described in Subsection 707.03.

9. Preparation of Bearing Areas and Setting Anchor Bolts:

a. The Contractor shall prepare bridge seats for bearing devices and shall finish the bridge seats to the elevations shown in the contract. The top shall form a true continuous plane surface.

b. Anchor bolts shall be set at the time of placing the concrete, or they may be placed and grouted in blocked out holes.

c. Anchor bolts shall be set plumb and at the proper location and elevation with templates.

d. Blocked out wells for grouted anchor bolts may be either round or square and shall be 1 1/2 inches (38 mm) larger than the bolt diameter. An approved non-shrink grout shall be placed and vibrated or tamped to completely fill the well.

e. Drilling holes for anchor bolts is not allowed.

10. Placing Concrete:

a. Preparation:

(1) The Contractor shall give the Engineer 1 NDOT work day advance notice before starting to place concrete in each unit of the structure.

(2) The forms and the reinforcement for a structure shall be set before any concrete is placed.

(3) Concrete shall not be placed in structures bearing on the soil until all pile driving within a radius of 25 feet (7.6 m) has been completed. If concrete pours must be made within this area before completion of pile driving, such concrete shall cure at least 3 days before further driving is allowed.

(4) All dirt, sawdust, and other extraneous materials shall be removed from the forms before concrete is placed.

(5) Concrete shall not be placed in the superstructure until the substructure forms have been stripped and the concrete inspected for defects. The load of the superstructure shall not be allowed to bear on the substructure until its concrete has attained a compressive strength of 2,000 psi (14 MPa).

b. Equipment:

(1) When authorized by the Engineer, chutes and pipes may be used for conveying concrete to the forms.

(2) Equipment shall be arranged so that segregation does not occur.

(3) When steep chutes are necessary, the chutes shall be equipped with baffle boards or shall be in short sections that reverse the direction of the concrete's movement.

(4) All chutes and pipe shall be metal, metal lined plastic, rubber, or other nonreactive material.

(5) Chutes shall be kept clean and free from concrete coatings.

(6) Aluminum or aluminum alloys that react with the concrete shall not be used for chutes

c. Environmental Conditions:

(1) Concrete shall not be placed when weather conditions may damage the concrete or prevent proper construction.

(2) Mixing and concreting operations shall be discontinued when the descending ambient air temperature reaches 40°F (4°C) and shall

not be resumed until an ascending ambient air temperature reaches 35°F (2°C).

(3) Concrete shall not be placed on frozen material. When concrete is being placed and the air temperature may be expected to drop below 35°F (2°C), the concrete shall be protected.

d. Placement:

(1) The Contractor shall place concrete in one continuous operation.

(2) The maximum allowable interval for placing successive concrete batches into forms shall be 30 minutes.

(3) The sequence of placing concrete shall be as shown in the contract.

(4) Depositing and consolidating the concrete shall be done so that voids are not induced and the concrete is uniform and has smooth faces on all surfaces.

(5) Material segregation and displacement of the reinforcement shall be avoided.

(6) Concrete in girders shall be deposited uniformly for the full length of the girder and brought up in horizontal layers.

(7) Concrete placement shall be regulated to control fluid pressures.

(8) Special care shall be taken to work the coarse aggregate back from the face of the forms and to force the concrete under and around the reinforcement bars without displacing them.

(9) After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting bars.

(10) After placing concrete in the forms, the concrete shall not be moved laterally more than 6 feet (1.8 m). Use of a vibrator to move concrete shall be prohibited.

(11) The forms shall be filled uniformly.

(12) Concrete free fall distance shall not exceed 5 feet (1.5 m). This includes free fall in a discharge pipe.

(13) The concrete shall be discharged in a continuous stream free of air pockets so that a constant pressure head is maintained.

11. Placing Concrete Under Water:

a. The Engineer shall approve all concrete placed under water.

b. Concrete placed under water shall be the same class and mix as used in the remainder of the structure except cement content shall be increased 10%.

c. Tremie:

(1) The tremie shall consist of a watertight tube having a diameter of not less than 10 inches (250 mm). It shall be constructed in sections having flexible, watertight couplings.

(2) The tremies shall not be constructed of aluminum or aluminum alloy that will react with the concrete.

(3) The tremies shall be supported to allow free movement of the discharge-end over the entire top surface of the work. They shall allow rapid lowering when necessary to retard or stop the concrete flow.

d. Placing Concrete:

(1) The discharge end shall be closed at the start of the work so as to prevent water from entering the tube and shall be entirely sealed at all times. The tremie tube shall be kept full at all times.

(2) When a batch is dumped into the hopper, the concrete flow shall be induced by slightly raising the discharge-end and yet always keeping it in the concrete that is being deposited.

(3) The flow shall be continuous until work is completed.

(4) Concrete shall be placed continuously from start to finish. The surface of the concrete shall be kept as nearly horizontal as practicable at all times.

(5) Concrete shall be tremied in place forming a compact mass free of voids. It shall not be disturbed after being deposited.

(6) Still water shall be maintained at the point of deposit, and the forms shall be watertight.

d. Once the concrete has set, standing water shall be removed, the concrete inspected, and all laitance or other unsatisfactory material shall be removed from the surfaces.

12. Pumping:

a. Concrete that is pumped into a form shall be in a continuous stream and free of air pockets. The concrete in the pipeline shall be ejected in such a manner that there will be no contamination or segregation of the concrete.

b. Pump discharge pipes shall be designed to maintain a positive pressure head on concrete, and the free fall distance shall not exceed 5 feet (1.5 m) at discharge.

c. Air tests, slump tests, and fabrication of concrete test cylinders shall be performed at the final discharge point.

13. Consolidation of Concrete:

a. The Contractor shall consolidate all concrete to a uniform density. Consolidation shall be accomplished by mechanical vibration during and immediately after being placed as described in this Subsection.

(1) Concrete shall be placed in continuous horizontal layers not more than 18 inches (450 mm) thick.

(2) Each layer shall be placed and consolidated before the preceding layer has taken an initial set.

b. Internal vibration shall be used.

c. Vibrators:

(1) Vibrators shall be approved by the Engineer.

(2) The vibration frequency shall be greater than 4,000 impulses per minute.

(3) The intensity of vibration shall visibly move the mass of concrete throughout a radius of 18 inches (450 mm).

(4) The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch immediately after it is placed in the forms.

(5) The Contractor shall have a tachometer available to check the speed of the vibrators.

d. Procedure:

(1) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms.

(2) The vibrators shall be inserted and withdrawn out of the concrete slowly. Contact with reinforcement shall be avoided.

e. The vibrations shall not cause segregation. Localized grout formation shall be avoided.

f. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

g. Vibrations shall not be applied directly to or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration.

h. Vibrators shall not be used to move the concrete in the forms.

14. Successive pours:

a. Preparation:

(1) Immediately after placing concrete, all accumulations of mortar splashed on the reinforcement steel and the surfaces of forms shall be removed.

(2) Dried mortar chips and dust shall be kept out of the plastic concrete.

(3) Care shall be exercised in order not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steel.

(4) When concrete placement is temporarily discontinued, the concrete shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.

(5) To avoid visible joints at exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.

(6) If a "concrete wedge" might be produced at a construction joint, as in the sloped top surface of a wingwall, an insert shall be placed in the form to block out the wedge layer so that the placed concrete thickness is never less than 6 inches (150 mm).

b. Limitations:

(1) Successive concrete pours can be made after the preceding pour is complete if the concrete compressive strength of the preceding pour has reached 2,000 psi (14 MPa).

c. Concrete shall not be placed in the superstructure until the substructure forms have been stripped and the concrete inspected for defects. The load of the superstructure shall not be allowed to bear on the substructure until its concrete has attained a compressive strength of 2,000 psi (14 MPa).

d. Cast-in-place concrete railings shall not be placed on concrete slab bridges until the falsework supporting the roadway slab has been released.

15. If any section of concrete is found defective, it shall be repaired or replaced, as directed by the Engineer, at no additional cost to the Department.

16. Concreting in Cold Weather:

a. The following requirements shall govern the placement of concrete when the ambient temperature is less than 40°F (5°C):

(1) The temperature of the concrete shall not be less than 50°F (10°C) immediately after being placed.

(2) The Contractor shall furnish heating equipment and/or enclose and protect the structure in such a way that the concrete and air surrounding it shall be maintained at a temperature between 50°F (10°C) and 100°F (38°C) for the first 72 hours after the concrete has been placed, and at a temperature between 40°F (5°C) and 100°F (38°C) for the next 48 hours. The temperature of the air surrounding the concrete shall be gradually reduced to the outside air temperature at a rate not faster than 5°F/h (2.8°C/h).

(3) Curing moisture shall be maintained.

(4) The use of "salamanders" or other open flame heating units is prohibited. A shield shall be provided on heating equipment involving combustion so that no exposed metal will be in contact with the source of heat.

b. Insulated Forms:

(1) The Contractor may use form insulation to maintain concrete at the temperatures indicated in Paragraph 14.a.(2) of this Subsection.

(2) The temperature of the concrete at the time of mixing may be adjusted to assure that the temperature of the concrete will not exceed 100°F (38°C) due to the heat of hydration.

(3) The insulated forms shall remain in place for 5 days.

(4) The forms may be loosened slightly, if necessary, to control the temperature of the concrete below the maximum value specified. If loosening of the forms is necessary, prior approval of the Engineer must be obtained before the forms can be loosened.

(5) When forms are to be removed after the specified 5 day period, the fall of the concrete temperature shall not be at a rate faster than 5°F (2.8°C) in any 1 hour.

(6) The Engineer will use a digital thermometer with a thermocouple placed inside the fresh concrete to measure the concrete temperature. If a digital thermometer is not available, the Contractor shall provide four galvanized steel conduit tubes 1 inch (25 mm) in diameter and 12 inches (300 mm) long for each application of insulated forms. These tubes shall be provided with satisfactory rubber stoppers. The tubes shall be placed in the concrete as directed by the Engineer and shall be used to take the concrete's temperature. After curing is completed, the tubes shall be removed and the remaining holes shall be grouted.

(i) The Contractor may provide a calibrated digital thermometer with a thermocouple for the Department's use.

c. Bridge Deck Curing in Cold Weather

(1) The following requirements shall govern the placement of bridge deck concrete when the temperature will be less than 40°F during the 10-day wet curing period.

(i) The temperature of the concrete shall not be less than 50°F immediately after being placed.

(ii) The Contractor shall furnish heating equipment and/or enclose and protect the structure in such a way that the concrete shall be maintained at a temperature between 50°F and 100°F for the first 72 hours after the concrete has been placed, and at a temperature of between 40°F and 100°F for the next 168 hours.

(iii) After 240 hours of curing is complete, the fall of the concrete temperature shall not be at a rate faster than 5°F/hour.

c. The Contractor shall assume all risk connected with the placing of concrete during cold weather, and permission given by the Engineer to place concrete during such time will in no way relieve the Contractor of the responsibility for satisfactory results. Any concrete showing damage from cold weather placement or curing shall be rejected.

17. Joints:

a. Joints shall be square and normal to the forms; and bulkheads shall be provided for all, except horizontal, joints.

b. Construction joints shall not allow movement of abutting surfaces. They shall be made only where located in the contract or indicated in the placing diagram unless otherwise provided in these Specifications and approved by the Engineer.

c. Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened and the concrete surface shall be thoroughly cleaned of foreign matter and laitance.

d. The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints shall be carefully finished true to line and elevation.

e. Open Joints:

(1) Open, expansion, and fixed joints; water stops; and bearing seats shall be constructed according to the details shown in the contract.

(2) Open joint templates shall be placed and removed without chipping or breaking the corners of the concrete.

(3) When preformed, filled, expansion joints are specified, the material shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed.

(4) The plates, angles, or other structural components of steel joints shall be accurately shaped at the shop to conform to the sections of the concrete floor.

(5) Steel joints shall be maintained in the correct position when placing the concrete.

18. Concrete Surface Finish:

a. The Contractor shall finish all concrete surfaces, except bridge decks, in accordance with the requirements of this Section.

b. All formed concrete surfaces shall first be given an ordinary surface finish.

c. Ordinary Surface Finish:

(1) Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces.

(2) Cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and then pointed and trued. The mortar shall be made from cement and fine aggregate mixed in the same proportions as the concrete class being finished.

(3) Mortar used in pointing shall be not more than 1 hour old.

(4) The mortar patches shall be cured as described in this Subsection.

(5) All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete.

(6) The joint filler shall be left exposed for its full length with clean and true edges.

d. Surfaces requiring a rubbed finish are shown in the contract.

e. A "grout-cleaned" surface finish will be considered an acceptable alternate to a rubbed finish. Concrete cast against steel forms or smooth, hard form liners, such as masonite, metal, or fiberglass, may be given a "grout-cleaned" surface finish.

f. Concrete surfaces which are not to receive a rubbed finish shall be float-finished.

g. Rubbed Finish:

(1) For designated rubbed finish areas only, forms must be in place at least 12 hours, exclusive of time when the temperature is below 40°F (5°C), before they are removed to allow a rubbed surface finish. Forms must remain in place as described in Section 704.03 paragraph 7 on all other formed surfaces of the structure.

(2) If forms are removed before curing is complete to apply a rubbed surface finish, the concrete shall be kept wet while exposed.

(3) When rubbing is completed, the surfaces shall be covered and the wet-cure resumed until a 72-hour wet-cure period is complete.

(4) The concrete surface to be finished shall be saturated with water.

(5) Rod holes and defects shall then be painted and allowed to set.

(6) The surface shall be rubbed with a medium coarse corborundum stone using a small quantity of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being finished.

(7) Rubbing shall continue until all form marks, projections and irregularities have been removed, all voids are filled, and a uniform surface has been obtained.

(8) The paste produced by this rubbing shall be left in place.

(9) The final finish shall be obtained by rubbing with a fine corborundum stone and water. This rubbing shall be continued until the entire surface has a smooth texture and uniform color.

(10) After the final finish is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

h. Grout Cleaned Finish:

(1) Surfaces to be grout cleaned shall be steel brushed to remove laitance and scale and to reveal partly obscured air bubble holes. Uneven form joints shall be ground smooth.

(2) The surface shall be dampened and covered with an application of grout composed of 1 part cement to 1.5 parts fine sand with sufficient water to produce a thick paint consistency.

(3) Immediately after application of the grout, the surface shall be scoured with a cork float or other suitable material. This floating shall completely fill all holes and other irregularities in the surface.

(4) When the grout is of such plasticity that it will not be pulled from the holes, a float of sponge rubber or burlap shall be used to remove excess grout.

(5) When the grout is thoroughly dry, the surface shall be vigorously rubbed with dry burlap to completely remove any dried grout. No visible film of dry grout shall remain.

(6) Grout cleaning shall be done when the air temperature is at least 40°F (5°C) and rising. All cleaning on an area shall be completed the same day it is started.

(7) Cement for grout cleaning shall be Type I with white Portland cement added as necessary to produce the desired color.

i. Floated Surface Finish:

(1) Exposed concrete surfaces shall be struck off with a wooden template. Sufficient excess concrete shall be maintained ahead of the strike-off so that coarse aggregate is forced below the surface.

(2) The surface shall be thoroughly worked with a wooden float to produce a reasonably smooth, fine-grained surface.

(3) Edges, corners, and joints shall be carefully finished by means of suitable edging tools.

19. Curing Concrete:

a. Exposed, unformed concrete surfaces which do not require a rubbed finish shall be wet-cured or membrane-cured.

b. Formed Concrete Surfaces:

(1) Formed concrete surfaces will not require covering and curing until the forms are removed.

(2) No additional covering or curing is required after the forms are removed if they were in place for at least 72 hours.

c. Unformed concrete surfaces which will receive a rubbed finish shall be wet-cured.

d. A wet-cure requires that immediately after finishing, the exposed concrete be covered with a double thickness of wet burlap, which shall be kept saturated for at least 72 hours.

e. Membrane Curing:

(1) Membrane curing requires that immediately after finishing, the exposed concrete shall be sprayed with a continuous, uniform coating of white pigmented, membrane-forming curing compound. The application shall be uniform and applied at a rate no less than 1 Gal/200 SF (0.2 L/m²).

(2) Curing compound shall not be applied to construction joints, reinforcing steel, or surfaces which are to receive a rubbed finish. Any compounds applied to such surfaces or items shall be removed by blast cleaning.

(3) The curing membrane shall be protected and maintained throughout the 72-hour curing period. Any damage to the membrane during this period shall be immediately repaired.

20. Benchmarks:

a. This work shall consist of installing Department furnished benchmarks on structures. The benchmarks shall be installed near the right corner of abutment No. 1 on the horizontal portion of the top of the concrete barrier rail. The Contractor shall cast the benchmark into the concrete so its perimeter is flush with the finished surface and the top is above the surface. Recessed installations are not acceptable.

b. The benchmark is a circular, 2 inch (50 mm) diameter, solid brass marker with a slightly domed head and a 2 inch (50 mm) long ribbed shank. The Contractor shall obtain the benchmarks at the District Office. The Department will stamp the benchmark with the required information.

21. Preparation of Existing Structures:

a. When the contract provide for using any part of the existing concrete or masonry bridge or structure in the new bridge or structure, only those portions shall be removed which are so indicated in the contract. The connecting edges of the existing structure shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging that part of the structure to be retained. All existing reinforcing steel which is encountered shall be cleaned, straightened, and extended into the new work as shown in the contract.

b. When part or all of an existing bridge deck is to be removed, the removal operation shall be performed without damage to the girders or any portion of the structure to be retained.

c. The term damage to the girders is defined as, but not limited to, the following:

(1) For concrete girders – spalling or cracking of the girder or damaging the existing reinforcing steel which projects from the top of the girder.

(2) For steel girders – punching through or denting/distorting the top flange, damaging the flange to web weld or damaging the shear connectors that project from the top of the girder.

d. At least 10 working days prior to the deck removal operation, the Contractor shall submit to the Engineer details of the removal operations showing the methods, sequence of removal and equipment to be used.

e. At the beginning of the removal operation, the Contractor shall demonstrate to the Engineer that the removal operation is acceptable by removing a 10 feet long x 4 feet wide (3 m x 1.2 m) section of the deck, over the top of a girder. If the girder or any other portion of the structure that is to remain in place has not been damaged, the Contractor may continue. If the Engineer determines that damage has been done or is likely to occur, the Contractor shall alter the removal operation.

f. Any damage to the girders, reinforcement or shear connectors that occurs during the trial demonstration shall be repaired as directed by the Engineer at no additional cost to the Department.

g. Any isolated or accidental damage that occurs during the removal operation shall be repaired as directed by the Engineer at no additional cost to the Department.

h. Should a girder sustain damage, which in the opinion of the Engineer renders it unfit to remain in place, it shall be replaced at no additional cost to the Department.

22. The Contractor shall paint all exposed metal, except weathering grade steel, as described in Section 709.

23. Barrier Curbs and Rails:

a. Concrete barrier curbs and bridge rails shall present a smooth, uniform appearance conforming to the horizontal and vertical lines shown in the contract or as directed by the Engineer, and shall be free of lumps, sags, or other irregularities.

b. The top and visible edges of barrier curbs and rails shall not vary more than 1/4 inch (6 mm) from the edge of a 10 foot (3 m) straightedge, and the front and back faces shall not vary more than 1/2 inch (13 mm) from the edge of a 10 foot (3 m) straightedge. Areas not conforming to the above requirements shall be removed and replaced by the Contractor at no additional cost to the Department.

24. Protective System for Bridges with Weathering Steel Girders

a. It is the responsibility of the Contractor to protect the exposed faces of abutments, piers and MSE walls from staining caused by runoff from the weathering steel superstructure. Acceptable methods of protection which may be used are:

(1) Before steel girders are set, the exposed face of the abutments and the top ten feet (three meters) of the piers and the MSE walls directly under the bridge shall be wrapped with 6 mil (0.15 mm) polyethylene to protect against staining. The polyethylene wrap shall remain in place until after the bridge deck is poured. When the wrap is removed, concrete surfaces of abutments, piers and MSE walls shall be cleaned of any stains from the weathering steel.

(2) As an alternate, a stain resisting coating may be used in place of the polyethylene wrap. The stain resisting coating shall be applied to the exposed face of the abutments and the top ten feet (three meters) of the piers and the MSE walls directly under the bridge. The stain resisting coating shall be applied to the concrete surfaces prior to erecting the steel superstructure.

b. Preparation of the concrete surface and mixing and applying the coating shall be in accordance with the manufacturer's instructions. Minor appearance inconsistencies resulting from application of stain resistant coating shall be acceptable.

c. After the bridge deck is poured, concrete surfaces of the abutments, piers and MSE walls shall be cleaned of any stains from the weathering steel.

704.04 -- Method of Measurement

1. The quantity of concrete for which payment will be made shall be computed by the Department in cubic yards (cubic meters) from dimensions shown in the contract. No field measurement is required. Pay quantities are those shown in the contract.

2. When shown in the bid proposal Schedule of Items, the seal course concrete quantity will be measured in cubic yards (cubic meters) of concrete placed within a volume bounded by vertical planes 18 inches (450 mm) outside and parallel to the limits of the footings.

3. When seal course concrete is not shown in the bid proposal Schedule of Items, it shall be paid for as “extra work” when it is necessary to stop unforeseen water intrusion.

4. Calculations:

a. The volume involved in fillets, scorings, and chamfers 1 square inch (645 mm²) or less in cross sectional area shall be neglected.

b. The concrete plan quantity accounts for the volume of precast or cast-in-place concrete piles or pipe piles encased in the concrete.

c. No deductions shall be made for the volume of concrete displaced by steel reinforcement, H-pile, floor drains, or expansion joint material.

d. Box Culverts:

(1) The Department will compute the quantity of concrete for box culverts based on the cross-sectional area of the culvert’s walls times the centerline length of the culvert.

(2) An additional allowance is made for concrete box culverts constructed with either a horizontal or vertical break in barrel alignment.

(3) The additional allowance for each break in alignment shall be calculated by measuring the inside perimeter of the nominal box opening in feet (meters), then dropping the units (feet) (meters) and multiplying the unit-less perimeter measurement times 0.05 cubic yards (0.125 cubic meters).

5. "Preparation of Bridge _____" is measured by the Each (ea) or Square Yard (SY) [Square Meter (m²)].

704.05 -- Basis of Payment

1. Pay Item	Pay Unit
Class _____ Concrete for _____	Cubic Yards (CY) [Cubic Meters (m ³)]
Seal Course Concrete	Cubic Yards (CY) [Cubic Meters (m ³)]
Preparation of Bridge _____	Each (ea) Square Yard (SY) [Square Meter (m ²)]

2. All costs for concrete rails shall be included in the appropriate concrete and reinforcing steel pay items for the structure.

3. The seal course concrete shall not be thicker than 9 inches (225 mm), and any concrete placed in excess of 9 inches (225 mm) deep will be done at no additional cost to the Department. Seal course excavation is subsidiary to the seal course concrete.

4. All costs associated with obtaining benchmarks from the District Office and installing them shall not be measured for payment but shall be considered subsidiary to the items for which direct payment is provided.

5. Concrete curing shall be considered as subsidiary to the concrete construction.

6. Furnishing, placing, and grouting bars for rock anchors is subsidiary to the concrete bid item for the structure.

7. The construction of weep holes is subsidiary to the concrete bid item for the structure.

8. Payment Deductions:

a. The 28-day compressive strength is determined by the average strength of all cylinders made on a specific day to determine the 28-day compressive strength of all of a group's class of concrete poured that day. Concrete with a 28-day compressive strength not meeting the design compressive strength is subject to removal.

b. If the 28-day compressive strength is less than the design compressive strength, cores may be taken, at the discretion of the Engineer, within 45 days after the concrete was placed. The average of the cores will be used to determine the compressive strength.

c. If either the 28-day compressive strength or the average core strength is less than the design strength and the Engineer determines that the concrete is acceptable for use, the concrete is subject to a payment deduction. The pay deduction is shown below:

$$\frac{2 \times (\text{Design Compressive Strength} - 28\text{-day Compressive Strength})}{\text{Design Compressive Strength}} = \text{Percent Reduction}$$

Or

$$\frac{2 \times (\text{Design Compressive Strength} - \text{Average Core Compressive Strength})}{\text{Design Compressive Strength}} = \text{Percent Reduction}$$

9. The polyethylene wrap or stain resisting coating will not be paid for directly, but shall be subsidiary to the item "Class ____ Concrete for ____".

10. Payment is full compensation for all work described in this Section.

SECTION 705 -- PRECAST OR PRECAST/PRESTRESSED CONCRETE STRUCTURAL UNITS

705.01 -- Description

1. This work consists of all labor, materials, and equipment required in the production of Precast or Precast/Prestressed Structural Units.
2. The contract shall be supplemented by Contractor-provided working drawings submitted in accordance with Subsection 105.02.

705.02 -- Material Requirements

1. The materials used shall meet the requirements described in Table 705.01.

Table 705.01

Material Requirements	
Applicable Material	Section
Concrete	1002
Admixtures	1007
Water	1005
Fine Aggregate	1033
Course Aggregate	1033
Fly Ash	1008
Spiral Reinforcing Wire	1023
Prestressed Steel Strand	1026
Post-Tensioning Assembly Steel	1025

2. The concrete class used in the manufacture of Precast or Precast/Prestressed Structural Units shall be shown in the contract.
3. The Contractor shall be responsible for the concrete mix design. Concrete mix designs shall be proportioned in accordance with ACI Standard 318 and the following additional requirements:
 - a. The mix designs or change to a mix design shall be submitted for approval to the Engineer 4 weeks before beginning any concrete work. Refer to Table 705.03 for required testing for any mix design.
 - b. Concrete shall consist of Type I, Type II, or Type III Portland cement, aggregate, air-entraining admixture, and water. Concrete may also contain Class C or Class F fly ash, slag cement or Silica Fume and ASTM C 494 approved Type A, Type B, Type D, and Type F admixtures.
 - c. No change shall be made in the approved concrete mix design during the progress of the work without the prior written permission of the Engineer.
4. Reinforcement shall be furnished, handled, stored, and placed in accordance with the requirements of Section 707.
5. Welding of reinforcing steel is prohibited unless specifically authorized by the Engineer.
6. Prestressing steel other than that specified in the contract may be furnished with the approval of the Engineer. The yield and ultimate strength and other pertinent characteristics of this steel shall be submitted to the Engineer.

7. The area of broken wires shall not exceed 2% of the cross sectional area of the stressing strands when the number of strands is 14 or less.

8. No more than 1 broken wire will be allowed in a single strand.

9. Bars for post-tensioning shall be of high tensile strength steel. They shall be equipped with wedge type end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area. The physical properties of the bar steel determined by static tensile tests shall conform to the requirements in Table 705.02.

Table 705.02

High Strength Steel Post-Tensioning Requirements	
Ultimate Stress.....	145,000 psi (1000 MPa) minimum
Stress at 0.7% Elongation.....	130,000 psi (900 MPa) minimum
Stress at 0.3% Elongation.....	75,000 psi (500 MPa) minimum
Elongation in 20 Diameters	4% minimum
Modulus of Elasticity	25,000,000 psi (172,00 MPa) minimum
Diameter Tolerance.....	Plus or Minus 0.1 inch (2.5 mm)

10. Materials specified for testing shall be furnished 30 days before the anticipated time of use. All materials required for testing shall be furnished by the Contractor to the Engineer without additional costs to the Department. The Engineer shall select a representative sample length for the various prestressed steel as follows:

a. Six feet (1.8 m) for wires requiring heading.

b. For wires not requiring heading, sufficient length to make up one parallel-lay cable 6 feet (1.8 m) long consisting of the same number of wires as the cable to be furnished.

c. Six feet (1.8 m) between near ends of fittings for a strand furnished with fittings.

d. Six feet between threads at the ends of bars furnished with threaded ends.

11. If the anchorage assemblies are not attached to prestress steel samples, 2 anchorage assemblies shall be furnished for testing, complete with distribution plates of each size or type of prestress steel to be used.

12. Any defective material shall be rejected.

13. Concrete quality control shall be the responsibility of the Contractor. Concrete shall be sampled and tested as shown in Table 705.03.

a. The Contractor's test results are the basis for acceptance. If the Department's quality assurance testing is not within 10% of the Contractor's test results on any given sets of three cylinders, the Engineer will initiate an investigation to find the cause of the variation between the Contractor's and the Department's test results. While the investigation is in progress, the department will continue with quality assurance testing as shown in Table 705.03. Any structural units represented by these tests will be subject to rejection.

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b. If more than one set of cylinders is required per Table 705.03 for a single Precast or Precast/Prestressed Concrete Structural Unit, each set of three cylinders will be averaged separately. All averaged sets must meet the minimum design strengths.

c. If 40 cubic yards makes more than one Precast or Precast/Prestressed Concrete Structural Unit and the Contractor elects to make the minimum set of cylinders, that single set of cylinders will be used to determine the girder strength for all of the Precast or Precast/Prestressed Concrete Structural Units that set of cylinders represents. If the Contractor elects to make more than the minimum cylinders required, in order to represent each Precast or Precast/Prestressed Concrete Structural Unit, only the set of cylinders representing the corresponding unit will be used to determine the strength of that unit.

**Table 705.03
Precast Plant Approval**

Plant Certification	<u>Contractor</u>	<u>NDOT</u>
	<p><u>Prestressed</u>: Shall submit PCI Certification every two years to the PCC Engineer.</p> <p><u>Precast</u>: Precast plants that are not PCI certified will be NRMCA certified.</p>	<p>Approve and add to SiteManager.</p>

Quality Control & Quality Assurance at Plant Site

Frequency	Daily	Weekly
Number of Acceptance Cylinders to be fabricated	<u>Contractor Quality Control</u>	<u>NDOT Personnel Quality Assurance</u>
	<p>- Will make a minimum of six cylinders for every 40 cubic yards.</p> <p>- NDOT personnel will record results and enter into SiteManager. These samples will be identified and tagged by NDOT. NDOT shall have access to these QC samples at all times.</p>	<p>- Will make a minimum of six sets of three cylinders per week of production.</p> <p>- The NDOT samples will be taken at the same location within a load of concrete as the contractor's QC samples. NDOT shall choose the location of these samples within the load/girder.</p> <p>- Enter results into SiteManager.</p>
Required Testing for Acceptance Cylinders	<u>Contractor Laboratory:</u>	<u>NDOT Laboratory:</u>
	<p>- 7 Day Compressive Strength: three cylinders averaged at contractor's discretion.</p> <p>- 28 Day Compressive Strength: three cylinders averaged.</p> <p>- 56 Day Compressive Strength: The remaining three cylinders will be tested for 56 day compressive strengths; only if the 28 day compressive strength failed to meet specification requirements. Note: No cylinders are to be discarded until all design strengths are met and the prestressed unit(s) is accepted.</p> <p>- Air Content - ASTM C 231</p> <p>- Slump Flow - ASTM C 1621</p> <p>- Visual Stability Index (VSI) Appendix of ASTM C 1611 is required.</p>	<p>- 28 Day Compressive Strength: Three cylinders averaged.</p> <ul style="list-style-type: none"> ● The 28 day compressive strength is to be used for validation of the contractor's strength. ● Note: If the Contractor's and Department's 28 day test results are not within 10%, the average set of three cylinders for 28 or 56 day will be used for acceptance. ● NDOT will be onsite to witness the testing for all Acceptance Cylinders. <p>- Air content - ASTM C 231</p> <p>- Witness Slump Flow & Visual Stability Index</p>

Table 705.04

**Mix Design Approval/Change Cement or Aggregate Source
Refer to policy in the Material & Sampling Guide for the following:
Frequency Weekly**

Required Inspection	<ul style="list-style-type: none"> ● Precast/Prestressed Concrete Plant Inspection-NDOT Inspector ● Precast/Prestressed Concrete Plant Inspection-Fabricator Inspector 	
Trail Mix	<p><u>Contractor</u></p> <p>Data from 15 trial tests as a minimum (New Mix Design) Data from 5 trial tests as a minimum (Change in Cement or Aggregate)</p>	<p><u>NDOT</u></p> <p>Contractor is responsible to notify PCC Engineer 4 weeks in advance.</p>
Testing	<p><u>Contractor</u></p> <ul style="list-style-type: none"> - Compressive Strength - AASHTO T 22 - Flexure Strength of concrete (using simple beam with third-point Loading) - ASTM C 78 - Air Content - ASTM C 231 - Slump Flow - ASTM C 1611 - Passing Ability by J-Ring Method - ASTM C 1621 - Visual stability Index (VSI) - Appendix of ASTM C 1611 is required. 	<p><u>NDOT</u></p> <p>Sampling and Testing two of the contractor's trail tests.</p> <ul style="list-style-type: none"> - Compression Strength - AASHTO T 22 - Flexure Strength of concrete (using simple beam with third-point Loading) - ASTM C 78 - Air Content - ASTM C 231 - Witness (Slump Flow & J Ring)
Approval	<p><u>Contractor</u></p> <p>Submit data from lab testing to PCC Engineer.</p>	<p><u>NDOT</u></p> <ul style="list-style-type: none"> - Data review/ensure specifications are met - Approve mix design - Add to SiteManager with NDOT Mix Design Number

Change to Admixtures in Approved Mix Design

Testing/ Approval	<p><u>Contractor</u></p> <p>Contractor is responsible to notify the PCC Engineer 3-4 weeks in advance.</p> <ul style="list-style-type: none"> - Air Content - ASTM C 231 - Slump Flow - ASTM C 1621 - Passing Ability by J-Ring Method - ASTM C 1621 - Visual Stability Index (VSI) Appendix of ASTM C 1611 is required. 	<p><u>NDOT</u></p> <ul style="list-style-type: none"> - Air Content - ASTM C 231 - Witness Slump Flow, Passing Ability and Visual Stability Index
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14. Plant Approval Requirements:

- a. All Prestressed Concrete Structural Units shall be produced in a Precast/Prestressed Concrete Institute (PCI) certified plant.
- b. All concrete for Precast/Prestressed Concrete Structural Units shall be produced at a PCI or NRMCA certified plant.

(1) Whenever there is reason to suspect a problem with the equipment, any or all of the equipment may be inspected.

c. The method of manufacture and quality of concrete are also subject to Department approval/inspection.

d. A Contractor proposing to furnish Precast or Precast/Prestressed Structural Units shall submit the following additional details to the Department concerning the method of manufacture:

(1) Type, number, size, and location of the prestressing elements, and the name of the manufacturer of the post-tensioning or pretensioning elements.

(2) Complete information as to type, size, and method of installation of devices for anchoring post-tensioning elements.

(3) The proposed manufacturing methods and the plans and design details of proposed casting beds and forms.

e. The use of portable pretensioning beds for the manufacture of concrete structural units or piles will not be allowed.

15. Mix Design Approval Requirements:

a. The results of 15 individual trial mixes shall be produced using the same process as the plants normal production run. All test results of individual trial mixes shall be given to the Engineer. The test results collected shall include the following:

(1) The release and 28-day compressive strength test results shall conform to AASHTO T 22.

(2) The water/cement ratio.

(3) The air content (between 2.0% and 6.0% inclusive).

(4) The cement, fly ash, Slag Cement and Silica Fume content.

(5) The amount of fine aggregate, coarse aggregate, and sand and gravel.

(6) Slump Flow test results shall conform to ASTM C 1611

(7) Passing Ability by J-Ring Method test results shall conform to ASTM 1621.

(8) Visual Stability Index (VSI) test results shall conform to the Appendix of ASTM C 1611.

(9) Flexure Strength of concrete at 28-day test results shall conform to (using simple beam with third-point loading) ASTM C 78.

b. Any change of cement or aggregate source which must be on the Department's Approved Product List shall require 5 new individual trial mixes. Refer to Table 705.04 for required testing procedures.

c. Any changes using admixtures, the Contractor shall verify the properties of the concrete. Refer to Table 705.04 for the required testing procedures.

d. The compressive strength test results of 15 individual trial mixes shall be performed by the Contractor. An individual trial mix shall

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consist of two sets of three cylinders with three cylinders being averaged at release and at 28-day. One set shall be taken within the first third of the load and the second set shall be taken within the two thirds of the load.

e. All tests for elastic modulus and compressive strength will be conducted using 4 inch x 8 inch (100 mm x 200 mm) cylinders.

f. The flexure strength test results of 15 individual trial mixes shall be performed by the Contractor. An individual trial mix shall consist of two sets of two beams with two beams being averaged at 28-day. One set shall be taken within the first third of the load and the second set shall be taken within the two thirds of the load.

705.03 -- Construction Methods

1. The Contractor shall construct precast or precast/prestressed structures and piles as shown in the contract.

2. The Contractor shall provide the Engineer a 4-week production schedule that is updated as necessary. If the Engineer is given less than 1 NDOT work day notice of a schedule change, then the fabricator may not proceed until the Engineer has reviewed the change. The Engineer may observe any or all of the procedures and shall have access to all reported data at any time during fabrication. The Engineer shall report any inconsistencies to the job superintendent.

3. The concrete producer shall report the following information for each load of concrete used to fabricate girders:

a. Brand, mill, type, certified test number, and weight of cement.

b. Brand, mill, class, certified test number, and weight of fly ash.

c. Type, source, location, weight, and free moisture content for each aggregate. Aggregate moisture shall be determined according to NDOT T 506 for each half day production.

d. Source, type, name, and amount of each admixture.

e. Water added during batching and at placement site.

f. Time, water and cement are initially mixed into the batch.

g. Time placement is started and completed.

4. Tensioning:

a. Methods:

(1) In all methods of tensioning, the stress induced in the prestressing elements shall be measured by the Contractor both with jacking gauges and by elongation of the elements; and these results shall be the same within a 5% tolerance.

(2) Means shall be provided for measuring the elongation of reinforcement to at least the nearest 1/8 inch (3 mm).

(3) All steel stressing devices, whether hydraulic jacks or screw jacks, shall be equipped with accurate reading calibrated pressure gauges, rings, or other devices as applicable to the jack being used.

(4) All devices shall be calibrated and, if necessary, recalibrated to allow the stress in the prestressing steel to be computed at all times.

(5) A certified calibration curve shall accompany each device.

(6) Safety measures must be taken by the Contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

b. Measurement:

(1) Pressure gauges, load cells, dynamometers, and any other devices used in determination of loads and/or pressures shall be accurate in their effective range within a 2% tolerance.

(2) Such equipment shall be calibrated by an approved testing laboratory.

(3) The Contractor's laboratory shall furnish calibration curves for each device and shall certify the curves as being accurate and verifiable.

(4) The calibration of tensioning devices shall be accomplished in place.

(5) The configuration of jacks, gauges, and other components during calibration shall be exactly the same as during the actual stressing operation.

(6) The method of calibration shall be approved by the Engineer.

(7) Tensioning devices shall be calibrated at least once a year and at any time a system appears to be operating in an erratic or inaccurate manner or gauge pressure and elongation measurements fail to correlate.

c. If the strand tension indicated by the gauge pressure and by elongation methods fail to agree within 5%, the operation shall be carefully checked and the source of error determined before proceeding further.

d. Measurement Consideration:

(1) The Contractor's elongation and jacking pressure measurements shall make appropriate allowance for friction and all possible slippage or relaxation of the anchorage.

(2) For pretensioned members, independent references shall be established adjacent to each anchorage by the Contractor to indicate any yielding or slippage that may occur between the time of initial stressing and final release of the cables.

(3) The Contractor may tension straight post-tensioned tendons from one end. Curved tendons shall generally be stressed by simultaneous jacking from both ends.

e. In all stressing operations, the Contractor shall keep stressing force symmetrical about the member's vertical axis.

5. Stressing Procedure:

a. Prestressing methods are shown in the contract. When the Contractor elects to use a method other than that shown in the contract, the Contractor shall submit complete shop plans for the proposed method.

b. Pretensioning Method:

(1) The amount of stress to be given each strand by the Contractor shall be as shown in the contract.

(2) All strands to be prestressed in a group shall be brought to a uniform initial tension before being given their full pretensioning. This uniform initial tension of approximately 1,000 to 2,000 pounds (450 to 900 kg) shall be measured by a dynamometer or other approved means so that it can be used as a check against the computed and measured elongation.

(3) After initial tensioning, either single strand or multiple strand groups shall be stressed until the required elongation and jacking pressure are attained and reconciled within the 5% tolerance.

(4) With the strand stressed in accordance with the contract, and with all other reinforcing in place, the Contractor shall cast the concrete to the lengths desired. Strand stress shall be maintained between anchorages until the concrete has reached the compressive strength specified in the contract.

c. Post-tensioning Method - For all post-tensioned elements, the Contractor shall set the anchor plates exactly normal in all directions to the axis of the bar or tensioning strand. Parallel wire anchorage cones shall be recessed within the beams. Tensioning shall not be done until the concrete has reached the compressive strength specified in the contract.

d. Combined Method - In the event that the girders are manufactured with part of the reinforcement pretensioned and part post-tensioned, the applicable portions of the requirements listed above shall apply to each type.

6. Forms:

a. Forms for Precast or Precast/Prestressed Concrete Structural Units shall conform to the requirements for concrete formwork as provided in Subsection 704.03.

b. Precast or precast/prestressed forms shall be accessible for the vibration and consolidation of concrete.

c. If the ambient temperatures are above 90°F (32°C), precautions shall be taken so the forms, reinforcing steel and steel beams of structural units will be the ambient temperature.

7. Placing Concrete:

a. The Contractor shall provide the Department a 4-week production schedule that is updated as necessary. Unscheduled production changes may delay fabrication. Unscheduled production may result in rejection of Precast or Precast/Prestressed Concrete Structural Units.

b. The Engineer may observe any or all of the procedures. The Contractor shall provide access to all reported data at any time during fabrication. The Engineer will report any inconsistencies to the job superintendent.

c. Concrete shall not be placed before completing the forming and placing of reinforcement.

d. Placing Procedure:

(1) Concrete shall be placed continuously in each unit, taking care to avoid horizontal or diagonal planes of weakness.

(2) However, if there is a delay in delivery of concrete or for some other reason placement is interrupted for more than 30 minutes, then the concrete shall be rejected.

e. Consolidation:

(1) Whether concrete requires vibration or self-consolidating concrete is used, special care shall be exercised to work and consolidate the concrete around the reinforcement and to avoid the formation of stone pockets, honeycombs and other defects.

(2) Self-consolidated concrete (SCC) shall not be vibrated. Rodding of Self-consolidated concrete (SCC) is permissible in areas of tight reinforcement.

(3) The other concrete shall be consolidated by vibrating.

f. The concrete shall be a homogenous mixture and shall not contain cement balls.

g. The forms shall be overfilled, the excess concrete screeded off, and the top surfaces finished to a uniform, even texture.

h. Each Precast or Precast/Prestressed Concrete Structural Unit shall be stamped or marked with an identification number and its manufacture date.

i. Environmental Limitations:

(1) The optimum range of concrete temperatures from the time the concrete is completely mixed until the beginning of the presteam segment of the steam curing cycle shall be 50° to 95°F (10° to 35°C). Failure to operate within the optimum range shall be cause for curtailment of operations. During the presteam segment of the curing cycle, the temperature of the concrete shall not exceed 100°F (38°C) or fall below 50°F (10°C). These temperature restrictions apply when heat is supplied to the curing enclosure prior to initial set.

(2) When placing concrete under cold weather conditions (ambient air temperature less than 36°F [2°C]), the cold weather specifications in Sections 1002 and 704 shall be followed.

(3) Forms and reinforcing materials shall be preheated to a minimum temperature of 40°F (4°C) and a maximum temperature not to exceed that of the concrete at the time of placement.

(4) The Contractor may preheat the drums of the mixer-trucks to the limits set for forms and reinforcing, but under no condition shall heat be applied to the drums while they contain any of the batch materials or concrete.

8. Curing:

a. General:

(1) The Contractor shall cure the concrete with wet burlap, waterproof covers, polyethylene sheets, or liquid membrane-forming compounds. Curing with liquid membrane-forming compounds shall be accomplished in accordance with the requirements of Section 1012 and Subsection 704.03, except that liquid membrane-forming compounds shall

not be used on that portion of precast/prestressed concrete girders, twin tees, or bridge beams upon which concrete will be cast later.

(2) Water spray curing or other moist curing methods may be used subject to the approval of the Engineer.

(3) The period of concrete curing shall be determined by the results of the compressive strength test on cylinders made during the progress of the work and cured to closely approximate the concrete strength of the product it represents.

(4) Side forms may be removed 12 hours after placing the concrete, provided curing is continued with one of the approved Department curing procedures.

b. Steam or radiant heat will be allowed for accelerated curing provided the following procedure is adhered to:

(1) Curing chambers shall be reasonably free of leakage and shall have a minimum clearance of 3 inches (75 mm) in order to insure adequate circulation of heat. The relative humidity within the curing enclosure shall be maintained between 70 and 100%.

(2) Temperature:

(i) One approved continuous recording thermometer for each 115 feet (35 m) of casting bed, with a minimum of 2 continuous recording thermometers, shall be located in each enclosure or curing chamber.

(ii) Continuous temperature record charts for each casting shall be available to the Engineer for examination and approval at any time.

(iii) If the temperature records or other temperature readings taken by the Engineer indicate that manual control of heat is producing temperature changes in excess of those specified, the Engineer may reject the Precast or Precast/Prestress Structural Unit.

(iv) Temperature of the curing concrete shall be 50°F to 105°F (10°C to 40°C) and shall be maintained near placement temperature until the concrete has reached initial set as determined by ASTM C 403 "Time of Setting of Concrete Mixture by Penetration Resistance". These temperature restrictions apply when heat is supplied to the curing enclosure prior to initial set.

(v) The temperature rate of rise shall not exceed 60°F (15.5°C) per hour.

(3) The concrete shall be completely enclosed with a waterproof curing chamber during accelerated curing periods.

(4) Steam jets shall not be directed at the concrete or the steel forms.

(5) If the temperature of the concrete rises above 175°F (79°C), the concrete shall be rejected.

(6) The temperature in the concrete shall be maintained so that at any given time the difference between the highest and lowest

temperature station readings will not be more than 30°F (-1°C). If the temperature varies more than 30°F (16°C), the product shall be rejected.

(7) Eight hours after placing the concrete, individual sections may be uncovered to remove their forms. The curing may be discontinued during this operation. The section shall not be left uncovered longer than necessary and never longer than 30 minutes. Waterproofed covers shall be used to recover the product.

(8) After the heat source has been turned off, the curing cover shall be maintained in place during the curing period until the release strength has been reached.

(9) Detensioning shall be accomplished before the temperatures of the units drop more than 60°F (34°C) from the peak cure strength temperature and while they are still moist.

(10) Master slave heat curing system may be used for curing quality control cylinders.

c. After detensioning, prestressed concrete girders shall be inspected for cracking. If any cracks are discovered between quarter points in the middle of the girder on the bottom flange face, the girder shall be rejected.

9. Defects and Repair Procedures:

a. After the forms are removed, stone pockets, honeycombs, or other defects may be exposed. The Engineer shall determine if these defects affect the item's structural integrity and whether the item will be rejected.

b. Precast or Precast/Prestressed Concrete Structural Units which have chipped, spalled, honeycombed, or otherwise defective areas which are not considered detrimental to the structural integrity may be used after being repaired by the Grooming and Repair Procedures for Precast Concrete Products in the Department's Materials Sampling Guide.

10. Surface Finish:

a. On structures serving as highway grade separations, the following shall apply:

(1) The exterior face of all exterior girders or beams plus the bottoms and chamfers on all lower flanges shall be given the following finish:

(i) All uneven form joints in excess of 1/8 inch (3 mm) shall be ground smooth.

(ii) The surface shall be steel brushed to remove scale, laitance, and to open partially obstructed holes.

(iii) The surface shall be dampened.

(iv) Grout shall be applied to the surface.

(v) The grout shall consist of 1.5 parts of fine sand, 1 part of Portland cement, and sufficient water to produce a consistency of thick paint. The cement used in the grout shall be a blend of regular Type I and white Portland cement to duplicate the lighter appearance of the steam cured units.

(vi) If necessary, an admixture which will not discolor the concrete may be used in the grout to reduce shrinkage if approved by the Engineer. Admixtures containing iron particles shall not be used.

(vii) The surface shall be float finished with a cork or other suitable float. This operation shall completely fill all holes and depressions on the surface.

(viii) When the grout is of such plasticity that it will not be pulled from holes or depressions, sponge rubber or burlap shall be used to remove all excess grout.

(ix) Surface finishing during cold weather shall not be performed unless the temperature is 40°F (4°C) and rising. The surface shall be protected against temperature drops below 40°F (4°C) for a period of 12 hours after finishing.

(x) A uniform appearance will be required. In the event the appearance produced by the above procedure is not uniform, both in texture and coloration, the precast or precast/prestress structural unit will be rejected. The Contractor may request other methods approved by the Engineer to create a uniform appearance.

11. Grouting for Post-Tensioned Units:

a. The Contractor shall install steel in flexible or other approved tubes which shall be cast in the concrete and shall be pressure-grouted after the post-tensioning process has been completed.

b. Bonding grout shall be made to the consistency of thick paint and shall be mixed in the proportions as follows: Portland cement (Type I), 100 pounds (45 kg); fly ash (ASTM C 618), 34 pounds (15 kg); water, 45 to 62 pounds (20 to 28 kg) (adjust at site); and nonshrink admixture approved by the PCC Engineer.

c. The final grouting pressure shall be at least 80 psi (550 kPa).

d. The Contractor shall make provisions to demonstrate to the Engineer that grouting material has completely filled all areas within the conduit.

13. Handling, Transporting, and Storing:

a. (1) Prestressed concrete structural units must be at least 9 days old before they can be set on the bridge substructure. Surveying for shim shots, forming the bridge deck or diaphragms and placing construction material on the girder is not allowed until the girders have attained the minimum age and design strength specified in the contract.

(2) The Contractor shall be responsible for exercising extreme care in lifting, handling, storing and transporting the prestressed concrete structural units to prevent cracking or damage. Prestressed concrete bridge girders shall be maintained in an upright position and supported within 18 inches of the ends at all times. When supported at the proper positions, no part of the units shall be allowed to rest on the ground. Prestressed concrete bridge girders shall be set on a level area to prevent field bowing and adequate supports shall be placed under their bearing devices to prevent settlement into the ground. Proper support bearings shall be used to avoid twisting of the prestressed concrete bridge girders. Prestressed

concrete structural units shall be lifted by devices designed by the Contractor.

(3) The Contractor must provide any temporary intermediate diaphragms and/or bracing necessary to provide lateral and torsional stability for the girders during construction of the concrete slab. The temporary intermediate diaphragms/bracing shall be removed after the concrete has attained its design strength. The cost of furnishing, installing and removing the temporary intermediate diaphragms and/or bracing shall be subsidiary to the pay item "Class 47BD-_____ Concrete for Bridges".

(4) (i) The girders shall be transported in an upright position and the points of support and direction of the reactions with respect to the girder shall be approximately the same during the transportation and storage as when the girder is in its final position. If the Contractor finds it necessary to transport the precast girders in some other position, the Contractor shall be prepared to prove that no internal damage results.

(ii) Adequate padding shall be provided between tie chains and cables to prevent chipping of the concrete.

(iii) Live loads shall not be allowed on the superstructure units until the floor slab is placed and attains the design strength shown in the contract.

13. Inspection Facilities:

The Contractor shall arrange with the producer of Precast or Precast/Prestressed Concrete Structural Units to provide an office, laboratory, and bathroom for the Department's inspector. The areas shall meet the following requirements:

a. Thermostatically controlled heating and air conditioning shall be provided so that temperature can be maintained between 68° and 77°F (20° and 25°C).

b. The floors shall be tile or a similar floor covering.

c. Interior and exterior walls shall be well maintained and painted.

d. All exterior doors shall have cylinder locks, and all keys shall be turned over to the Engineer.

e. Ceiling lighting shall provide a minimum of 465 foot-candles (5000 lx) of light on all working surfaces.

f. Electrical outlets shall be spaced no more than 6 feet (1.8 m) apart with no less than 1 outlet on any wall of the office or lab.

g. A single trunk telephone and a means to the internet with a minimum of 1.5 mb of download stream shall be installed in the office, and the installation charges shall be paid by the Contractor. The monthly service charges will be paid by the Department.

h. A fire extinguisher and First-Aid kit shall be provided.

i. A ventilated bathroom with a toilet and sink shall be provided in the structure. A fresh water supply and drain will be required in the lab area.

j. The lab, office, and bathroom shall be separate rooms with interconnecting doors.

705.03 Precast or Precast/Prestressed Concrete Structural Units

- k. The minimum lab area is 230 square feet (21 m²).
- l. The minimum toilet area is 20 square feet (2 m²).
- m. The minimum office area is 160 square feet (15 m²).
- n. The Contractor shall clean and maintain the rooms and shall supply all heating fuel, electricity, and water.
- o. The Contractor shall also supply for the sole use of the inspectors all desks, work tables, chairs, files, lockers, and sanitary supplies necessary and commensurate with the inspection of his/her plant. It is anticipated that the following minimum amount of office and lab equipment will be required: One desk with approximately 3 foot x 6 foot (0.9 m x 1.8 m) top; one upright locker or wardrobe, with shelves, approximately 5 feet (1.5 m) deep; two 4-drawer file cabinets; 1 chair per inspector; 10 square feet (1 m²) of work surface per inspector in the office area; and a lab counter (approximately 3 x 18 feet [0.9 m x 5.5 m]) with storage space beneath.

705.04 -- Method of Measurement

- 1. Precast or Precast/Prestressed Concrete piles shall be measured in accordance with the requirements of Section 703.
- 2. Precast or Precast/Prestressed Concrete superstructures will be measured for payment by the lump sum.

705.05 -- Basis of Payment

- 1. Prestressed or Precast Concrete piles shall be measured and paid for as described in Section 703.

2. Pay Item	Pay Unit
Precast/Prestressed Concrete _____ Superstructure at Station _____	Lump Sum (LS)

- 3. Reinforcing steel, prestressing tendons, and all other components of the Precast or Precast/Prestressed Concrete superstructure are subsidiary to this pay item.
- 4. The cost of furnishing and maintaining the inspection facilities will not be paid for directly, but shall be subsidiary to "Precast/Prestressed Concrete _____ Superstructure at Station _____".
- 5. If a Precast or Precast/Prestressed Structural item's 56-day compressive strength is less than the design strength, then the Engineer will determine if the item can be used. If the item is to be used, a payment deduction of 25% will be taken if the 56-day compressive strength is less than 95% of the design strength.
- 6. All equipment calibrations and tests are subsidiary to "Precast/Prestressed Concrete _____ Superstructure at Station _____".
- 7. Payment is considered full compensation for all work described in this Section, including the cost of prestressing and precasting.

SECTION 706 -- CONCRETE BRIDGE FLOORS

706.01 -- Description

1. This work shall consist of providing all necessary materials and construction of concrete bridge floors in accordance with the contract and specifications.

706.02 -- Material Requirements

1. Reinforcement shall be furnished, handled, and placed in accordance with the requirements of Section 707.

2. White polyethylene film shall comply with the requirements of Section 1010.

3. Concrete retardants shall meet the requirements of Sections 1002 and 1007.

4. Concrete shall meet the requirements of Section 1002.

706.03 -- Construction Methods

1. Reinforcement Steel:

a. Before placing concrete for bridge floors, the placement of top reinforcing steel shall be checked for clearance to the surface of the slab by measuring from the reinforcing steel to the strike-off screed.

b. Such checking shall be done by the Contractor in the presence of the Engineer and shall be repeated at a sufficient number of locations to demonstrate that concrete cover over the reinforcing steel as required in the contract will be obtained at all points on the slab.

c. Such checking does not preclude subsequent checks by the Engineer during and after concrete placement.

2. Environmental Conditions:

a. The Contractor shall perform bridge floor construction in accordance with the requirements of Section 704. Bridge floor concrete shall not be placed when the anticipated wind velocity during the concrete placement period is expected to exceed the limitations shown in Table 706.01.

Table 706.01

Temperature and Wind Velocity Limitations	
Air Temperature in the Shade	Maximum Wind Velocity
90°F (32°C)	10 mph (16 kph)
77°F (25°C)	16 mph (25 kph)
68°F (20°C)	22 mph (35 kph)
59°F (15°C)	28 mph (45 kph)
50°F (10°C)	40 mph (65 kph)

b. Bridge floor concrete shall not be placed when the ambient air or concrete temperature is above 90°F (32°C).

3. Placement:

a. The Contractor's sequence of placing shall be as shown in the contract.

b. Placement of bridge floor concrete shall be continuous, and no delays are allowed between successive loads for any reason except at an expansion or construction joint.

c. Concrete slab bridge floors shall be placed and finished at a rate of at least 10 feet/hour (3 m/h).

d. Concrete bridge floors on steel girders, prestressed concrete girders, or prestressed double-tee beams shall be placed and finished at a rate of at least 20 feet/hour (6 m/h).

4. Removal of Formwork:

a. The Contractor shall notify the Engineer before releasing any temporary structural supports.

b. The Contractor shall remove falsework before placing concrete floors on steel spans.

c. The Contractor's floor and curb forms shall be supported entirely by the steel frame.

5. No work shall be performed on the bridge deck, including forming and placing reinforcement for concrete curbs or railing until the wet curing of the concrete deck is complete. Only equipment necessary for forming and pouring the bridge rail shall be allowed on the deck during the 7 days of white pigment curing.

6. Finishing:

a. The Contractor shall finish concrete bridge decks and approach slabs with an approved mechanical, self-propelled finishing machine.

b. The finishing machine shall consist of one or more devices mounted on a rigid frame and be capable of striking off and finishing the surface either transversely or longitudinally. Finishing machines shall be of sufficient size to finish the entire width of the bridge deck in one pass.

c. Finishing Machine:

(1) The machine shall be supported on adjustable rails or tracks of sufficient strength to prevent deflection between rail supports.

(2) The rails should be installed outside the slab limits and shall be set and maintained true to the desired grade, line, and cross section during the entire finishing operation.

(3) Rail supports shall be unyielding, and falsework or forms shall be strengthened as necessary to support the imposed load without deflection.

(4) Rail supports located within the limits of the slab shall be constructed to allow their removal to at least 2 inches (50 mm) below the slab surface. The resulting holes in the concrete slab shall be acceptably filled during the final finishing operation.

(5) Supports shall not be welded to the girders.

d. The finishing machine shall make at least 2 passes over the bridge floor at such intervals as will give proper consolidation and produce the desired surface condition. The concrete shall not be disturbed or worked further, except that any remaining surface irregularities or mortar ridges shall be immediately removed by use of a long-handled float or straightedge.

e. The Engineer may require the Contractor to submit a complete description of the proposed method for handling, placing, and finishing the slab, including the equipment for transporting and delivering the concrete, the finishing machine, and complete details of the supports for such equipment. Approval by the Engineer will not relieve the Contractor of the responsibility for the satisfactory performance of his/her methods and equipment.

7. Finishing Small Areas:

a. For finishing concrete slab widenings or other small or irregular deck areas, hand-finishing methods will be allowed.

b. After the concrete has been consolidated, as specified in Subsection 704.03, the surface shall be carefully struck-off with an approved screed to conform to the grade and cross section shown in the contract and to accurately match adjacent existing concrete surfaces.

c. The screed shall be advanced with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and manipulated so that neither end is raised from the side form or template during the process.

d. Excess concrete shall be maintained in front of the cutting edge to avoid creation of surface low spots.

e. The surface shall be floated using approved methods and equipment to remove all surface irregularities and to seal the surface. Special attention shall be given to areas adjacent to construction joints to achieve proper consolidation and surface finish.

f. Immediately after floating, the surface shall be tested with a 10 foot (3 m) straightedge. Any depressions shall be filled with fresh concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to areas adjacent to deck joints so that these surfaces are especially smooth.

8. Surface Texture:

a. Immediately following the finishing machine, the Contractor shall give the bridge floor surfaces a drag finish with wet burlap, carpet, or a soft bristled broom. The drag finish shall create a uniform, fine-grained finish on the sealed concrete surface.

b. Grooving

(1) When grooving is called for in the contract, transverse tining the plastic concrete of bridge decks (and approaches on new bridges and bridge deck replacements) will not be allowed.

(2) The Contractor shall cut longitudinal grooves into hardened concrete surfaces using a mechanical cutting device. The Contractor shall perform longitudinal grooving after surface correction grinding.

(3) The longitudinal grooves shall be:

- (i) 1/8 inch \pm 1/64 inch wide,
- (ii) 1/8 inch to 1/4 inch (3 mm to 6 mm) deep, and
- (iii) Uniformly spaced at 3/4 inch intervals measured center to center of groove.

(4) Longitudinal grooving shall include both bridge and paving approaches. Grooving shall terminate approximately 6 inches (150 mm) from bridge expansion joints.

(5) Longitudinal grooving on the bridge deck and approach sections shall be discontinued 3 feet from the bridge curb, rail, raised medians, or barriers unless otherwise indicated in the contract.

(6) For phased bridge and bridge approach construction:

(i) The Contractor may cut longitudinal grooves in the hardened concrete at the end of each phase of construction or wait until all phases have been completed. If the Contractor elects to delay cutting of the longitudinal grooves until completion of all phases, the Contractor shall apply an interim broom finish on the concrete deck and bridge approach during placement for all phases opened to traffic.

(ii) The Contractor shall finish all longitudinal grooving for all phases within 30 calendar days following completion of the last phase of the bridge.

(iii) The interim broom finish will not be allowed as a surface texture when opened to traffic over a winter season. If the interim broom texture is present and the Contractor is not in a position to finish all phases of the bridge, the Contractor shall cut longitudinal grooving into the hardened concrete in order to establish an acceptable driving surface texture for the winter season.

(7) Grooves shall be constructed using multi-blade saw cutting equipment, fitted with diamond-tipped circular saw blades.

(i) Before grooving operations, two approved gauges to verify groove depth shall be supplied. The gauges shall be accompanied by the manufacturer's instructions for their use.

(ii) During grooving operations, the groove dimensions will be checked at random. If the minimum groove depth has not been achieved, grooving operations shall stop and the necessary adjustments shall be made.

(8) Sidewalks and top of curbs shall not be grooved and shall receive a final finish with a fine – bristle broom.

c. Tining:

(1) When grooving is not called for in the contract, bridge floors and approach slabs except those which are to receive a subsequent concrete overlay surface course shall also be tined. Tining shall consist of creating uniform, transverse grooves in the final concrete surface.

(2) The grooves shall be approximately 1/8 inch (3 mm) wide by 1/8 inch (3 mm) deep, spaced 0.6 inch (15 mm) apart.

(3) Grooves shall be discontinued at 2 feet (600 mm) from the bridge curb or rail.

(4) A tining rake shall be used to texture the surface after the burlap or carpet drag finish. The use of a corrugated bull float or other device that creates a smooth finish between the grooves will not be permitted.

9. Curing

a. For this Specification, the bridge deck is defined as the concrete deck and pavement cast between the bridge grade beams. Approaches outside the grade beams are excluded.

b. For complete deck replacements of girder and slab bridges:

(1) The Contractor shall cure the concrete deck with wet burlap for at least 240 hours. Burlap with Polyethylene backing will not be allowed on decks unless allowed by the Engineer.

(i) The Contractor shall place uniformly saturated wet burlap on the concrete no later than 20 minutes after the finishing machine passes.

(ii) The burlap shall be thoroughly wetted prior to placing it on the concrete. The burlap shall be kept continuously wet by means of a sprinkling or wetting system for the 10 days.

(iii) The wet burlap shall be secured or weighed down so that it remains in contact with the concrete surface.

(iv) After 96 hours, the Contractor may place white opaque polyethylene film over the wet burlap to reduce the amount of water needed.

(2) After the 10 day wet cure, the Contractor shall apply an approved white pigment curing compound within 45 minutes of removing the wet burlap.

(i) The total rate of combined applications shall be a minimum of 1 Gal/150 SF of surface area.

(ii) The Contractor shall cure the deck with the white pigment curing membrane for an additional 7 days. The Contractor may work on the bridge concrete rail during the 7 days provided caution is used to limit damage to the membrane.

(iii) Curing compound shall not be applied to construction joints or reinforcing steel.

c. For partial deck replacements and deck widenings; including approaches that are not part of a complete deck replacement:

(1) The contractor shall place uniformly saturated wet burlap on the finished concrete within 20 minutes of finishing the concrete.

(2) The contractor shall keep the burlap uniformly saturated for 96 hours.

(3) After 96 hours, the Contractor may place white opaque polyethylene film over the wet burlap to reduce the amount of water needed.

d. The Contractor must provide a list of equipment, equipment certification, and the number of personnel that will be dedicated to the curing operation at least 24 hours before the actual casting date.

e. The Contractor shall be responsible for the repair of all visible cracks more than 3 inches (75 mm) in length that develop on the bridge deck up to the time the project is accepted at no additional cost to the Department.

f. Cracks shall be repaired with a product from the Approved Product List for "Bridge Deck Crack Sealant". The crack sealants shall be installed in accordance with the manufacturer's recommendations.

g. Concrete Bridge curbs and rails shall be cured in accordance with Subsection 704.03.

10. Grinding

a. The grinding and grooving shall not be done until after the 17 days of curing is complete.

b. Bridge decks shall be ground for smoothness in accordance with Section 733.

(1) For bridge decks and approaches that are not covered by Section 733:

(i) The Contractor shall test the cured concrete for surface irregularities with either a 10 foot straightedge placed or operated parallel to the centerline of the roadway or some other device for measuring deviations from a plane. Variations greater than 1/8th inch shall be plainly marked for removal, except that for decks which are to receive a subsequent overlay course greater than 1 inch thick, where 1/4 inch variations are allowed.

(ii) The Contractor shall grind or cut irregularities that exceed the above limits. Bush hammering or other impact methods are not allowed.

11. Retarders:

a. Retarders may be used to aid concrete finishing.

b. Retarders shall be used to establish a one hour delay in the concrete set time when the air temperature is 60°F (15°C) or higher.

(1) Type B – Retarding Admixture or Type D – Water Reducing and Retarding Admixtures, as shown on the Department's Approved Products List, shall be used.

(2) Type A – Water Reducing Admixtures, as shown on the Department's Approved Products List, shall not be used as retarders.

c. Retarders are intended to keep the concrete from setting while construction loads are still at critical locations on the deck.

(1) Dosage rates vary depending on the length of time the retardation needs to last and the air and concrete temperature.

(2) Admixture suppliers shall supply recommendations for dosage rates for varying lengths of time and temperatures.

12. Decks Overlays:

a. When the bridge floor is to receive a subsequent overlay course of high density, low slump concrete, the Contractor shall form test wells into the concrete floor surface. Wells shall be 10 inches (250 mm) by 10 inches (250 mm) and set 1 1/2 inches (38 mm) below the floor surface.

b. The Contractor shall place test wells at intervals not to exceed 50 feet (15 m), except at the point where placing starts. The first 3 wells will be placed at 5 foot (1.5 m) intervals.

13. Drainage:

a. The Contractor shall furnish and install deck drainage systems at the locations shown in the contract. This work includes drain boxes, pipes, anchors, supports, and connections.

b. Floor drains and appurtenances shall be fabricated from structural steel and/or galvanized standard steel pipe (schedule 40) meeting the requirements of ASTM A 36/A 36M or ASTM A 53 Grade B, respectively. After fabrication, floor drains and appurtenances shall be galvanized in accordance with the applicable sections of ASTM A 123.

14. The Contractor shall paint all exposed metal, except weathering grade steel, as described in Section 709.

15. Time for Opening Bridge Floors to Public Traffic:

a. The Contractor shall not open the bridge floor to traffic until approval has been given by the Engineer. The Engineer may open the bridge when the concrete has reached a minimum age of 17 days and developed a minimum compressive strength of 3500 psi.

b. Construction equipment will not be allowed on the deck until after the 10 day wet curing period. Vehicles needed for construction activities and weighing less than 4.0 kips, and comparable materials and equipment loads, may be allowed on any span only after the last placed deck concrete has attained a compressive strength of at least 2.4 ksi. Loads in excess of the above shall not be carried on bridge decks until the deck concrete has reached 80% of the minimum compressive strength described in the contract and after the 10 days wet curing period.

706.04 -- Method of Measurement

1. a. The Department will pay contract quantity when items are constructed according to the contract geometrics.

b. The Contractor may request that the Department recalculate the quantity for the concrete haunch, using the girder shim shots on a prestressed concrete girder bridge.

2. Drainage systems or floor drains will be measured as single units, complete and in place.

706.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete Class _____ for Bridges	Cubic Yard (CY) [Cubic Meter (m ³)]
Drainage System at Station _____	Each (ea)
Floor Drains _____	Each (ea)
Bridge Deck Grooving	Square Yard (SY) [Square Meter (m ²)]

2. Finishing, curing, texturing, set retarders, and test wells are subsidiary to the concrete floor.

3. Miscellaneous items that are listed in the contract to be included in the complete structure, but for which separate items are not shown in the proposal and for which no direct payment has been provided, shall be incorporated in the structure and the necessary work performed by the Contractor. Direct payment for such items will not be made, and they shall be considered as subsidiary to the relevant pay item.

4. If the recalculated concrete quantity of the concrete haunch on a prestressed concrete girder bridge is greater than the contract quantity, the additional concrete quantity will be paid at 1.33 times the concrete invoice price. The Contractor shall furnish the Engineer signed invoices for the Concrete Class _____ for Bridges prior to the request for recalculating the concrete haunch quantity.

5. Payment is full compensation for all work described in this Section.

SECTION 707 -- REINFORCEMENT

707.01 -- Description

1. This work shall consist of furnishing and placing reinforcing steel as required by these Specifications and as shown in the contract.

707.02 -- Material Requirements

1. Reinforcing steel shall conform to the requirements as described in Sections 1020, 1021, 1023, and 1024.

2. Two samples of all reinforcing steel (coated and uncoated) shall be submitted to the Department's Materials and Research Division for testing. The length of each sample shall be 6 linear feet (1.8 m).

707.03 -- Construction Methods

1. Fabrication:

a. Reinforcing bars shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcing Steel Institute. When reinforcing bars are not shipped from tested and approved stock, the identification of all reinforcing bars (manufacturer, heat number, and size) shall be maintained by the fabricator throughout the fabrication process to assure that the fabricated bars are identified with proper tags for final shipment to the job site.

b. The Contractor shall bend reinforcing bars without the use of heat to the dimensions and shapes shown in the contract, and bars having cracks or splits at the bends shall be rejected.

c. Epoxy Repairs:

(1) The epoxy coated rebar shall be free of any cracking or debonding. The Contractor may repair epoxy coated reinforcing bars that show any visible evidence of cracking or disbonding of the coating in the bend area with approval of the Engineer.

(2) Epoxy coatings cut, broken, or abraded shall be repaired before rusting of the bar occurs.

(3) All patching shall be done as provided in Section 1021.

d. All reinforcing steel shall be identified and tagged as required in Subsection 1021.03.

2. Protection of Material:

a. The Contractor shall protect reinforcing steel from damage at all times. When placed in the work, the reinforcing steel shall be free from dirt, paint, grease, oil, rust, or other foreign substances. The Engineer shall be the final judge as to acceptability of the reinforcing material's condition.

b. Reinforcement with any appreciable reduction in section dimensions caused by corrosion will be rejected.

3. Placing and Fastening:

a. The Contractor shall place all reinforcement in the position shown in the contract, and it shall be held securely in position.

b. Fastening:

(1) Reinforcing bars shall be tied at all intersections, except when the spacing is less than 1 foot (300 mm) in both direction, in which case alternate intersections shall be tied.

(2) Welds at all points of intersection of the wire in welded steel wire fabric shall be of sufficient strength that they will not be broken during handling and placing.

(3) Tie wire for epoxy coated bars shall be plastic coated. Plastic clips suitable for the purpose may be used.

c. Positioning and Support:

(1) The Contractor shall position steel reinforcement in concrete walls at the proper clearance from forms by approved chairs, stays, or hangers.

(2) Reinforcing steel in concrete decks and slabs shall be positioned on plastic coated supports or chairs to accurately maintain the specified clearance to the surface of the concrete. Supports shall be spaced at distances not greater than 3 feet for #4 top bars or 4 feet for all other reinforcing.

(3) When wire bar support units are placed in continuous lines, they shall be so placed that the ends of the supporting wires are lapped to lock the last legs of adjoining units. No reinforcing shall be placed more than 2 inches (50 mm) beyond the last leg at the end of any continuous support run.

(4) Reinforcing steel on bar supports shall not be used to support runways for construction equipment. If such runways are used, they shall be supported independently.

(5) Bar support units shall be standard products from a reputable manufacturer of such items. Properly sized supports shall be furnished in sufficient numbers, manufactured to serve their intended purpose, and capable of carrying imposed loads without measurable deflection or displacement of the reinforcing steel. The type and adequacy of supporting units shall be at least equal to that recommended by the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*.

(6) Bar supports which are at exposed concrete surfaces shall be corrosion resistant as described in the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*.

d. Welding or flame cutting on reinforcing steel is prohibited unless specifically authorized by the Engineer.

e. Fiber reinforced concrete support spacers must have at least 4% Polyamide fiber. The flexural strength shall be at least 580 psi (4 MPa) and the compressive strength not less than 9,000 psi (62 MPa). The coefficient of expansion must be the same as for the cast-in-place concrete.

4. Splicing:

a. The Contractor shall furnish all reinforcing steel in full lengths, except where splices are indicated in the contract. Splices in adjacent bars shall be staggered.

b. The Contractor shall splice bars by lapping the ends. The overlap length shall be as shown in the contract or the Construction Manual. Lapped splices shall be made by securely wiring the bars in contact, maintaining alignment and clearances.

c. Spiral reinforcement shall be held in place by wiring to the main reinforcing. Pitch shall be maintained by adequate spacers. Splices shall be made by lapping 1.5 turns.

d. The Contractor shall overlap sheets of welded steel wire fabric reinforcement to maintain uniform strength and fasten them securely at the ends and edges. The edge lap shall not be less than one mesh opening in width, and the end lap shall be not less than 1 foot (300 mm).

707.04 -- Method of Measurement

1. All reinforcing steel used in concrete for bridges, box culverts, culvert headwalls, retaining walls, and all other reinforced concrete structures is measured in pounds (kilograms). Payments will be based on the plan quantities when the structure is built according to the contract.

707.05 -- Basis of Payment

1. Pay Item	Pay Unit
Reinforcing Steel _____	Pound (lb) [kilogram (kg)]
Epoxy Coated Reinforcing Steel _____	Pound (lb) [kilogram (kg)]

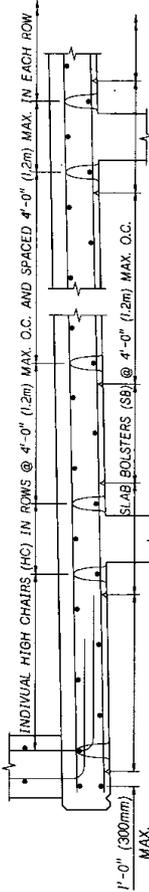
2. Welded steel wire fabric (wire mesh) is subsidiary to the relevant concrete pay item.

3. Payment is full compensation for all work described in this Section.

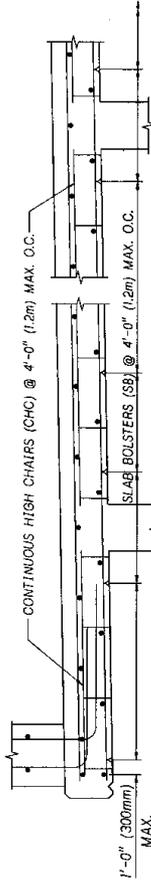
Acceptance of the support spacers will be based on a certificate of compliance furnished by the supplier.

BAR SUPPORTS FOR STRUCTURAL SLAB REINFORCEMENT

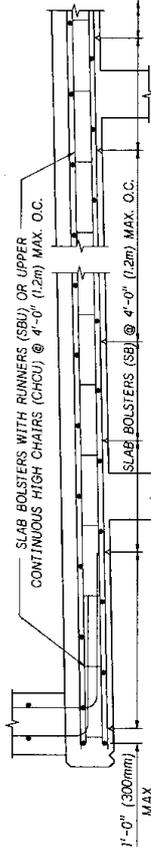
1. SLABS ON FLAT FORMWORK



DETAIL A
SHOWING INDIVIDUAL HIGH CHAIRS (HC)



DETAIL B
SHOWING CONTINUOUS HIGH CHAIRS (CHC)



DETAIL C
SHOWING SLAB BOLSTERS WITH RUNNERS (SBU)
OR CONTINUOUS HIGH CHAIRS (CHCU)

SECTION 708 -- STEEL STRUCTURES

708.01 -- Description

1. a. This work shall consist of furnishing, fabricating, and erecting all bolted or welded steel structures. They shall be fabricated, constructed, and erected in accordance with the details shown in the contract and as required by these Specifications.

b. Construction of the steel superstructure for a new steel girder bridge is described by the pay item "Steel Superstructure at Station _____".

c. When the Department widens or repairs a bridge with steel components, the work is described by the pay items "Structural Steel for Superstructure and/or Substructure". These pay items are also found on new bridges when steel components are required to complete the construction. However, when these pay items are used, notes are placed in the contract to describe what steel items are to be constructed by the pay item "Structural Steel for Superstructure and/or Substructure".

2. The structural steel fabricating plants doing work for the NDOT shall be certified under the AISC Quality Certification Program:

a. Category "SBR" certification is required to fabricate main members of Simple Steel Bridge Structures.

b. Category "CBR" certification is required to fabricate main members of Major Steel Bridges (other than rolled beam structures).

c. When a fabricator holds either a SBR or CBR certificate, a Certified Welding Inspector must be present during all aspects of fabrication and painting. The Certified Welding Inspector must follow the specified duties for Quality Control according to AWS DW 1.5 Section 6.0.

d. Category "SBD or SBR" certification is required to fabricate secondary members.

e. Sole Plate fabrication for Bearing Devices is allowed without AISC certification.

3. a. All welding and weld qualification tests shall conform to the provisions of the current ANSI/AASHTO/AWS D1.5 Bridge Welding Code, referred to as *AWS Standard Specifications*.

b. The Quality Control personnel must be a Certified Welding Inspector and shall be separate from production. The Quality Control personnel shall be present at all times during fabrication and painting. The Quality Control personnel shall be knowledgeable of the specification requirements to insure that the fabrication performance is in conformance with the contract and the current AWS D1.5 Bridge Welding Code book.

4. Field Welding shall require a Welder Qualification Certification. The certification for the welder performing the work shall be submitted to the Engineer three weeks prior to starting the welding. The welder shall produce his/her credentials and photo ID at the jobsite.

5. Field welding is prohibited unless specifically shown in the contract.

6. Welder Certification:

a. All welders, operators, and tackers shall be competent, trained in the particular arc welding process to be used, experienced in the type of

welding required, and capable of producing reliable fillet and groove welds in the weld positions for which they are qualified.

b. (1) All welders shall be qualified under *AWS Standard Specification* criteria.

(2) Qualification testing is required.

(3) The testing may be done by the Engineer, a private laboratory recognized and accepted by the Engineer, or laboratories of other State Highway Departments. The qualifications of welders, operators, or tackers shall remain in effect indefinitely unless the person is not engaged in the given welding process for more than 6 months or unless there is some specific reason to question the person's ability.

(4) A certificate of the welder's qualifications shall be initially submitted to the Engineer. The initial certificate shall state:

(i) The name of the welder, operator, or tacker.

(ii) The name and title of the Engineer that observed the testing.

(iii) The arc welding process.

(iv) The welding position.

(v) The qualification positions.

(vi) Whether for groove or fillet weld.

(vii) Whether for limited or unlimited plate thickness.

(viii) The AWS Electrode and flux or electrode classification.

(ix) The date and results of the test and any other pertinent information.

(5) Failure to follow described welding procedures while performing the work may be cause for suspending a welder's qualifications in Nebraska.

(6) All suspensions may be contested by an appeal to the Engineer.

c. The Contractor shall furnish a certified statement for each welder, operator, or tacker stating that they have satisfactorily welded with the required processes in the 6-month period before the subject work.

d. To arrange Department Qualification Testing, the Contractor shall notify the Engineer as to the time and location of the test at least 48 hours in advance of the time the testing will begin so that the Engineer may observe the weld test.

e. *AWS Standard Specifications* weld test procedures shall be used to evaluate the welds made by automatic welding machines.

708.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 708.01.

Table 708.01

Applicable Materials	Section
Structural Steel	1045
Low Strength Bolts, Nuts and Washers	1057
Structural Threaded Fasteners	1057, 1058
Steel Forging	1048
Cold-Finished Bars and Shafting	1049
Steel Castings	1050
Gray Iron Castings	1051
Malleable Castings	1051
Sheet Lead	1055
Sheet Aluminum	1054
Iron Pipe	1039
Steel Pipe	1040
Welding Electrodes	1047
End Welded Studs	1046

2. Wherever steel shapes, plates, and miscellaneous steel items are specified, all designations and dimensional requirements shall be understood to be the same as those of the AISC *Manual of Steel Construction*.

3. Certified Mill Test Reports:

- a. The Contractor shall furnish to the Engineer 3 copies of all mill orders or 3 copies of the Certified Mill Test Reports before starting fabrication of material covered by these reports.

- b. Before the project is complete, the Certified Mill Test Reports must be provided to the Engineer.

4. The Contractor, through the fabricator, shall furnish to the NDOT Bridge Engineer a cutting list of all material to be used. The list shall include the direction of rolling (only for splice plates, bent plates, flanges, and webs), heat numbers, and fabrication piece marks.

5. All material shall be stored in such a manner as to prevent rust. Material shall not be stored so as to rest upon the ground or in water, but must be placed on suitable skids or platforms.

6. Threads for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC - ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 1.4 inches (35 mm) or more shall be threaded, 1 thread per each 0.16 inch (4 mm) of bolt length.

7. Sheared plates more than 5/8 inch (16 mm) thick which carry calculated stresses shall have the entire sheared surface planed, milled, ground, or thermally cut to remove 1/4 inch (6 mm) of the plate along the entire cut.

8. Bolts, nuts, and washers used in the assembly of "weathering" steel shall conform to ASTM A325/A 325M Type 3.

9. This Specification covers swedged anchor bolts, nuts and washers for use on bridge bearing devices:

a. Anchor Bolts

(1) Unless specified otherwise in the contract, anchor bolts shall conform to the requirements of ASTM A307, Grade A.

(2) Coating. The anchor bolts shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(3) Threads. Anchor bolts shall be threaded to the length shown on the contract. Threads shall be the Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling. The minimum body diameter on products for which no minimum limits are shown in the dimensional tables shall not be less than the minimum pitch diameter of the thread (See ANSI B18.2.1 and ANSI B1.1).

(4) Deformations. The depth of the deformation of the swedged anchor bolt shall not be more than 1/8 inch (3 mm) with a radius not less than 1/2 inch (12.5 mm). There shall be no more than one deformation occurring in any plane perpendicular to the shaft of the bolt. There shall be at least one deformation within each 1 inch (25 mm) length of the bolt and the deformations shall be a minimum of 90 degrees out of phase with the adjacent deformation. No cutting is allowed to form deformation.

b. Nuts

(1) Dimension. Nuts for anchor bolts shall be Heavy Hex nuts as specified in ANSI B18.2.2.

(2) Strength. Nuts shall comply with the proof load or Brinell hardness requirements of ASTM A307.

(3) Threads. Threads shall be the Coarse Thread series as specified in ANSI B1.1.

(4) Coating. The nuts and washers shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(5) Thread fit. After galvanizing, the thread fit of the bolt-nut combination shall be snug and shall be such that the nuts can be turned on the bolts without the application of excessive torque. The Engineer may conduct proof load tests on the bolt-nut combination to check the thread fit.

c. Washers

(1) Washers for use with anchor bolts shall be Type A or Type B Regular as specified in ANSI B18.22.1 except that the following tolerances, based on uncoated washers, shall apply:

- | | |
|-----------------------|--|
| (i) Inside diameter | $\pm 1/16$ inch (1.6 mm) |
| (ii) Outside diameter | $\pm 1/18$ inch (1.4 mm) |
| (iii) Thickness | -0.03, +0.05 inch
(-.8 mm, +1.3 mm) |

10. Any bolt lots which do not bear the Department inspection tags and markings will not be accepted by the Engineer.

11. If the fasteners are shipped to the job site directly from the manufacturer, fabricator, or supplier, they must be sampled by State personnel and submitted to the NDOT Materials and Research Division for testing.

12. Prestressed concrete girder structures:

a. All structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A709/A709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A123.

b. Bolts, nuts, and washers used to install and assemble steel diaphragms shall conform to ASTM A325 or ASTM A325M and shall be galvanized in accordance with ASTM A153.

13. Shear connectors shall conform to the requirements of Subsection 708.02 and Section 1046 of the *Standard Specifications*.

708.03 -- Construction Methods

1. General Requirements:

a. The Contractor shall assemble and place all structural steel as shown in the contract.

b. All structural steel shall be shaped by methods which will not damage the metal. Metal with sharp kinks or bends shall be rejected.

c. Bent steel shall be shaped using procedures that will not produce fractures or damage. The metal shall not be heated unless approved by the Engineer, in which case the heating shall not be done to a temperature higher than 1150°F (621°C). After heating, the metal shall be left to cool at ambient air temperatures above 40°F (4°C). Accelerated cooling is not allowed.

d. The work quality and finish shall equal or exceed ANSI, AASHTO, and AWS Standards.

e. Shearing, thermal cutting, and chipping shall be done accurately; and all portions of the work shall be finished neatly.

2. Plans and Working Drawings:

a. Plans shall be supplemented by the Contractor's working drawings provided in accordance with the requirements of Subsection 105.02.

3. Bolt Holes:

a. The Contractor shall punch or drill and ream all bolt holes. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch (1.5 mm) larger than the nominal diameter of the bolts whenever the thickness of the metal is not greater than 3/4 inch (19 mm) for structural steel or 5/8 inch (16 mm) for high strength low alloy steel.

b. When there are more than 5 thicknesses of material or when any of the main material is thicker than 3/4 inch (19 mm) in carbon steel or 5/8 inch (16 mm) in alloy steel, or when required under Paragraph 6. of this Subsection, all the holes shall be subpunched or subdrilled 3/16 inch (5 mm) smaller and, after assembling, reamed 1/16 inch (1.5 mm) larger or drilled 1/16 inch (1.5 mm) larger than the nominal diameter of the bolts.

4. Punched Holes:

The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch (1.5 mm). If any holes must be enlarged to admit the bolts, they shall be reamed. Holes must be clean cut and without torn or ragged edges. Material with poorly matching holes will be rejected.

5. Accuracy of Hole Group:

a. All holes punched full size, subpunched, or subdrilled shall, after assembling (before any reaming is done), allow a cylindrical pin 1/8 inch (3 mm) smaller in diameter than the nominal size of the punched hole to be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch (5 mm) smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

b. When holes are reamed or drilled, 85% of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/16 inch (15 mm) between adjacent thicknesses of metal.

c. Having met the foregoing criteria, remaining offsets may be corrected by further reaming to admit bolts perpendicular to the face of the member.

d. Except where restoration by welding is necessary for structural or other reasons, mislocated holes shall be left open or filled with bolts.

e. Reaming:

(1) Reamed or drilled holes shall be cylindrical, perpendicular to the member, and shall comply with Paragraph 3. of this Subsection as to size.

(2) Where practical, reamers shall be directed by mechanical means.

(3) Burrs on the outside surfaces shall be removed.

(4) Reaming and drilling shall be done with twist drills, twist reamers, or sluggers (rotobroach cutters).

(5) Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

f. Tolerances:

(1) Holes not more than 1/32 inch (0.75 mm) larger in diameter than the true decimal equivalent of the nominal diameter that may result from a drill or reamer of the nominal diameter are considered acceptable. The slightly conical hole that naturally results from punching operations is considered acceptable.

(2) The width of slotted holes which are produced by thermal cutting or a combination of drilling or punching and thermal cutting shall generally be not more than 1/32 inch (0.75 mm) greater than the nominal width.

(3) The thermal cut surface shall be ground smooth.

6. Drilling, Subpunching, Reaming, and Shop Assembly:

a. (1) Unless otherwise specified, holes in all field connections and field splices of main members of trusses, arches, continuous beams, girders, or rigid frames shall be drilled full size or subpunched (or subdrilled) and reamed, with all members assembled in the shop.

(2) If splices are to be drilled full size, one splice plate from each flange or from each web splice may be predrilled full size and the predrilled plate used as a template for drilling the flange or web and opposite splice plates, provided the resulting holes are equal in quality to holes drilled completely or subdrilled (or subpunched) and reamed through the assembled plates.

(3) The assembly, including camber, alignment, and accuracy of holes and milled joints, shall be approved by the Engineer before reaming of under size holes or drilling of full size holes is commenced.

(4) The connecting parts shall be assembled and held securely while being reamed or drilled and shall be match-marked.

(5) No parts shall be interchanged. (See Paragraph 8. of this Subsection.)

b. All holes for field end connections of floor beam and stringers shall be subpunched and reamed to a steel templet or reamed while assembled.

c. The Contractor shall clean metal surfaces before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The members shall be free from twists, bends, and other deformation.

7. Drifting of Holes:

The drifting done during assembling shall be only that amount necessary to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the bolts, they shall be reamed.

8. Matchmarking:

a. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matchmarked by the Contractor, and a diagram showing such marks shall be furnished to the Engineer.

b. Where steel stamping is used, impressions shall be placed on the thicker tension-joint member in transition joints. Impressions shall not be made on tensile-stressed plate members except at field splices. The maximum allowable depth of the impression shall be 0.01 inch (250 μm). Any metal die stamping shall be done using low-stress dies with rounded edges conforming with the requirements in Table 708.02.

Table 708.02

Low Stress Die Edges	
Character Size inches(millimeter)	Minimum Character Face Radius inches(micrometer)
1/8 (3)	.007 (180)
3/16 (4.5)	.008 (212)
1/4 (6)	.010 (250)

9. Unfinished Turned or Ribbed Bolt Connections (Not applicable to high-strength bolts):

a. The Contractor shall provide bolted connections as required by the contract.

b. Unless otherwise specified, approved lock washers shall be used on all bolts.

c. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal.

d. The bolts shall be of lengths which will extend entirely through their nuts and washers but not more than 1/4 inch (6 mm) beyond them.

e. All bolts shall have hexagonal heads and hexagonal nuts. The diameter of the bolt holes shall be not more than 1/16 inch (1.5 mm) greater than the diameter of the bolts used unless otherwise shown.

10. Structural Joints Using High Tensile Steel Fasteners:

a. When shown in the contract, high tensile steel bolts shall be used for the fabrication of structural steel forming rigid joints in installations where the initial tension in the bolt body is depended upon to produce resistance to shear loads through friction at the faying surfaces.

b. Fastener material requirements, as well as manufacturing, testing, documentation, and shipping requirements, shall be as set forth in Section 1058.

c. Testing:

(1) The rotational capacity test described in Section 1058 will also be performed by the NDOT Materials and Tests Division on each rotational capacity lot before bolt installation at the project site or fabricator's plant.

(2) This test will be performed by the Department in addition to the rotational capacity testing certified by the manufacturer or distributor.

(3) If the fasteners are shipped to the job site directly from the manufacturer, fabricator, or supplier, the Engineer has the option of performing the rotational capacity test and verification testing required in Section 1058 at the job site or fabricator's plant.

(4) If, however, the bolts have not been pretested in accordance with AASHTO M164 (ASTM A325) by State personnel, they must be sampled by State personnel and submitted to the NDOT Materials and Tests Division for testing.

(5) These requirements apply to shop bolts as well as field bolts.

d. Bolted parts shall fit solidly together when assembled. There shall be no compressible material such as gaskets or insulation within the grip. Holes may be punched, subpunched or reamed, or drilled as required by the applicable specifications and shall be of a diameter not more than 1/16 inch (1.5 mm) in excess of the nominal bolt diameter.

e. Faying Surface Preparation:

(1) The faying surfaces shall be free of burrs, pits, and other defects that would prevent solid seating of the parts or would interfere with the development of friction between the parts. The Contractor shall clean surfaces that are to be painted in accordance with Subsection 709.03, Paragraph 1.b.

(2) If unpainted "weathering" steel is specified, the faying surfaces shall be cleaned as described in Subsection 709.03, Paragraph 4.

f. Bolts:

(1) Heavy hex structural bolts and heavy hex nuts shall be required unless other dimensional requirements are stipulated in the contract.

(2) Bolts shall be assembled with a hardened washer under the nut, unless otherwise specified.

(3) A hardened steel flat washer shall be used when the abutting surface adjacent to the bolt head or nut does not have a slope of more than 1 to 20 with respect to a plane normal to the bolt axis.

(4) Where an outer face of the bolt part has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a smooth, hardened steel beveled washer shall be used to compensate for adjoining surfaces not being parallel.

g. Installation:

(1) The sequence of tightening the bolts in a connection shall be such that the stiffest or most restrained area is tightened first, with work progressing toward the free edges.

(2) Sufficient bolts shall be installed and brought to a "snug-tight" condition to ensure that all parts of the connection are in full contact.

(3) Snug-tight is defined as the tightness attained when an impact wrench begins to impact or when the full effort of a person using a standard 18 inch (450 mm) spud wrench is applied.

(4) Snug-tight is more specifically defined as the tightness necessary to produce approximately 15% (but no more than 50%) of the minimum bolt tension as shown in Table 708.03 (A or B), column (3).

(5) This snug-tight tension may be verified using an approved bolt tension calibrator.

(6) All remaining bolts shall be installed and tightened to a snug-tight fit.

(7) The Engineer may require bolts previously installed to be rechecked for tightness.

Table 708.03A

Bolt Tension ASTM A325 Bolts Used in Slip-Critical and Direct Tension Connections			
U.S. Standards			
(1)	(2)	(3)	(4)
Bolt Size	Snug-Tight Tension (kips)	* Minimum Bolt Tension (kips)	+5% Required Installation Tension (kips)
1/2"	2	12	13
5/8"	3	19	20
3/4"	4	28	29
7/8"	6	39	41
1"	8	51	54
1 1/8"	8	56	59
1 1/4"	11	71	75
1 3/8"	13	85	89
1 1/2"	15	103	108
* Minimum tension values shown in column (3) are equal to 70% of the specified tensile load as shown in ASTM A325 specifications (tested full size with UNC threads loaded in axial tension), rounded to the nearest kip (kN).			

Table 708.03B

Bolt Tension ASTM A325M Bolts Used in Slip-Critical and Direct Tension Connections			
SI Standards			
(1)	(2)	(3)	(4)
Bolt Size (mm)	Snug-Tight Tension (kN)	* Minimum Bolt Tension (kN)	+5% Required Installation Tension (kN)
16	14	91	96
20	21	142	149
22	26	176	185
24	31	205	215
27	40	267	280
30	49	326	342
36	71	475	499
* Minimum tension values shown in column (3) are equal to 70% of the specified tensile load as shown in ASTM A325 specifications (tested full size with UNC (metric coarse) threads located in axial tension), rounded to the nearest kip (kN).			

h. Bolt Tension Methods:

High strength fasteners must be installed using either the turn-of-nut method.

(1) Turn-of-Nut Method:

(i) The following requirements for installation of fasteners by this method apply in addition to the specifications in the AASHTO Standard Specifications for Highway Bridges, Division II, Section 11, when high-strength bolts are installed in the field or shop.

(ii) Bolts shall be installed in accordance with AASHTO Division II, Section 11, Article 11.5.6.4.4, for turn-of-nut tightening, using required hardened steel washers under the turned element (the turned element being the high strength nut, unless otherwise specified).

(iii) If the manufacturer's markings on the nuts are raised, the nuts must be installed so that the markings are not in contact with the hardened washer.

(iv) During installation, particular care should be exercised so that the required snug-tight condition is achieved.

(v) After all bolts in the connection have been properly snug-tightened (see Paragraph 10.g. of this Subsection), the nuts shall be match-marked by the Contractor or fabricator using paint, crayon, or other approved means in order to provide the Engineer a reference for determining the relative rotation of the parts during final tightening.

(vi) The outer face of the nut must be match-marked to the protruding end of the bolt after the joint has been snug-tightened, but before final tightening.

Table 708.04

Nut Rotation from Snug-Tight Condition Disposition of Outer Faces of Bolted Parts			
Bolt Length (as measured from underside of head to extreme end of point)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Table Notes:

1. Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees. For bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.
2. No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.
3. Applicable only to connections in which all material within grip of the bolt is steel.

(vii) The element not being turned must be held stationary with a wrench or other suitable means to ensure that no rotation of the unturned element occurs.

(viii) After being properly match-marked, the bolts shall be tensioned by applying the amount of nut rotation as specified in Table 708.04.

(ix) If impact wrenches are used for tightening, they shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

(x) When all bolts in the connection are tight, each bolt should provide a tension at least 5% greater than the minimum tension values shown in Table 708.03 (A or B), column (3).

(xi) These minimum installation tension values are shown in column (4) of Table 708.03 (A or B).

i. Inspection:

(1) Fasteners of appropriately assigned and tested lot numbers shall be assembled together when installed.

(2) Such fasteners shall be protected from dirt and moisture at the job site (in protective storage from the outside elements) in the original containers. These containers or kegs will be sealed and tagged by Department personnel before shipment.

(3) Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from the protected storage. Fasteners not used shall be returned to the protective storage at the end of the shift.

(4) Any fasteners not properly stored or handled are subject to rejection by the Engineer.

(5) Fasteners shall not be cleaned of lubricant that is required to be present in the as-delivered condition.

(6) The Contractor in the field and the bridge fabricator in his/her shop shall provide a certified, calibrated, dial indicator type manual torque wrench and bolt tension measuring device (a Skidmore-Wilhelm calibrator or other acceptable bolt tension indicating device) when high-strength fasteners are being tightened and the Engineer requires a rotational capacity test as required in Section 1058 and/or to verify the tension requirements of Table 708.03 (A or B) for the complete fastener assembly.

(7) Calibration of this equipment will be performed by the Department's Materials and Research Division. Such devices must be submitted to the Department at least 1 week before their use is anticipated.

(8) Recalibration of the torque wrench and tension measuring device will be required at any time which, in the opinion of the Engineer, the equipment is not functioning properly or is out of calibration.

(9) Bolts tightened by the turn-of-nut method may be accepted by the Engineer on the basis of a visual inspection of the match-marks.

(10) If there is a disagreement or question as to the tension of the installed bolts, the Engineer shall require the following procedure to be used:

(i) Five bolts of the same brand, grade, diameter, length, and condition as those under inspection shall be placed individually in the calibration device. The samples selected must be representative of the fasteners used in the work and should be from the same manufacturer's lot if at all possible.

(ii) When the fasteners to be inspected have been installed in the structure for any significant length of time as determined by the Engineer and have been exposed to the elements, the samples should be selected from the fasteners in the work.

(iii) A hardened steel washer must be used under the nut's faying surface with a minimum of 3, but not more than 5, exposed threads included in the grip portion of the bolt.

(iv) Steel shim plates may have to be used as spacers between the washer and the calibrator in order to provide this spacing requirement.

(v) Bolts must first be brought to a snug-tight tension as shown in Table 708.03 (A or B).

(vi) Match-marks are then applied for the purpose of rotational referencing from snug-tight.

(vii) Each of the 5 bolts shall then be tightened in the calibration device, beyond snug-tight, by any convenient means to the minimum tension specified for its size as shown in Table 708.03 (A or B), column (3).

(viii) Tightening from the initial snug-tight condition must not produce greater nut rotation than that allowed in Table 708.05.

(ix) The inspecting wrench shall then be applied to each of the 5 tightened bolts and the torque necessary to turn the nut 5 degrees [1 inch (25 mm) in a 12 inch (300 mm) radius] in the tightening direction shall be determined.

(x) From a practical standpoint, this is the torque necessary to just start rotation of the nut. Record all 5 torque determinations.

(xi) The job inspection torque shall be taken as the average of the 3 remaining values after rejecting the high and low values.

(xii) This job inspection torque is to be used in the manner specified as follows:

(a) Bolts represented by the sample described in Paragraphs 10.i.(10)(x), and (xi) of this Subsection which have been tightened in the structure shall be inspected by applying the inspecting wrench with the accompanying job inspecting torque to a minimum of 10% of the bolts, but not less than 2 bolts, selected at random in each connection.

(b) If no nut is turned by this application of the job inspection torque, the connection shall be accepted as properly tightened. If any nut is turned by the application of job inspection torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut is turned by the job inspection torque shall be tightened and reinspected; or, alternatively, the fabricator or Contractor may retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

Table 708.05

Maximum Nut Rotation from Snug-Tight	
Bolt Length	Rotation
4 diameters or less	1/2 turn
Greater than 4 but not exceeding 8 diameters	3/4 turn
Greater than 8 diameters but not exceeding 12	1 turn

(11) The Engineer will monitor the fastener conditions in order to detect any change in the level of lubrication or accumulation of dirt or other detrimental fastener conditions. At any time during the erection process when the Engineer suspects there may have been a change in the lubrication or fastener conditions, he/she may require the Contractor to run a rotational capacity test as well as verification testing as indicated in these Specifications.

(12) Bolts tightened in-place, then removed, shall be discarded and not reused.

11. Bearing Surfaces and Abutting Joints:

a. Bearing surfaces shall conform to the ANSI B46.1, Surface Texture in Table 708.06.

Table 708.06

Surface Texture	
Surface	Texture
Steel slabs	2000
Heavy plates in contact with shoes	1000
Flame cut surfaces of members carrying calculated stress	1000
Flame cut surfaces of members not carrying calculated stress	2000
Mill ends of compression members	500
Bridge rollers and rockers	250
Pins and pinholes	125
Sliding bearings	125

b. Caps and base plates of columns, the sole plates of girders and trusses, and other steel components shall fit as required by AWS when assembled. The plates, if warped or deformed, shall be hot-straightened, planed, or otherwise treated to secure an accurate, uniform contact as approved by the Engineer. Correspondingly, the surfaces of base and sole plates which are to come in contact with concrete shall be rough finished and be free from warps or other deformations.

c. Abutting ends of compression members shall, after the members have been fastened, be accurately faced to secure an even bearing when assembled in the structure. (Applicable to truss bridge only.)

d. The contract shall state which ends of tension members at splices shall be faced to provide an even bearing. Where joints are not faced, the opening shall not exceed 1/4 inch (6 mm).

12. Pins and Rollers:

a. Pins and rollers shall be accurately manufactured to the contract dimensions and shall be smooth, straight, and free from flaws. The final surface shall be produced by a finishing cut and shall conform to the requirements of Paragraph 11. of this Subsection.

b. Pins and rollers more than 9 inches (225 mm) in diameter shall be forged and annealed. Pins and rollers 9 inches (225 mm) or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

c. Pinholes shall be bored true to detailed dimensions, smooth and straight, at right angles with the axis of the member, and parallel with each other. A finishing cut shall always be made.

d. The diameter of the pinhole shall not exceed that of the pin by more than 1/50 inch (0.5 mm) for pins 5 inches (125 mm) or less in diameter, or by 1/32 inch (0.75 mm) for larger pins.

e. The Contractor shall provide 2 pilot nuts and 2 driving nuts for each size of pin.

13. Thermal Cutting:

a. Structural steel may be thermally cut provided a smooth surface is attained by the use of a mechanical guide. Thermal cutting by hand shall be done only where approved by the Engineer; and the surface shall be made smooth by planing, chipping, or grinding according to ANSI B46.1 Surface Texture.

b. Cuts shall not go beyond the described limit lines.

c. Reentrant cuts shall be filleted to a radius of not less than 1/2 inch (13 mm). Thermal cut surfaces shall meet the ANSI surface roughness rating of 500 micro inches, except members carrying no calculated stress shall meet a rating of 2,000 micro inches.

d. Thermal cut surfaces of members carrying calculated stress shall have their corners rounded to a 1/16 inch (1.5 mm) radius by grinding after thermal cutting.

14. Bent Plates:

a. Cold-bent load-carrying rolled-steel plates shall conform to the following:

(1) They shall be bent at right angles to the direction of rolling.

(2) Cold bending shall be such that no cracking of the plate occurs. Minimum bending radii, measured to the concave face of the metal, are given in Table 708.07.

Table 708.07

Minimum Bending Radii			
Thickness in Inches (millimeters) [t]			
	Up to ¼ (6 mm)	Over ¼ to ½ (6 mm to 12 mm)	Over ½ to 1 (12 mm to 25 mm)
Bending radii for all grades of structural steel	2t	3t	5t

(3) If a shorter radius is essential, the plates shall be bent hot. Hot bent plates shall conform to the requirements of Paragraph 14.a. of this Subsection.

(4) Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch (1.5 m) throughout that portion of the plate at which the bending is to occur.

(5) Allowance for the springback of Grades 100 and 100W steels should be about 3 times that for Grade 36 steel. For break press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

b. If a radius shorter than the minimum specified for cold bending is essential, the plates shall be bent hot at a temperature not greater than 1,200°F (649°C), except for Grades 70W, 100, and 100W. If Grades 100 and 100W steel plates are to be bent and are heated to a temperature greater than 1,100°F (593°C), and if Grade 70W plates are heated to a temperature greater than 1,050°F (565°C), they must be requenched and tempered in accordance with the producing mill's standard practices.

15. Fabrication of Steel Girders:

a. Welding Procedure:

(1) The Contractor shall submit shop drawings for girders and a proposed Welding Procedure Specification (WPS) to the Engineer for review before any fabrication is started. The WPS is maintained on file in the Department.

(2) The fabricator may submit a WPS directly to the Department's Bridge Engineer.

(3) The WPS shall include the following:

(i) Joint description or preparation.

(ii) Welding process and type of welding equipment.

(iii) Base-metal material specifications.

(iv) Welding position.

(v) Amperage, voltage, and travel speed.

(vi) Type current, polarity, and electrical stickout.

(vii) Electrode or electrode-flux classification and manufacturer.

(viii) Gas shielding type and flow rate.

(ix) Preheat and other heating requirements.

(x) Procedure Qualification Record (PQR) used to derive the WPS.

(xi) Other data to fully describe the WPS.

b. The Contractor shall complete the following work before welding webs to flanges:

(1) Butt splices in the flanges and webs shall be welded and radiographed by the fabricator before being approved by the Engineer. The maximum number of weld repairs is three.

(2) The tee joint shall be freed from carbon, rust, pits, dirt, scale, moisture, and other deleterious material.

(3) An external source of heat or force shall be applied to bend the flanges of irregular shaped girders. After the heat or the force is removed, the flange shall fit the contour of the web. If heat is used, it shall be limited to a steel temperature of 1,150°F (621°C). After heating, the metal shall be left to cool at ambient air temperatures above 41°F (5°C) and the velocity of the air shall not exceed 5 mph (8 km/h) throughout the cooling period. Accelerated cooling is not allowed.

c. (1) The girder material shall be held securely in position during welding, and the welding sequence shall be such as to minimize internal stresses and distortion.

(2) Heating and cooling shall be controlled to produce a product within the dimensional tolerances specified.

d. All fillet or groove welds connecting flange plates to web plates shall be made with a submerged-arc automatic welder. Other welds may be made with an automatic, semi-automatic, or manual welder.

e. Unauthorized welds are prohibited. The Engineer's written permission is required before producing any temporary or permanent welds not shown in the contract or allowed in the specifications.

f. All repairs must be Pre-Approved and must have a Welding Procedure and a final report submitted.

g. Preassembly:

(1) In the shop, preassembly of field connections for steel girders is required to verify the geometry of the completed structure and prepare field joints. The details and methods of preassembly of field connections shall be consistent with the erection plan and blocking diagrams prepared by the Contractor and approved by the Engineer.

(2) Camber and blocking tolerances shall be according to AWS Standard Specifications, Section 3.5.1.3. The span length is the length of girder between the end support and a field splice or between field splices.

(3) Only minor weld repairs shall be allowed following preassembly of field connections. Girders placed while checking preassembly of field connections shall have the following items completed:

- (i) Welding.
- (ii) Cambering.
- (iii) Curving.
- (iv) Straightening.
- (v) Flattening of bearing surfaces.
- (vi) Flange Tilt

(4) (i) Preassembly of field connections shall consist of 3 or more contiguous girders accurately adjusted for line and camber. Successive segments shall consist of at least 1 girder from the previous assembly plus 2 or more girders at the advancing end.

(ii) The Department will approve a 2-girder laydown if the fabricator's shop is too small to handle the 3-girder laydown.

16. Heat Curved Girders:

a. Rolled beams and plate girders which are manufactured to a specified yield point of 50,000 psi (345 MPa) or less may be heat curved in accordance with the Standard Specifications when so indicated in the contract.

b. Heating:

(1) Heating Procedures are required for the following:

- (i) Camber Correction
- (ii) Horizontal Curving of Beams and Girders
- (iii) Correcting of flange tilt
- (iv) Web Flatness Correction

(2) Beams and girders may be curved by either continuous or V-Type heating as approved by the Engineer.

(ii) For the continuous method, a strip along the edge of the top and bottom flanges shall be heated simultaneously; the strip shall be of sufficient width and temperature to obtain the required curvature.

(iii) For the V-Type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. The spacing and temperature shall be as required to obtain the required curvature, and heating shall progress along the top and bottom flanges at approximately the same rate.

(iv) For the V-Type heating, the apex of the truncated triangular area applied to the inside flange surface shall terminate just before the junction of the web and the flange is reached. To avoid unnecessary web distortion, special care shall be taken when heating the inside flange surfaces (the surfaces that intersect the web) so that heat is not applied directly to the web.

(v) When the radius of curvature is 1,000 feet (305 m) or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web.

(vi) When the radius of curvature is less than 1,000 feet (305 m), the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to 20% of the flange width or 3 inches (75 mm), whichever is less.

(vii) The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 10 inches (250 mm).

(viii) Variations in the patterns described above may be made with the approval of the Engineer.

(3) For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is only mandatory when the flange thickness is 1 1/4 inches (32 mm) or greater, in which case, the 2 surfaces shall be heated concurrently. The maximum temperature shall be 1,150°F (621°C).

c. The girder shall not be artificially cooled, cooled below 41°F, nor shall the velocity of the air exceed 5 mph (8 km/h) throughout the cooling period.

d. Heating Position:

(1) The girder may be heat-curved with the web in either a vertical or a horizontal position.

(2) When curved in the vertical position, the girder must be braced or supported so that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn or be damaged.

(3) When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required, to obtain a uniform curvature. The bending stress in the flanges due to the dead weight of the girder must not exceed the usual allowable design stress.

(4) When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within 2 inches (50 mm) of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

e. The girder shall be heat-curved in the fabrication shop before it is painted. The heat-curving operation may be conducted either before or after all the required welding of transverse intermediate stiffeners is completed.

(1) However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat curving.

(2) If longitudinal stiffeners are required, they shall be heat-curved or thermal-cut separately and then welded to the curved girder.

(3) When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 2 1/2 inches (64 mm) and the radius of curvature is greater than 1,000 feet (305 m).

(4) For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached. Cover plates must be either heat-curved or thermal-cut separately and then welded to the curved beam.

f. Girders shall be cambered before heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the Engineer. For plate girders, the web shall be cut to the described camber with suitable allowance for shrinkage due to cutting, welding, and heat curving.

g. Tolerance Checking:

(1) Horizontal curvature and vertical camber shall not be measured for final acceptance before all welding and heating operations are completed and the flanges have cooled to the ambient air temperature.

(2) Horizontal curvature shall be measured with the girder blocked with the web in a normal, vertical position.

(3) Vertical camber may be measured in an unloaded position.

h. Moderate deviations from specified camber may be corrected by carefully supervised heating subject to the approval of the Engineer.

i. The bearing ends of bearing stiffeners shall be flush and square with the web and shall be connected to the bottom with a full penetration weld. As an alternate, the stiffener shall be ground to bear and attached with fillet welds. Grind to bear shall mean that at least 75% of the area under the stiffener is in contact with the flange. Contact is defined as being such that a 0.001 inch gage will not pass between the stiffener and the flange.

17. Welding:

a. The Contractor shall perform all preapproved welding using the following processes; shielded metal-arc, submerged arc, gas metal-arc, or flux cored arc process.

b. Steel Backing:

(1) Welds made with the use of steel backing shall have the weld metal thoroughly fused with the backing.

(2) Steel backing shall be continuous for the full length of the weld with run-off plates in place. All necessary joints in the steel backing shall have complete joint penetration welds in butt joints.

(3) Steel backing of welds that are transverse to the direction of computed stress shall be removed, and the joints shall be ground or finished smooth. Steel backing of welds that are parallel to the direction of stress or are not subject to computed stress need not be removed, unless specified by the Engineer or shown in the contract. Where the steel backing of longitudinal welds is externally attached to the base metal by welding, such welding shall be continuous for the length of the backing.

c. When back gouging is required, the surface to be welded shall be cleaned of all spatter and ground smooth.

d. Run-off Plates:

(1) Run-off plates shall be similar to the plate being welded and be sized to provide a reasonable run-off length and allow adequate heat dissipation.

(2) Run-off plates shall be removed when the weld has cooled. The edges of the weld shall be ground smooth and flush with the edges of abutting parts.

e. Tack welds shall not be made outside of the weld area.

f. Preheat and interpass temperature shall be sufficient to prevent weld cracking. The minimum preheat and interpass temperature shall be in accordance with AWS Standard Specifications.

g. The Contractor shall match filler metal to base metal in accordance with the AWS Standard Specifications.

h. Aluminum welding shall be done in accordance with the requirements of Section 418.

18. End Welded Studs:

Stud welding shall be accomplished in accordance with the AWS D1.5 Standard Specifications Section 7.

19. Drip Plates:

When drip plates are required on the exterior girders the weld material shall stop 1/2 inch from the end of the drip plate and 1/2 inch from the edge of the girder. The edges are required to be filled as shown in the contract with a clear colored, 100% silicone product from the Department's Approved Products List.

20. Steel Diaphragms:

a. Flatness or deflection of steel diaphragms and separators after bending shall not exceed half the thickness of the material being bent.

b. The item "Steel Diaphragms" shall include furnishing and installation of all cross frames, bent plate separators, angles, plates, bolts, and other incidentals necessary to complete the installation of the diaphragms as shown in the contract.

c. For prestressed concrete girder structures, all structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A709/A709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A123.

d. Bolts, nuts, and washers shall conform to ASTM A325/A325M and shall be galvanized in accordance with ASTM A153.

21. Shop and Field Inspection:

a. The Contractor shall give the Engineer 30 days advanced notice of shop work and provide a copy of the anticipated production schedule. The Engineer will schedule a Prefabrication Meeting at the fabrication shop to review the applicable codes and specifications and the production schedule. The Engineer shall be notified three working days (Saturdays, Sundays, and Holidays are excluded) before actual fabrication start time so inspection can be scheduled.

b. The Contractor shall perform inspection and testing at least to the extent specified in the current AWS D1.5 Standard Specifications and additionally as necessary to assure conformance with the requirements of the contract.

c. The Contractor shall facilitate the inspection of material and work quality in the shop, and the Engineer shall be allowed free access to the plant.

(1) The Contractor shall have the fabricator of main members for structural steel bridges provide an office area for the exclusive use of the Department inspectors assigned to the fabrication plant. The office shall be accessible during all fabrication operations. Parking shall be provided nearby.

(2) The office facility shall have a floor area of approximately 110 square feet (10 m²). It shall be weatherproof, insulated, lighted, and secured. An office key shall be furnished to each assigned inspector.

(3) The office shall be equipped with 115 volt, 60 cycle A/C electrical outlets, telephone with direct outside line and intra-plant capabilities, and a heating-cooling-ventilation system which circulates clean smoke-free air and will maintain an ambient air temperature of 72°F (22°C).

(4) The office shall be furnished with an office desk [approximately 30 inches (750 mm) x 60 inches (1500 mm)] with drawers, a swivel chair, and a locking storage cabinet.

d. When structural steel is fabricated outside of Nebraska, the Engineer may elect to make complete inspections of all fabricated work after delivery to the site.

22. Cleaning, Painting and Storage of Material

a. Cleaning and Painting of all final structural members with the exception of Cross Frames and Diaphragms/Separators shall conform to Section 709.

b. Storage of all final structural members shall conform to Section 106.04.

c. All bearing devices while on the job site must be protected from the elements of weather. Devices shall either be stored in a job trailer or properly covered with tarps until the devices are put into place. Devices with sole plates and fabric pads require final field inspection by the Bridge Fabrication Manager and approved prior to installation.

23. Marking and Shipping:

a. Each structural member shall be scribed or paint marked for identification. An erection drawing shall be furnished showing identification marks.

b. When the weight of a member exceeds 3 tons (3 Mg), then the weight shall be marked on the member.

c. Bolts of one length and diameter and loose nuts and washers of each size shall be packed separately.

d. Pins, small parts, and small packages of bolts, washers, and nuts shall be shipped in boxes, crates, kegs, or barrels of convenient sizes. An inventory list with a complete description of each item shall be plainly marked on the outside of each shipping container.

e. The loading, transporting, unloading, and storing of all material shall be conducted so that the material is kept clean and is not damaged.

24. Field Assembly:

a. Methods:

(1) The Contractor shall request the Engineer's approval of the proposed assembly methods at least 2 NDOT work days before starting the work.

(2) Work shall not begin until the Engineer's approval has been obtained.

(3) Approval of these methods does not relieve the Contractor of responsibility for performing the work safely in accordance with the contract.

b. The Contractor's preparation of bearing areas shall include:

(1) Contractor shall contact the Department's Bridge Office a minimum of two weeks prior to installation of Bearing Plates for final inspection.

(2) Column bases and bearing devices shall have full and uniform bearing upon the substructure concrete. Bearing plates or pads shall not be placed upon bridge seat areas of piers or abutments which are deformed, irregular, or improperly finished.

(3) The bearing devices and the bases of columns shall be rigidly and permanently located to the correct alignment and elevations.

(4) A 1/8 inch (3 mm) thick lead sheet shall be placed between all steel and concrete at all areas where a bearing load is transferred. For example, a 1/8 inch (3 mm) lead sheet is required under all pot bearings and special bearings.

(5) Anchor bolts shall be cast in the concrete as shown in the contract.

c. The Contractor's methods and equipment used to assemble the structure shall not damage the members. Damaged members shall be rejected.

d. The Contractor shall adjust the structure to its correct grade, alignment, and elevations and confirm splices are properly aligned before installing bolts. The correct camber and relative elevations shall be established before tightening the bolts.

e. The Contractor shall block those girder segments assembled on the ground according to the camber and blocking diagram before bolted field splices are tightened.

f. Plates, angles, and other shapes shall be straightened by methods that will not produce fracture or other damage. Metal shall not be heated unless allowed by the Engineer. If the Contractor uses heat, a proposal for its use shall be provided. The proposal shall include methods of heating, cooling, and other pertinent details.

g. After straightening a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

h. Corrections:

(1) Minor corrections involving reaming, cutting, and chipping are expected. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting of parts by the moderate use of drift pins or by a limited reaming, chipping, or cutting shall be reported immediately to the Engineer.

(2) Correction using approved methods shall be made in the Engineer's presence.

(3) The Contractor shall be responsible for all misfits, errors, and damage and shall make the necessary corrections and replacements.

25. Falsework:

Falsework shall be designed, constructed, and removed as described in Subsection 704.03, Paragraphs 5. and 7.

26. Installation of shear connectors shall be in accordance with ANSI/AASHTO/AWS *Bridge Welding Code*.

708.04 -- Method of Measurement

1. a. "Steel Superstructure at Station _____" is measured as a lump sum.
 - b. Structural steel for substructures and superstructures is measured by the pound (kilogram).
 - c. Steel diaphragms are measured by the each.
 - d. Payment quantities are shown in the contract.
2. a. "Steel Superstructure at Station _____", "Structural Steel for Superstructure", and "Structural Steel for Substructure" shall include all structural steel and miscellaneous metals, except railing and handrails, necessary for the construction as shown in the contract.
 - b. The weight of structural steel shall be computed by the Department on the basis of the dimensions shown in the contract.
 - c. In the computation of quantities, no deductions will be made for copes, cuts, and open holes, except that in cases of gusset plates, tapered plates, and irregular shaped plates such as the webs and cover plates of tapered columns and the webs of curved plate girders, skewed bearing plates, and shim plates, the actual sizes as assembled in the completed structure shall be measured for payment. In the case of rolled plates which have been beveled by milling, payment will be made on the basis of full maximum thickness throughout.
 - d. The weight of paint or weld metal on structural steel will not be included in the quantities.

708.05 -- Basis of Payment

1. Pay Item	Pay Unit
Steel Superstructure at Station _____	Lump Sum (LS)
Structural Steel for Substructure	Pound (lb) [Kilogram (kg)]
Structural Steel for Superstructure	Pound (lb) [Kilogram (kg)]
Steel Diaphragm	Each (ea)

2. Direct payment for arc welding and prequalification testing, including all labor, equipment, materials, tools, and incidentals shall not be made but shall be considered subsidiary to the relevant items for which the contract provides direct payment.
3. The cost of furnishing and maintaining an inspection office will not be paid directly, but shall be considered subsidiary to the relevant items for which direct payment will be made.
4. All bolts and fasteners, including anchor and swedge bolts for bearing devices, shall not be paid for directly but shall be considered subsidiary to the various structural steel and steel diaphragm pay items.
5. Payment is full compensation for all work described in this Section.

SECTION 709 -- PAINTING

709.01 -- Description

1. The Contractor shall prepare the surfaces to be painted, furnish the paint, apply the paint, protect the paint, and dry the paint.

709.02 -- Material Requirements

1. The Contractor shall furnish a paint system listed on the Department's Approved Products List or as specified in the contract.

2. The Contractor shall furnish the paint manufacturer's certification that the paint complies with the paint system specified. The Contractor shall submit the certification at least 14 days prior to starting the painting.

3. The Contractor shall furnish the Engineer with a complete set of the paint manufacturer's product data sheets and application procedures. The Contractor shall submit the data sheets and application procedures at least 14 days prior to starting the painting.

709.03 -- Construction Methods

1. The Contractor shall paint structural steel as follows:

a. General:

(1) All painting shall be done in strict compliance with the paint manufacturer's recommendations and the contract.

(2) All new structural steel work shall be painted with the system specified in the contract.

(3) The exposed surfaces of the steel bearing piles, steel sheet piles, steel pile shells, and steel pile enclosures above finished ground line or stream bed shall be cleaned and painted with a prime coat. The final coat is not required.

(4) All miscellaneous steel, tie rods, armor angles, nose angles, and extrusions for strip seals, except surfaces against which plastic concrete is to be placed, shall be cleaned and painted with a prime coat. The final coat is not required.

(5) Weathering steel shall not be painted.

(6) Galvanized surfaces shall not be painted.

b. Surface Preparation:

(1) All steel surfaces to be painted shall be blast-cleaned to a near-white condition in accordance with The Society for Protective Coatings standard SSPC-SP10. The pictorial reference standards contained in SSPC-VIS 1, which correspond to specification SSPC-SP10, may be used to aid the evaluation of the surface cleaning.

(2) The abrasives used shall be clean, dry, sand; steel grit; or iron, steel, or synthetic shot and shall be of a gradation which produces acceptable results. When shot is used for blasting, it must contain sufficient grit to produce a sharp, angular, anchor pattern. If there is not a manufacturer's recommendation, the typical profile height shall be 2 to 2 1/2 mils (50 to 63 µm). The blasting surface profile height shall be in accordance with manufacturer's recommendations.

(3) The cleaned surface shall be one that is free of all rust, mill scale, and paint, with only slight shadows, streaks, or discolorations. At least 95% of the surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above. Hammers, brushes, scrapers, and other hand or power tools shall be used to supplement blast cleaning, as necessary.

(4) Surfaces that will be inaccessible after fabrication shall be blast cleaned before assembly.

(5) All blasted surfaces shall be brushed clean with bristle or wood fiber brushes, blown clean with compressed air which is free of oil or water, or cleaned by vacuum to remove any trace of blast products from the surface, pockets, or corners. All oil spots shall be cleaned with a suitable solvent.

(6) The cleaning shall be inspected by the Engineer before painting commences.

(7) Blast cleaned surfaces shall receive the prime coat of paint within 24 hours after cleaning unless otherwise authorized by the Engineer. Any rust or surface contamination occurring before painting will require recleaning.

(8) Where touch-up of the prime coat is required, cleaning of small areas may be accomplished by the use of a needle gun or coarse sandpaper. Larger areas shall be blast cleaned.

c. Mixing and Thinning Paint:

Mixing, thinning, pot life, and storage shall be in accordance with the paint manufacturer's recommendations.

d. Application of Paint:

(1) Application of paint shall not be allowed until the certification stating that the paint complies with the paint system specified has been received and accepted by the Engineer.

(2) Painters and quality control personnel to be involved with the paint system shall have passed a training program given by the paint manufacturer's technical representative. The paint manufacturer shall issue a certificate for each individual who has been trained. The Contractor shall present copies of these current certificates to the Engineer prior to application of the paint system.

(3) All painting shall be done in a neat and professional manner in accordance with the paint manufacturer's recommendations. Paint shall be applied to the structure to produce a smooth, uniform film without runs, sags, lap marks, or dry spray overspray. Paint shall be applied at temperatures and humidities specified by the paint manufacturer. Paint shall not be applied upon damp surfaces or under any weather conditions that, in the judgement of the Engineer, are unsatisfactory for painting.

(4) Quality Control:

(i) It shall be the responsibility of the Contractor to conduct and document quality control inspection of the painting, including measurements of temperature, dew point, surface profile, and paint thickness.

(ii) The measurements shall satisfy the recommendations of the paint manufacturer and shall meet the requirements of the contract.

(iii) Written documentation of measurements taken shall be provided to the Engineer daily.

(5) Paint which is not acceptable shall be completely removed and the surface recoated by the Contractor to the satisfaction of the Engineer. Additional compensation will not be allowed for this cleaning or recoating.

(6) During fabrication and shop coating, scaffolding shall be furnished and erected so the Engineer can inspect the steel before and after coating.

(7) Rubber rollers or other protective devices shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

e. Shop Painting:

(1) When all fabrication work is completed and has been inspected, all surfaces not painted before assembling shall be painted with the first, or prime, coat.

(2) Before the material may be moved, the first, or prime, coat shall be allowed to cure for a minimum of 24 hours or the time that the manufacturer recommends. The minimum dry-film thickness of the prime coat shall be 2 mils (50 μm). The maximum dry-film thickness shall not exceed 6 mils (150 μm). The total dry-film thickness shall be in accordance with manufacturer's recommendations.

(3) The dry-film thickness of the prime coat shall be 1 1/2 to 2 mils (38 to 50 μm) for surfaces held in contact with high strength steel bolts (in lieu of the thickness specified for the regular paint system).

(4) Surfaces against which plastic concrete is to be placed need not be painted. Bolts, nuts, and washers installed in the field shall not be painted in the shop.

(5) Surfaces which are not to be in contact but which will be inaccessible after erection shall be painted in the shop with the full paint system required on the completed structure.

(6) If the proper dry-film thickness of the prime coat is not obtained with 1 coat, the cured film shall be cleaned of all contaminants and blasted to slightly etch the existing film. Since adhesion problems may occur between coats of zinc primers, the area shall be coated to the proper film thickness with a zinc-rich primer specifically recommended for this procedure by the manufacturer of the cured primer. In no case shall the total dry-film thickness of the prime coats exceed 6 mils (150 μm), or in accordance with manufacturer's recommendations.

(7) The prime coat shall be allowed to stand a sufficient length of time to allow the film to cure thoroughly throughout its entire thickness before the final, or finish, coat is applied. This time will vary with weather conditions, but in no case should the drying time be less than that specified by the paint manufacturer. The prime coat shall be thoroughly cured before the painted steel is loaded for shipment.

(8) Erection marks for field identification of members and weight marks shall be painted on the top flange of girders or upon the prime coat applied in the shop.

f. Field Painting:

(1) Before applying the final or finish coat, the first, or prime, coat shall be cleaned in accordance with the paint manufacturer's recommendation and the surfaces allowed to dry. The cleaning shall be inspected by the paint manufacturer and the Engineer before application of the final coat commences.

(2) Before application of the final coat, all areas where the prime coat has been damaged during shipping, handling, and erection shall be cleaned as specified under "Surface Preparation" and painted with the primer to a condition equal to that required for the prime coat applied in the shop.

(3) Unless otherwise specified, all structural steel that has received the first, or prime, coat, except contact surfaces, shall be field painted after erection with the final, or finish, coat. The minimum dry-film thickness of the final, or finish, coat shall be 2 mils (50 μm), or in accordance with manufacturer's recommendations.

(4) When the erection work is complete and before the final coat is applied, all bolts, nuts, and washers shall be cleaned of all adhering rust, scale, dirt, grease, or other foreign matter in an applicable manner as described in Paragraph 1.b. of this Subsection and painted with primer to a condition equal to that required for the first, or prime coat applied in the shop.

(5) If, in the judgement of the Engineer, traffic produces an objectionable quantity of dust, the Contractor shall, at no additional cost to the Department, take measures to reduce the dust for the necessary distance on each side of the structure and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces to be painted.

2. The Contractor shall overcoat existing painted structural steel as follows:

a. General:

(1) All painting shall be done in strict compliance with the paint manufacturer's specifications and the contract.

(2) All existing steel structures, unless otherwise specified, shall be painted with the system specified in the contract.

(3) Only the exposed surfaces of the steel bearing piles, steel sheet piles, steel pile shells, and steel pile enclosures above finished ground line or stream bed shall be cleaned and painted with a prime coat. The final coat is not required.

(4) All miscellaneous steel, armor angles, nose angles, and extrusions for strip seals, shall be cleaned and painted with a prime coat. The final coat is not required.

(5) Paint on existing structural steel which contains lead in excess of State or Federal limits shall be treated as a hazardous material and shall be subject to the appropriate governing regulations and laws.

b. Surface Preparation:

(1) All steel surfaces shall be cleaned and prepared in accordance with manufacturer's recommendations; and all debris or waste shall be contained, collected, and disposed of in accordance with the special provisions for "Environmental Protection" in the contract.

(2) Cleaned surfaces shall receive the first coat of paint within 24 hours after cleaning, unless otherwise authorized by the Engineer. Any rust or surface contamination occurring before painting will require recleaning.

(3) Where touch-up is required, cleaning of small areas may be accomplished by the use of a needle gun or coarse sandpaper. Larger areas shall be cleaned using the methods specified in the special provisions for "Environmental Protection" in the contract.

c. Mixing and Thinning Paint:

Mixing, thinning, pot life, and storage shall be in accordance with the manufacturer's recommendations.

d. Application of Paint:

(1) Application of paint will not be allowed until the certification stating that the paint complies with the paint system specified has been received by the Engineer 7 days in advance.

(2) Painters and quality control personnel to be involved with the paint system shall have passed a training program given by the paint manufacturer's technical representative. The paint manufacturer shall issue a certificate for each individual who has been trained. The Contractor shall present copies of these current certificates to the Engineer 7 days prior to application of the paint system.

(3) All painting shall be done in a neat and professional manner in accordance with the paint manufacturer's specifications. Paint shall be applied to the structure to produce a smooth, uniform film without runs, sags, lap marks, or dry spray overspray. Paint shall be applied at temperatures and humidities specified by the paint manufacturer. Paint shall not be applied upon damp surfaces or under any weather conditions that, in the opinion of the Engineer, are unsatisfactory for painting.

(4) Quality Control:

(i) It shall be the responsibility of the Contractor to conduct quality control inspection of the painting, including measurements of temperature, dew point, surface profile, and paint thickness.

(ii) The measurements shall satisfy the recommendations of the paint manufacturer and shall meet the requirements of the contract

(iii) Written documentation of measurements taken shall be provided to the Engineer.

(5) Paint which is not acceptable shall be thoroughly removed and the surface recoated by the Contractor to the satisfaction of the

Engineer. Additional compensation will not be allowed for this cleaning or recoating.

(6) During fabrication and shop coating, scaffolding shall be furnished and erected so the Engineer can inspect the steel before and after coating.

(7) Rubber rollers or other protective devices used on scaffold fastenings shall be approved by the Engineer. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

(8) If, in the judgement of the Engineer, traffic produces an objectionable quantity of dust, the Contractor shall, at no additional cost to the Department, take measures to reduce the dust for the necessary distance on each side of the structure and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces to be painted.

3. Handling Coated Steel:

a. Extreme care shall be exercised in handling the steel in the shop, during shipping, during assembly, and during subsequent construction of the structure. Painted steel shall not be moved or handled until sufficient cure time has elapsed to insure no damage is done to the fresh coating.

b. The steel shall be insulated from binding chains by softeners.

c. Hooks and slings used to hoist steel shall be padded.

d. Diaphragms and similar pieces shall be spaced to minimize rubbing during shipment.

e. The steel shall be stored on wooden pallets or wooden blocks at the job site, or by other means approved by the Engineer, so that it does not rest on the ground and so that components do not fall or rest on each other.

4. Cleaning Weathering Steel:

a. The exterior web of the exterior girders, and all splice plates and the contact surfaces of all bolted splices, shall be blast cleaned by the Contractor in accordance with The Society for Protective Coatings standard SSPC-SP6, Commercial Blast Cleaning. The cleaning of all other surfaces shall remove all rust, mill scale, paint, markings, dirt, and all other foreign material. The metal shall be uniformly cleaned, with only slight shadows, streaks, or discolorations from rust and mill scale oxides remaining. Grease, oil, and paint shall first be removed by suitable solvents.

b. All other steel surfaces (except those specified to be metallized or galvanized) shall be cleaned only to the extent necessary to remove oil, grease, and dirt.

c. All blast cleaned surfaces shall be protected against contamination by oil, grease, paint, or other markings during transportation, storage, and assembly, and against form marks and mortar leaks and spatters during decking and concrete placement.

709.04 -- Method of Measurement

1. "Painting Structure at _____" and "Painting Piles and Miscellaneous Steel" are not measured but are lump sum bid items.

709.05 -- Basis of Payment

1. Pay Item	Pay Unit
Painting Structure at _____	Lump Sum (LS)
Painting Piles and Miscellaneous Steel	Lump Sum (LS)

2. The painting of new structures and piling will not be paid for directly, but shall be considered subsidiary to the relevant structure pay item.

3. Cleaning weathering steel is subsidiary to the relevant structure pay item that contains the weathering steel.

4. The Contractor shall provide all necessary dust and dirt control measures at no additional cost to the Department.

5. Payment is full compensation for all work described in this Section.

SECTION 710 -- CONCRETE BRIDGE DECK REPAIR WITH CLASS 47BD 4000 CONCRETE

710.01 -- Description

1. The work shall include removing unsound concrete, disposing of the old concrete, preparation of the repair area, and furnishing, placing, finishing, and curing the concrete for repairs to bridge deck.

710.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 710.01.

Table 710.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Curing Materials.....	1010, 1011
Fine Aggregate for Concrete Bridge Deck Overlays.....	1033
Coarse Aggregate for Concrete Bridge Deck Overlays.....	1033
Water for Concrete.....	1005
Adhesive.....	1018
Joint Sealing Filler.....	1014

2. The 47BD concrete may use Class F coarse aggregate shown in Table 1033.03A.

710.03 -- Equipment

1. Surface preparation equipment shall be of the following types:

a. Concrete saws capable of sawing to a specified depth.

b. Sandblasting equipment able to remove rust and concrete from exposed reinforcing bars. The equipment shall also be able to remove loose and fractured particles from the prepared concrete surface.

c. Power-driven hand tools will be allowed with the following restrictions:

(1) Jackhammers greater than the nominal 60 lb (27 kg) class shall not be used.

(2) Jackhammers or chipping tools shall not be operated at an angle greater than 45 degrees measured from the deck surface.

(3) Chipping hammers greater than the 30 lb (13.5 kg) class shall not be used to remove concrete from beneath reinforcing bars in partial depth repair.

2. Vibrating screeds, either mechanical or hand operated shall be used to finish the concrete.

710.04 -- Construction Methods

1. General Requirements:

a. No loads other than construction equipment shall be allowed on any portion of the concrete deck which has undergone preparation and removal of the old concrete surface. No construction load will be allowed which exceeds either an 8,000 lb (3625 kg) wheel load or a 16,000 lb

(7250 kg) axle load. Any combination of axles closer than 4 feet (1.2 m) center-to-center will be considered to be one axle.

b. The Contractor shall take all necessary precautions to prevent damage to persons or property beneath the structure.

2. Concrete Removal Requirements:

a. When no overlay is indicated on the plan, the Contractor shall use a diamond blade to cut around the perimeter of the repair area to a depth of one inch. All repairs shall be cut so the edges are parallel or perpendicular to the traveled way. When an overlay is indicated on the plan, saw-cutting is not necessary and edges shall be left irregular.

b. The Contractor shall remove, scarify or chip the concrete deck to a minimum depth of two inches and until all unsound concrete is removed. Where scarifying equipment cannot be used, hand chipping will be required.

(1) Care shall be exercised to prevent cutting or otherwise damaging any exposed reinforcing bars. Repairs to damaged reinforcing steel shall be performed at no expense to the Department. Additional concrete removal and replacement necessary to repair damaged reinforcing steel shall be at no expense to the Department.

(2) Any damaged epoxy coating of existing reinforcing steel shall be repaired according to Subsection 1021.03.

c. Removal work is divided into two classes according to the depth of material removed:

(1) Partial Depth Repair - covers concrete removal from the deck surface to the mid-depth of the slab.

(2) Full Depth Repair - covers concrete removal depths from the lower limit for Partial Depth Repair through the entire remaining deck.

d. Partial Depth Repair:

(1) Where machine scarifying is employed to remove concrete, extreme care shall be used to avoid cutting reinforcing bars. Any damage caused by the Contractor shall be repaired by the Contractor as directed by the Engineer at no additional cost to the Department.

(2) At points where removal of unsound concrete is adjacent to reinforcing bars or the removal of unsound concrete leaves over 2/3 of the bar diameter exposed, the removal shall be continued to at least 3/4 inch (19 mm) below the bar that will allow new concrete to bond to the entire periphery of the exposed bar.

e. Full Depth Repair:

(1) Wherever removal of unsound concrete extends to the top of the bottom layer of steel, the remaining thickness shall be removed to the full depth of the slab; and such areas of removal shall be classified as "Full Depth Repair".

(2) When concrete removal is at approximately mid-depth of the slab, the Engineer shall determine if the concrete quality and structural integrity of the remaining thickness requires full depth removal.

(3) Any removals shall be carefully done to prevent damage to the bottom of the slab and to leave removal boundaries which will allow complete filling with plastic concrete.

3. Preparation of the Surface:

a. The Contractor shall sandblast and clean all exposed reinforcing bars, all prepared concrete surfaces, and the portion of the bridge curb and all surfaces of steel roadway joints which will be in contact with the concrete.

b. In cases where the placement of the concrete is delayed beyond 24 hours after the sand blasting has been completed, the formation of incidental rust on the rebars due to humidity or rain shall not be cause for re-sand blasting.

c. All debris and rubble resulting from deck removal shall be thoroughly swept up and disposed.

4. Forming:

a. Forms shall be provided in areas of Full Depth Repair requiring full depth slab replacement. Forms for small areas (1 square yard [meter] or less) may be wired to the reinforcing bars for support. Forms for larger areas shall be supported by blocking from the beams.

5. Placing Concrete:

a. The clean dry vertical and horizontal faces of the repair shall be coated with Grade 2 Epoxy Adhesive from the Department's Approved Products List just before placing the new concrete.

(1) The epoxy adhesive shall be applied to the vertical sides of the repair with a brush.

(2) The epoxy application rate shall be limited so the epoxy adhesive does not become dry before it is covered with the new concrete.

b. The Contractor shall furnish and place Class 47BD 4000 psi concrete for the deck repair. The concrete shall be handled and consolidated so there will be no separation of the aggregate and the mortar.

c. An internal vibrator shall be used to consolidate the concrete. Excessive vibration shall be avoided.

d. A vibrating screed shall be used on repairs 5 foot or wider to finish the concrete to the final elevation.

e. The surface shall be floated with a magnesium bull float. The surface shall be hand tined parallel to the existing tining in the deck. If the deck is to be overlaid prior to opening to traffic, no tining is required.

6. Sealing Joints:

a. All transverse and longitudinal joints surrounding the repair shall be sealed and the work considered subsidiary to the Partial or Full Depth Repair.

b. Sealing is not required if the repairs will be overlaid with asphalt or concrete.

7. Curing:

a. The Contractor shall apply curing compound to all concrete deck repairs.

b. The application rate shall be 1 Gal/200 SF (0.2 L/m2).

8. Smoothness:

a. The elevation of deck repairs shall be corrected in a manner that eliminates swales or bumps. Swales and bumps are defined as having 1/8 inch or greater deviation using an approved 10 foot straightedge. Corrective actions shall be completed by diamond grinding or replacement. The condition of the adjacent pavement shall be considered when evaluating the 1/8 inch deviation requirement.

710.05 -- Method of Measurement

1. "Bridge Deck Repair, Partial Depth", and "Bridge Deck Repair, Full Depth" will be measured for payment by the square yards (square meters) of deck area repaired in accordance with each classification, as determined by field measurements.

710.06 -- Basis of Payment

1. **Pay Item**

Pay Unit

Bridge Deck Repair, Partial Depth Square Yard (SY)
[Square Meter (m2)]

Bridge Deck Repair, Full Depth Square Yard (SY)
[Square Meter (m2)]

2. "Bridge Deck Repair, Partial Depth", and "Bridge Deck Repair, Full Depth" will be full compensation for all work specified in this Section including all sawing, removing, forming, sandblasting, concrete and materials used for the repair.

3. Payment is full compensation for all work described in this Section.

SECTION 711 -- CONCRETE BRIDGE DECK REPAIR AND OVERLAY

711.01 -- Description

1. This work shall consist of the removal of the existing deck surfacing, resurfacing with class 47B-OL concrete, and other incidental work as shown in the contract.

2. A pre-placement conference at a time mutually agreed upon shall be held before the initial placement of Class 47B-OL concrete. Representatives of the admixture manufacturers, the concrete producer, the Contractor, and Materials and Research shall meet with the Engineer to discuss the following:

- a. Mix proportions.
- b. Batching sequence.
- c. Batch size.
- d. Work schedule.
- e. Applicable specifications and special notes.
- f. All equipment that will be used.
- g. Delivery details.
- h. Special training for finishers.
- i. Duties of all personnel.
- j. Overlay construction details.
- k. Testing requirements.
- l. Acceptance criteria.
- m. Contingency plans.
- n. Methods of measurements.
- o. Basis of payment.

711.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 711.01.

Table 711.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Curing Materials.....	1010, 1011
Sand and Gravel Aggregate	1033
Ledge Rock Aggregate	1033
Water for Concrete.....	1005

2. Ledge Rock aggregate for use in Class 47B-OL concrete shall be uniformly saturated with water before it is used. The wetting shall begin 24 hours before concrete mixing to allow complete saturation.

711.03 -- Equipment

1. Machines with oil leaks or drips shall not be used on the prepared deck surface.

2. Surface preparation equipment shall be of the following types:

- a. Concrete saws capable of sawing to a specified depth.
- b. Scarifying equipment capable of uniformly cutting the existing concrete surface to the depths required.
- c. Sandblasting equipment able to remove rust and concrete from exposed reinforcing bars. The equipment shall also be able to remove loose and fractured particles from the prepared concrete surface.
- d. Power-driven hand tools will be allowed with the following restrictions:

(1) Jackhammers greater than the nominal 60 pound (27 kg) class shall not be used.

(2) Jackhammers or chipping tools shall not be operated at an angle greater than 45 degrees measured from the deck surface.

(3) Chipping hammers greater than the 30 pound (13.5 kg) class shall not be used to remove concrete from beneath reinforcing bars in Class II repair.

3. The placing and finishing equipment shall include adequate hand tools for distributing the plastic mix and working it down to approximately the correct level for striking off with the screed. Approved hand-operated vibrators may be used in small, otherwise inaccessible areas.

4. Finishing Machine:

a. An approved finishing machine shall be used. It shall comply with the requirements of Section 603 and the following additional requirements.

(1) The finishing machine shall consist of 1 or more devices mounted on a rigid frame, capable of striking off and finishing the surface either transversely or longitudinally. Finishing machines shall be of sufficient size to finish the entire width of the bridge deck in 1 pass.

(2) The finishing machine shall be equipped to travel on rails.

(i) The machine shall be supported on adjustable rails or tracks of sufficient strength to prevent deflection between rail supports.

(ii) The rails should be installed outside the slab limits and shall be set and maintained true to the desired grade, line, and cross section during the entire finishing operation.

(iii) Rail supports shall be unyielding, and falsework or forms shall be strengthened as necessary to support the imposed load without deflection.

(iv) Rail supports located within the limits of the slab shall be constructed to allow their removal to at least 2 inches below the slab surface. The resulting holes in the concrete slab shall be acceptably filled during the final finishing operation.

(v) Supports shall not be welded to the girders.

(vi) Rails shall be securely anchored to provide stability in all directions. The method of anchoring shall not damage the concrete

overlay. Supports for rails shall be fully adjustable (not shimmed) to obtain the correct profile.

b. The finishing machine shall be self-propelled, capable of forward and reverse movement under positive control, and shall have provision for raising the screeds to clear the work when traveling in reverse.

c. When placing concrete in a lane abutting a previously completed lane, that side of the finisher adjacent to the completed lane shall be equipped to travel on the completed lane.

d. Design of the finishing machine and associated equipment shall be such that positive machine finishing of the plastic concrete will be obtained as near the face of existing curbs as is possible. The length of the finishing shall be sufficient to extend at least 6 inches beyond the line where a saw cut is intended to form the edge of a subsequent placement and shall overlap the sawed edge of a previously placed lane at least 1 inch.

e. Design of the finishing machine and associated equipment shall be such that positive machine finishing of the plastic concrete will be obtained within 6 inches of the face of existing curbs.

f. The machine shall be inspected and approved in advance of the start of concrete placement.

711.04 -- Construction Methods

1. Concrete Removal Requirements:

a. The Contractor shall remove, scarify, or chip the old concrete deck to the depths indicated in the contract and until all unsound concrete is removed. Where scarifying equipment cannot be used, hand chipping will be required.

b. At points where removal of unsound concrete is adjacent to reinforcing bars or the removal of unsound concrete leaves over two-thirds of the bar diameter exposed, the removal shall be continued to at least 3/4 inch below the bar that will allow new concrete to bond to the entire periphery of the exposed bar.

(1) Care shall be exercised to prevent cutting or otherwise damaging any exposed reinforcing bars. Repairs to damaged reinforcing steel shall be performed at no expense to the Department. Additional concrete removal and replacement necessary to repair damaged bars shall be at no expense to the Department.

(2) Any damaged epoxy coating of existing reinforcing steel shall be repaired according to Subsection 1021.03.

c. Any removals shall be carefully done to prevent damage to the bottom of the adjacent slab and to leave removal boundaries which will allow complete filling with plastic concrete.

d. The Contractor shall take all necessary precautions to prevent damage to persons or property beneath the structure from falling rubble.

e. Removal work is divided into 3 classes according to the depth of material removed:

(1) Class I Repair - covers concrete removal from the deck surface to a depth shown in the contract (varies with each project).

(2) Class II Repair - covers concrete removal from the lower limit shown in the contract for Class I Repair to the mid-depth of the deck.

(3) Class III Repair - covers concrete removal depths from the mid depth of the slab through the entire remaining deck.

f. Where machine scarifying is employed to remove concrete, extreme care shall be used to avoid cutting reinforcing bars. An occasional bar may be cut to as much as 25% of its diameter without impairing the structure; but if a substantial number of bars are damaged, machine scarifying will be prohibited and other methods required. Any damage caused by the Contractor shall be repaired by the Contractor as directed by the Engineer at no additional cost to the Department.

g. Class III Repair:

(1) Wherever removal of unsound concrete extends to a depth exceeding 50% of the original deck thickness, the remaining thickness shall be removed to the full depth of the slab; and such areas of removal shall be classified as "Class III Repair".

(2) When concrete removal is at approximately mid-depth of the slab, the Engineer shall determine if, in his/her judgment, the concrete quality and structural integrity of the remaining thickness requires full depth removal.

h. Any concrete removal which is necessary to allow striking the full required overlay thickness down to meet roadway joints, floor drains, or other fixtures will be considered to be "Class II Repair".

2. Preparation of the Surface:

a. The Contractor shall sandblast and clean all exposed reinforcing bars, all prepared concrete surfaces, the portion of the bridge curb and all surfaces of steel roadway joints which will be in contact with the overlay concrete, and all edges of previously placed lanes not more than 24 hours before concrete placement.

b. Partial placements shall be given a 72-hour wet-burlap cure and shall be sandblasted and cleaned before proceeding with the general concrete overlay.

c. In cases where the placement of the overlay concrete is delayed beyond 24 hours after the sand blasting has been completed, the formation of incidental rust on the rebars due to humidity or rain shall not be cause for re-sand blasting.

d. All debris and rubble resulting from deck removal shall be thoroughly swept up and disposed.

e. Any areas of the prepared deck surface contaminated by oil leaks or substances detrimental to a good bond shall be thoroughly cleaned by an approved detergent method or shall be removed to such a depth as may be necessary.

f. All reinforcing steel which does not have sufficient clearance shall be depressed and fastened down. If necessary, concrete shall be removed beneath reinforcing bars to allow depressing the bars. Concrete so removed shall be classified as Class II Repair. If the areas where reinforcing bars lack sufficient clearance are extensive, the Engineer may modify the

profile grade to obtain the desired clearance without depressing the reinforcing bars.

g. No loads other than construction equipment shall be allowed on any portion of the concrete deck which has undergone preparation and removal of the old concrete surface. No construction load will be allowed which exceeds either an 8,000 pound wheel load or a 16,000 pound axle load. Any combination of axles closer than 4 feet center-to-center will be considered to be one axle.

3. Forming:

a. Forms shall be provided in areas of Class III Repair requiring full depth slab replacement. Forms for small areas (1 square yard or less) may be wired to the reinforcing bars for support. Forms for larger areas shall be supported by blocking from the beams.

b. Construction Joints:

(1) Longitudinal construction joints shall be provided as shown in the contract. If not shown, locations will be subject to the Engineer's approval. Longitudinal joints shall not be located in the traffic wheel paths if avoidable.

(2) A transverse construction joint shall be constructed in case of a delay in the placement operations exceeding 30 minutes.

(i) Transverse construction joints shall be minimized.

(ii) These joints shall be made against a bulkhead.

(iii) These joints must be sawed back as described in this

Subsection.

(3) At transverse and longitudinal construction joints, the edge of the previously placed concrete shall be sawed back to a straight and vertical edge before all abutting concrete is placed. Slurry from wet sawing shall be thoroughly removed from the prepared deck surface.

(4) Bulkheads or steel dam plates to be used at roadway joints shall be installed to accurate grade and crown.

4. Proportioning and Mixing:

a. Portland cement concrete shall be supplied by certified Ready Mix Plants that are in compliance with the requirements in the Quality Control Manual, Section 3, -- Certification of Ready Mixed Concrete Production Facilities published by the National Ready Mixed Concrete Association. Refer to the Department's Material Sampling Guide for the policy on stationary and portable plants.

b. The high range water reducer (Type F) may be added on the project site. The admixture shall be spread over the entire concrete surface inside the mixing truck and then mixed.

c. The testing for slump shall commence after the concrete is discharged and shall be performed as frequently as necessary to maintain control. The maximum allowable slump shall be 7 inches. There shall not be more than 2 inches of slump difference between any of the loads of concrete placed. The slump shall be increased by the addition of Type F, high range water reducer.

d. Water shall not be added at the project site. Only enough water to rinse the charging hopper and fins after the addition of the admixture is allowed. This water must be estimated and recorded on the batch ticket.

5. Placing Concrete:

a. The Engineer may require the Contractor to submit a complete description of the proposed method for handling, placing, and finishing the slab, including the equipment for transporting and delivering the concrete, the finishing machine, and complete details of the supports for such equipment. Approval by the Engineer will not relieve the Contractor of the responsibility for the satisfactory performance of his/her methods and equipment.

b. Individual areas of Class III removal requiring full depth slab placement shall be poured on forms. Any such areas exceeding 1 square yard (square meter) will require two-stage concrete placement. The first stage shall be poured up to the lower limit of Class I removal area or to match adjacent areas of Class II removal. This partial placement shall be made with Class 47B-OL concrete with a compressive strength of 4000 psi.

c. The Contractor shall thoroughly clean the deck, then saturate it with water 2 hours before concrete placement. Immediately before placing 47B-OL concrete, the deck shall be in a damp condition. Any excess water shall be removed.

d. The delivery truck may be positioned on the prepared deck to discharge the concrete directly in front of the finishing machine or may be located off the bridge deck and the concrete transported to the finisher by means of an approved system. In either case, equipment and operations shall be closely observed to ensure that no foreign materials are brought onto the prepared and cleaned deck surface.

e. Concrete placement shall be continuous. The forward speed of the finishing machine shall be adjusted to the average progress of the concrete production in order that the strike-off operations shall be as continuous and uninterrupted as possible. Hand finishing with a wood float may be required to produce a tight uniform surface.

f. The elapsed time between depositing the concrete on the deck and screeding shall not exceed ten minutes.

g. During delays of 30 minutes or less, the concrete that is placed in front of the paver shall be protected from drying by fogging, wet burlap or others means approved by the engineer. Concrete that has been discharged in front of the paver more than 30 minutes shall be removed. The concrete overlay may be resumed only after 72 hours of cure has elapsed. This restriction does not prohibit continuation of the concrete placement provided a gap is left in the overlay. This gap shall be sufficient in length to allow the finishing machine to clear the previously placed concrete.

h. The Contractor shall proportion, mix, place, and finish at least 2 1/2 CY/hr.

i. The finishing machine shall be operated so that the time between the screeding of the concrete on the deck and finishing shall not exceed 10 minutes.

6. Consolidation Requirements:

a. All fresh concrete shall be internally vibrated in addition to surface screeding.

7. Finishing Requirements:

a. The Contractor shall finish concrete bridge decks with an approved mechanical, self-propelled finishing machine.

(1) Rails for the finishing machine shall be set to the grade established by the Engineer to achieve the desired profile and to produce the minimum required overlay thickness over all points on the prepared deck surface. Before beginning concrete placement, a block with a thickness equal to the minimum overlay thickness shall be attached to the finishing machine screed and the machine operated over the prepared deck. All concrete failing to clear the block shall be removed.

(2) The finishing machine shall make at least 2 passes over the bridge floor at such intervals as will give proper consolidation and produce the desired surface condition. The concrete shall not be disturbed or worked further, except that any remaining surface irregularities or mortar ridges shall be immediately removed by use of a long-handled float or straightedge.

b. The addition of water directly to the surface during the finishing operations will not be allowed, but the use of an admixture finishing aid is allowed.

8. Smoothness:

a. The floor surface shall be tested for smoothness with a 10 foot straightedge while the concrete is still plastic.

b. The 10 foot straightedge shall be held in successive positions parallel to the road centerline and in contact with the surface.

c. The whole area shall be tested from one side of the floor to the other as necessary. The 10 foot straightedge shall be advanced along the deck in successive stages of not more than one half its length.

d. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, and refinished. High areas shall be cut down and refinished.

e. The straightedge testing and refloating shall continue until the entire surface has no deviations from the 10 foot straightedge that are greater than 1/8 inch and the floor has the required grade and contour.

f. When the surface area is so small it will not allow use of a 10 foot straightedge, special tools shall be employed to ensure that there are no deviations in the required longitudinal grade or contour lines in excess of 1/8 inch in 10 feet.

9. Surface Texture:

a. A tining rake shall be used to texture the surface after the burlap or carpet drag finish. The use of a corrugated bull float or other device that creates a smooth finish between the grooves will not be permitted.

b. The texturing requires 1/8 inch deep transverse grooves approximately 1/8 inch wide and spaced at 1/2 to 3/4 inch on center.

c. This operation shall be done at such time and in such manner that the desired texture is achieved with a minimum displacement of coarse aggregate particles.

d. The textured surface shall be discontinued 2 feet from the bridge curb.

e. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout. Before sealing, the adjacent surface shall be sandblasted or water-blasted to remove all dirt, curing compound residue, laitance, and any other foreign material.

10. Curing:

a. The Contractor shall incrementally apply white-pigmented curing compound within 30 minutes after the finish machine passes over the concrete. The application rate shall be a minimum a 1 Gal/100 SF of surface area for tined surfaces or 1 Gal/150 SF of surface for all other finishes.

b. The surface shall be covered with wet burlap as soon as it will support a single layer of wet burlap without deformation. Care shall be exercised to ensure that the burlap is well drained and that the surface is not damaged.

c. The Contractor shall cure the concrete with wet burlap for at least 168 hours. The burlap shall be kept continuously wet by means of a sprinkling or wetting system. However, after 72 hours, the Contractor may cover the wet burlap with a layer of 4 mils polyethylene film for a minimum of 96 hours in lieu of continuing the sprinkling or wetting system. The polyethylene film shall be fastened down along all edges throughout the curing period to prevent drying. Polyethylene film shall meet the requirements of Section 1010.

d. The 168 hours of curing time shall be counted when the overlay in place temperature is 40°F or greater. Hours during which the concrete temperature is below 40°F will not be counted as acceptable curing hours.

e. Adequate precautions shall be taken to protect freshly placed concrete from sudden or unexpected rain. The Engineer may order removal of any concrete damaged by rain.

11. Environmental Conditions:

a. Evaporation Rates:

(1) Class 47B-OL concrete for bridge deck overlays shall be placed when the rate of evaporation will not exceed 0.15 lb/SF/h.

(2) The initial rate of evaporation will be obtained by measuring the relative humidity near the deck, the wind velocity, the air temperature, and the deck concrete temperature.

(3) The fresh concrete temperature will be used in place of the deck temperature once placement has begun for calculating the evaporation rate.

(4) After the concrete paving operation has begun, if the rate of evaporation exceeds 0.15 lb/SF/h, white-pigmented curing compound shall be applied immediately behind the finishing operation.

(5) The Contractor must notify the Engineer regarding additional actions that will be taken to prevent plastic shrinkage cracking.

(6) The rate of evaporation shall be obtained by using the nomograph shown in Figures 711.01.

b. Temperature:

(1) Class 47B-OL concrete for bridge deck overlays shall not be placed when the ambient air temperature is above 77°F.

(2) Unsuitable climatic conditions may require that the concrete be placed at night.

(3) The Contractor shall provide adequate lighting for any night work.

12. The Contractor shall paint all exposed metal, except weathering grade steel, as described in Section 709.

13. Time for Opening Bridge to Traffic:

a. The Contractor shall not open the bridge deck to traffic until approval has been given by the Engineer. The Engineer may open the bridge deck when the concrete has reached a minimum of 7 days and has developed a compressive strength of 4000 psi.

b. Construction equipment meeting legal load limits will be allowed on the deck for bridge work after the 7 day wet curing period provided the deck has achieved a minimum 3500 psi compressive strength.

14. Acceptance:

a. Compressive strength tests shall be made in accordance with ASTM C 39. The 28-day compressive strength shall be 4,000 psi.

b. Before opening for traffic, the new overlay will be examined by the Engineer using visual and sounding techniques. All areas that are not bonded to the underlying deck will be removed to sound concrete and repaired at no additional cost to the Department.

c. The Contractor shall be responsible for repair of all visible cracks more than 3 inches in length that develop on the bridge deck up to the time the project is accepted at no additional cost to the Department.

d. Cracks shall be repaired with an approved bridge deck crack sealant (methacrylate). Crack sealants shall be installed in accordance with the manufacturer's recommendations.

e. The Contractor shall take every reasonable precaution to produce a smooth-riding concrete surface.

(1) Immediately after the curing period is completed, the deck surface shall be tested for surface irregularities with a 10 foot straightedge or other device for measuring deviations from a plane. High spots in excess of 1/8 inch in 10 feet shall be plainly marked. The Contractor shall eliminate such high spots by the use of grinding equipment in accordance with Section 733.05, Paragraph 2.

(2) The surfaces adjacent to longitudinal construction joints shall also match within 1/8 inch. Irregularities greater than 1/8 inch shall be removed by grinding to provide a smooth transition over the joint.

(3) Surface defects shall be corrected by the Contractor at no additional cost to the Department.

711.05 -- Method of Measurement

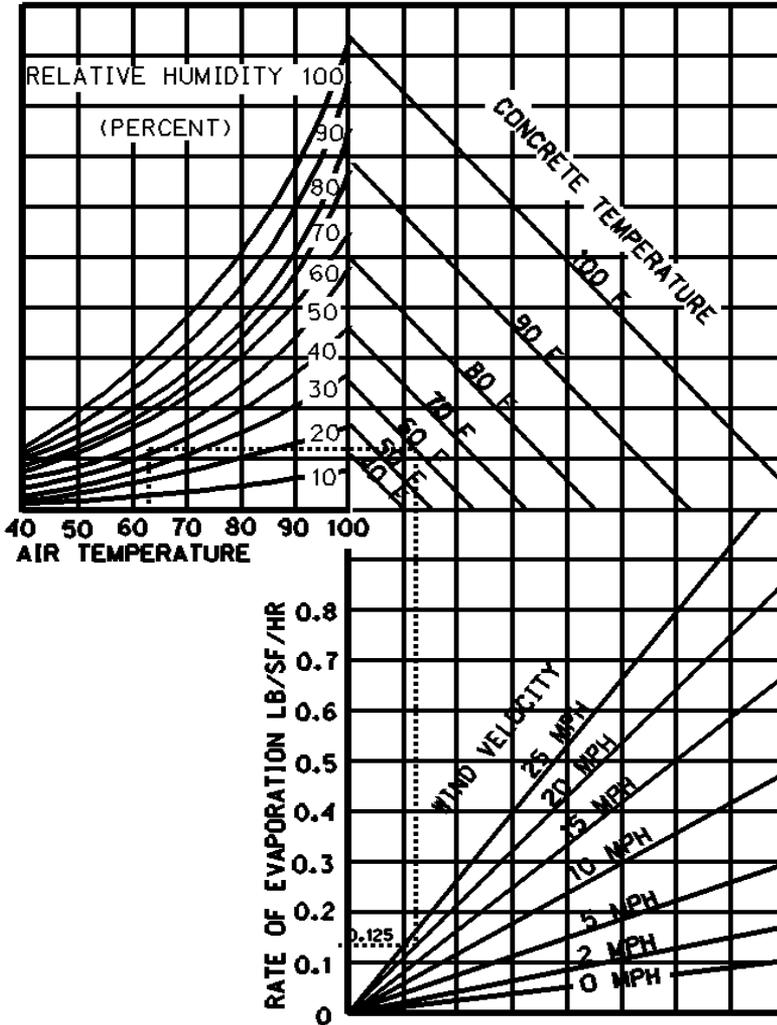
1. "Class I Repair", "Class II Repair", and "Class III Repair" will be measured for payment by the square yards of deck area repaired in accordance with each classification, as determined by field measurements.

2. "Placing, Finishing, and Curing Concrete Overlay – 47B-OL" will be measured for payment by the square yards of deck surface overlaid as determined by field measurement.

3. "Concrete for Overlay – 47B-OL" shall be measured for payment by the cubic yards of concrete placed in the structure (based on truck load tickets). Unacceptable concrete and any waste shall be deducted from the volume for which payment is made.

4. The plan quantity for "Concrete for Overlays - 47B-OL" is determined by the area of the deck times the depth of class 47B-OL overlay. Additional quantities of class 47B-OL concrete may be required to complete any Class II repairs. Additional quantities of class 47B-OL concrete may also be required to complete any Class III repairs that are under one square yard. The pay quantity of class 47B-OL will be based on the actual amount measured in the field.

EVAPORATION NOMOGRAPH



TO USE THIS CHART:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left: read approx. rate of evaporation.

IF THE EVAPORATION RATE EXCEEDS 0.15 lb/sf/h, THEN THE CONTRACTOR SHALL TAKE ACTIONS TO PREVENT PLASTIC SHRINKAGE CRACKING.

Figure 711.01

711.06 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|--|
| Concrete for Overlay – 47B-OL | Cubic Yard (CY)
[Cubic Meter (m ³)] |
| Placing, Finishing, and Curing
Concrete Overlay – 47B-OL | Square Yard (CY)
[Square Meter (m ²)] |
| Class I Repair | Square Yard (CY)
[Square Meter (m ²)] |
| Class II Repair | Square Yard (CY)
[Square Meter (m ²)] |
| Class III Repair | Square Yard (CY)
[Square Meter (m ²)] |
2. Payment is full compensation for all work described in this Section.

SECTION 712 -- FIXED BEARINGS AND EXPANSION BEARINGS, PTFE TYPE

712.01 -- Description

1. The Contractor shall furnish and install fixed bearings and polytetrafluoroethylene (PTFE) type expansion bearings at the locations shown in the contract.

2. The fixed bearings and expansion bearings, PTFE type, shall consist of the upper and lower assemblies shown in the contract. Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for review.

712.02 -- Material Requirements

1. Fixed Bearings:

a. Upper Assembly:

(1) The upper assembly shall consist of a sole plate conforming to the requirements of ASTM A709/A709M grade 50W (345W) weathering steel. All flame cut edges of the sole plate shall be ground to reduce hardness. All corners of the sole plate shall be rounded to a 1/16 inch (1.5 mm) radius.

(2) As an alternate, the sole plate may be ASTM A36/A36M grade 36 (250) steel, metallized. If the ASTM A36/A36M grade 36 (250) alternate is used, all flame cut edges of the sole plate shall be ground to reduce hardness and facilitate blast cleaning. All corners of the sole plate shall be rounded to a 1/16 inch (1.5 mm) radius. All exposed surfaces shall be blast cleaned to a near white finish and zinc metallized with a minimum thickness of 8 mils (200 mm). Zinc metallizing must be performed in accordance with American Welding Society Specification AWS C2.2.

b. The lower assembly shall consist of a cotton duck reinforced elastomeric pad (CDP) conforming to the requirements of the current AASHTO LRFD *Specifications for Highway Bridges* and the Department of Defense Specification MIL-C-882.

2. Expansion Bearings, PTFE Type:

a. Upper Assembly:

(1) The upper assembly shall consist of a sole plate conforming to the requirements of ASTM A709/A709M grade 50W (345W) weathering steel with an ASTM A240/A240M Type 304 stainless steel plate (at least 16 gauge when the maximum dimension of the surface is less than or equal to 12.0 in. and at least 13 gauge when the maximum dimension of the surface is larger than 12.0 in.) attached to the lower surface. All flame cut edges of the sole plate shall be ground to reduce hardness. All corners of the sole plate shall be rounded to a 1/16 inch (1.5 m) radius.

(2) As an alternate, the sole plate may be ASTM A36/A36M grade 36 (250) steel, metallized. If the ASTM A36/A36M grade 36 (250) alternate is used, all flame cut edges of the sole plate shall be ground to reduce hardness and facilitate blast cleaning. All corners of the sole plate shall be rounded to a 1/16 inch (1.5 m) radius. All exposed surfaces shall be blast cleaned to a near white finish and zinc metallized with a minimum thickness of 8 mils (200 mm). Zinc metallizing must be performed in accordance with American Welding Society Specification AWS C2.2.

(3) The face of the stainless steel plate in contact with the PTFE sheet shall be polished or rolled as necessary to provide a No. 8 mirror finish as established by the American Iron and Steel Institute Committee of Stainless Steel Producers "Finishes for Stainless Steel" at the completion of fabrication.

(4) The stainless steel plate shall be attached by welding around its full perimeter.

(5) Welding may be done with the shielded metal arc welding process using an AWS E308L-15 electrode, the gas metal arc welding process using an AWS ER308L electrode, or the gas tungsten arc welding process using an AWS ER308L filler metal.

(6) The weld shall not extend into the area of contact between the upper and lower assemblies.

b. Lower Assembly:

(1) The lower assembly shall consist of a CDP pad with a 94 mil (2.38 mm) thick, low friction, virgin, unfilled, polytetrafluoroethylene (PTFE) sheet bonded to the upper surface.

(2) Bonding of the PTFE shall meet the peel test requirements (ASTM D 903) of 25 lb/in (0.45 kg/mm) at an angle of 180 degrees.

(3) Bonding must be complete and without air gaps under the PTFE sheet to seal out moisture and provide a smooth, flat, slide surface.

(4) The PTFE sheet shall conform to the requirements of the current AASHTO LRFD Bridge Design Specifications and the Standard Specifications for Highway Construction.

c. Flatness of the bearing surfaces shall be determined by the following methods:

(1) A precision straightedge longer than the nominal dimension to be measured shall be placed in contact with and as parallel as possible to the surface to be measured.

(2) An attempt shall be made to insert a feeler gauge equal to the tolerance allowed and having an accuracy of ± 0.001 inch (0.025 mm).

(3) Bearing surfaces are "acceptable" if the feeler gauge does not pass under the straightedge.

(4) Flatness tolerances for the PTFE sheet and the stainless steel plate shall be $0.0005 \times$ "Nominal Dimension."

(5) The "Nominal Dimension" shall be the actual dimension, in inches (millimeters), under the straightedge where the straightedge is not parallel to any plan dimension of the sheet or plate being measured.

3. Certification:

a. All components for the bearing assemblies shall be fabricated, assembled, and certified by the manufacturer for the complete assembly. The assemblies shall be suitably packaged to prevent damage during shipment and storage.

b. The certification shall include all required test reports indicating that the static and kinetic coefficient of friction between the sliding surfaces

does not exceed 0.08 at the pressure of 500 psi (3.5 MPa) and shall state that all materials used in the fabrication of the bearing assemblies comply with the requirements of this Specification.

c. Testing shall be in accordance with the AASHTO *Standard Specifications for Highway Bridges*. The Engineer shall be allowed to witness all testing and approve the testing agency or other parties involved in the testing operation.

4. Anchor bolts, nuts, and washers shall conform to ASTM A 307 and shall be galvanized in accordance with ASTM A 153.

5. The manufacturer of the fixed or expansion bearings shall provide to the Engineer all appropriate certified mill test reports for all materials used in the manufacturing process.

712.03 -- Construction Methods

1. The Contractor shall provide and install the bearing assemblies as described in the contract.

712.04 -- Method of Measurement

1. The fixed bearings and expansion bearings are assembled units that are measured by the each.

712.05 -- Basis of Payment

1. Pay Item	Pay Unit
Fixed Bearing	Each (ea)
Expansion Bearing, PTFE Type	Each (ea)
2. Payment is full compensation for all work described in this Section.	

SECTION 713 -- CONFINED ELASTOMERIC BEARING DEVICES (POT BEARINGS)

713.01 -- Description

1. This work shall consist of furnishing and installing confined elastomeric bearing devices at the locations shown in the contract. Bearing devices furnished under this Specification shall adequately provide for thermal expansion and contraction, rotation, camber changes, creep, and shrinkage of structural members, where applicable.

713.02 -- Material Requirements

1. Unless otherwise specified in the contract, the pot bearings shall be designed in accordance with the applicable requirements of the AASHTO LRFD *Specifications for Highway Bridges*.

2. Before fabrication, the Contractor shall submit shop drawings to the Engineer for review. The shop drawings shall show complete details for inspection and construction purposes, detailed by the manufacturer with all appropriate notations and instructions for field installation.

3. Confined elastomeric bearing devices shall be supplied as fixed bearings, guided expansion bearings, and non-guided expansion bearings as shown in the contract.

a. Fixed Bearings:

(1) Fixed bearings shall allow rotation but no longitudinal or transverse movement.

(2) Fixed bearings shall consist of an elastomeric rotational element, confined and sealed by a steel piston and steel base pot.

b. Guided Expansion Bearings:

(1) Guided expansion bearings shall allow rotation and longitudinal movement, but transverse movement shall be restricted.

(2) Guided expansion bearings shall consist of an elastomeric rotational element, confined and sealed by a piston and steel base pot.

(3) To allow longitudinal movement, the upper surface of the steel piston shall be faced with a polytetrafluorethylene (PTFE) sheet and support a sliding steel top bearing plate.

(4) The mating surface of the sliding steel bearing plate shall be faced with polished stainless steel.

(5) Guided expansion bearings shall be designed to resist a transverse load of 10% of the rated capacity of the device.

(6) To restrict transverse movement, either a guide bar or keyway system shall be used.

(7) The guide bar or keyway systems and their mating steel surfaces shall be faced with strips of filled or unfilled PTFE, per AASHTO specifications, and stainless steel.

c. Non-guided Expansion Bearings:

(1) Non-guided expansion bearings shall allow rotation and longitudinal and transverse movement in the bearing plane.

(2) Non-guided expansion bearings shall consist of an elastomeric rotational element, confined and sealed by a steel piston and steel base pot.

(3) To allow longitudinal and transverse movement, the upper surface of the steel piston shall be faced with polytetrafluorethylene (PTFE) sheet and shall support a sliding steel top bearing plate.

(4) The mating surface of the sliding steel bearing plate shall be faced with polished stainless steel.

4. The elastomeric discs shall meet the following requirements:

a. The physical properties of neoprene and natural rubber used in these bearings shall conform to AASHTO specifications.

b. Confined elastomeric discs shall have a minimum thickness as determined by the following formula:

Elastomeric Disc Thickness Formula	
t	= ID/C
where: t	= minimum elastomeric disc thickness
ID	= inside diameter of pot cylinder
C	= 25 for less than 0.011 radians of rotation
C	= 20 for 0.011 thru 0.016 radians of rotation
C	= 15 for over 0.016 radians of rotation

c. Areas of elastomeric discs shall be designed for a working stress of 3,000 psi (20 MPa) ± 5% at the total dead and live loads of the structure.

d. The upper edge of the elastomer shall be recessed to receive the brass rings.

e. The entire top and bottom of the elastomeric disc shall be lubricated with an even film (approximately 1 to 3 mils (25 to 75 µm) thick) of silicone grease meeting Specification MIL-S-8660C.

f. Elastomeric discs may be either chloroprene or natural polyisoprene with a 50 ± 5 Shore A durometer hardness and shall be individually molded and monolithic. No layering of elastomers will be allowed.

5. The steel pot shall conform to the following requirements:

a. All steel used in pot bearings shall conform to the minimum requirements of ASTM A 709, Grade 36 (250), Grade 50 (345), or Grade 50W (345 W).

b. Pots shall be made from a solid plate by machining.

(1) The depth of the pot cavity shall be equal to or greater than the design rotation + 0.02 radians + 0.1 inch (2.5 mm) + the thickness of the elastomeric disc.

(2) Inside diameters shall be the same as the elastomeric disc.

c. The masonry plate shall conform to the following requirements:

(1) The pot shall be seated in a machined recess of 0.000125 inch (3.175 μm) Root Mean Squared (RMS) max. profile (before metallizing) in the masonry plate, without welding, to a depth required by design, but not less than 0.25 inch (6 mm).

(2) The inside dimension of the finished recess shall be 0.03 inch (0.75 mm) to 0.05 inch (1.25 mm) larger than the actual outside dimension of the finished pot base.

(3) The juncture formed between the edge of the pot and the top masonry plate surface must be caulked with a durable moisture sealant recommended by the bearing manufacturer and approved by the Engineer.

(4) The anchor bolt spacing in the masonry plate and any other considerations shall be incorporated in the design of the bearings to allow for future removal, replacement, or repair of the pot cylinder and piston assembly.

d. Pots or masonry plates must be designed to transmit a maximum bearing stress of 1,200 psi (8.25 MPa) (working stress design) to the concrete surface.

e. Lead sheet used under the masonry plate shall be of the shape and thickness shown in the contract, but not less than 1/8 inch (3 mm) thick, conforming to the requirements of ASTM B 29.

6. The piston shall conform to the following requirements:

a. The piston and/or top plate shall be seated in a machined recess of 0.000125 inch (3.175 μm) RMS max. profile (before metallizing) in the sole plate, without welding, to a depth required by design, but not less than 0.25 inch (6 mm).

b. The inside dimension of the finished recess shall be 0.03 inch (0.75 mm) to 0.05 inch (1.25 mm) larger than the actual outside dimension of the finished piston or top plate.

c. Pistons shall be designed with outside diameters as follows:

(1) Flat brass sealing rings, 0.03 inch to 0.05 inch (0.75 mm to 1.25 mm) less than pot inside nominal diameters.

(2) Round brass sealing rings, 0.02 inch to 0.1 inch (0.5 mm to 2.5 mm) less than pot inside nominal diameters.

d. Piston thickness shall be:

(1) POT ID x 0.08 (minimum) for square shape pots.

(2) POT ID x 0.06 (minimum) for round shape pots.

e. Pistons for round cross section sealing rings shall have the lower outside edge beveled to accept and retain the ring and allow full design rotation.

f. For laterally restrained pot bearings having a shear key in the piston, the top surface shall have keyway slot and cold finished bar press fit and welded at the ends. Pistons of this design shall be machined from one piece of steel.

7. Elastomeric sealing rings shall conform to the following requirements:

a. Flat brass sealing rings shall meet the following requirements:

(1) Width shall be 0.375 inch (9 mm) minimum for bearings up to 1,000 kips (4.44 MN) of capacity and 0.5 inch (12.5 mm) minimum for over 1,000 kips (4.44 MN) capacity. Rings must be manufactured to a tolerance of ± 0.005 inch (± 0.125 mm).

(2) The thickness shall be 0.05 inch (1.25 mm) minimum.

(3) Up to 1,000 kip capacity, 2 rings shall be used; from 1,000 kips (4.44 MN) to 3,000 kips (13.33 MN), 3 rings; and over 3,000 kips (13.33 MN), 4 rings shall be used.

(4) Rings shall fit the ID of the pot snugly, and the ends shall be cut at 45 degrees. When installed in the pot, the maximum gap shall be 0.05 inch (1.25 mm).

(5) Flat brass rings shall conform to the ASTM B 36, half hard requirements.

(6) Round cross section brass rings shall conform to the Federal Specification QQB626, composition half hard requirements.

(7) When 2 seal rings are used, the ring gaps must be staggered 180 degrees apart. When more than 2 rings are required, the gaps of the successive rings must be evenly spaced around the perimeter of the pot.

b. Round cross section brass sealing rings shall meet the following design requirements:

(1) Rings shall fit the POT ID snugly.

(2) Rings shall be made from one piece rolled into a circle and brazed.

8. The PTFE sliding surface shall conform to the following requirements:

a. The PTFE shall be manufactured from pure, virgin, unfilled TFE resin.

b. The properties of the PTFE shall conform to the current AASHTO Specifications for the PTFE bearing surfaces.

c. The area of the PTFE shall be designed for a working stress of 3,500 psi (24 MPa) at the full dead and live loads of the structure.

d. Unfilled PTFE shall meet the following requirements:

(1) PTFE shall be bonded and recessed into the surface of the piston for half its thickness. It shall be a minimum of 1/8 inch (3 mm) thick and not more than 3/16 inch (5 mm) thick.

(2) PTFE shall have a minimum ultimate tensile strength of 2,500 psi.

9. The stainless steel sliding surface shall meet the following requirements:

a. Stainless steel shall conform to the requirements of ASTM A 240, Type 304. Stainless steel in contact with the PTFE sheet shall be polished to a finish of 0.01 mil (0.25 μm) RMS or less.

b. The stainless steel surface shall cover the PTFE surface in all operating positions plus 1 inch (25 mm) in every direction of movement.

c. Stainless steel shall be a minimum of 0.07 inch (1.75 mm) to a maximum of 0.08 inch (2.0 mm) thick and shall be connected to the sole plate by means of a neat seal weld around the entire perimeter of the plate. Welding slag or other residues on the stainless sliding surfaces are not acceptable. Stainless steel used on guide bars or in keyways shall also meet these thickness and other general quality requirements.

d. Welding procedures shall be chosen such that the stainless steel surface is in contact with the sole plate and the surface is smooth and flat.

e. For pot bearings designed with center guided key, the finished recess in the sole plate shall be a maximum of 1/8 inch (3 mm) wider than the PTFE bonded shear key.

f. Stainless sliding surfaces shall face downward.

10. Guide bars shall meet the following requirements:

a. Guide bars may be connected to sole plates by means of either welding or recessed high tensile fasteners. High tensile fasteners, if required by design, shall be designed using 0.2 x F_u (stress ultimate) for allowable stress in single shear.

b. Guide bars and their connections to the sole plate shall be designed for the horizontal forces on the bearing and not less than 10% of the vertical capacity of the bearing.

c. Unless the space between the guide bars is specified, it shall be a total of 1/8 inch (3 mm).

d. Guiding arrangements shall be designed so that the guided member is always within the guides at all bearing translation points.

e. Guiding off the fixed base or any extension of it will not be allowed.

11. Fabrication Tolerances:

a. Steel pots shall meet the following tolerances:

(1) The inside diameter shall be machined to a tolerance of ± 0.005 inch (± 0.125 mm) up to 20 inch (500 mm) diameter and ± 0.007 inch (± 0.175 mm) over 20 inch (500 mm) diameter.

(2) Pot undersides shall be machined parallel to the inside to a Class "A" tolerance as defined in Paragraph 12.a.(4)(i) of this Subsection.

(3) Internal finish shall be 0.000125 inch (3.175 μm) RMS or better.

- b. Elastomeric disc tolerances shall be as follows:
- (1) Diameters greater than 20 inches (500 mm): + 3/32 inch (+2.38 mm).
 - (2) Diameters less than 20 inches (500 mm): +/- 1/16 inch (+/-1.50 mm).
 - (3) Thickness shall be -0.0 inch (0 mm) to + 1/8 inch (+3 mm).
 - (4) Discs shall be manufactured in one piece.
- c. Piston tolerances shall be as follows:
- (1) Diameters greater than 20 inches (500 mm): +/- 0.007 inch (+/-0.175 mm).
 - (2) Diameters less than 20 inches (500 mm): +/- 0.005 inch (+/-0.125 mm).
 - (3) Upper side flatness: Class "A" tolerance.
 - (4) Lower side flatness: Class "B" tolerance.
 - (5) Machine finishes shall be 0.000125 inch (3.175 μ m) RMS or better.
- d. Masonry and distribution plate tolerances shall be as follows:
- (1) Plan dimensions over 30 inches (750 mm): -0.0 inch to + 3/16 inch (-0.0 mm to +4.76 mm).
 - (2) Plan dimensions under 30 inches (750 mm): -0.0 inch to + 1/8 inch (-0.0 mm to +3.0 mm).
 - (3) Flatness: Class "B" tolerance.
- e. PTFE and stainless steel sliding surface tolerances shall be as follows:
- (1) Plan dimensions: total nominal design area -0.0 inch (-0.0 mm) to + 5%.
 - (2) Flatness: Class "A" tolerance.
 - (3) Bonding of the PTFE, where required, shall meet the peel test requirements (ASTM D 903) of 25 lb/in (0.45 kg/mm) at an angle of 180 degrees. Bonding must be complete and without air gaps under the PTFE sheet in order to seal out moisture and provide a smooth, flat slide surface.
- f. Sole plates shall conform to the following tolerances:
- (1) Plan dimensions over 30 inches (750 mm): -0.0 inch to + 3/16 inch (-0.0 mm to 4.76 mm).
 - (2) Plan dimensions under 30 inches (750 mm): -0.0 inch to + 1/8 inch (-0.0 mm to +3.0 mm).
 - (3) Thickness: -1/32 inch to + 1/8 inch (-0.8 mm to +3.0 mm).
 - (4) Flatness of the upper surface: Class "B" tolerance.
 - (5) No beveled edge shall be less than 5/8 inch (16 mm) thick.

g. Guide bar tolerances shall be as follows:

(1) Length: $\pm 1/8$ inch (± 3 mm).

(2) Section dimensions: $\pm 1/16$ inch (± 1.5 mm).

(3) Flatness, where it bears on another plate: Class "A" tolerance.

(4) Bar-to-Bar tolerance: "Nominal Dimension" $\pm 1/32$ inch (± 0.8 mm).

(5) Parallelism: The finished PTFE bonded guide bars shall not be more than $1/32$ inch (0.8 mm) out of parallel, vertically or horizontally.

h. The overall height of a bearing shall not exceed the nominal height by more than $3/16$ inch (4.5 mm) or be less than $1/16$ inch (1.5 mm) under.

i. The edges of all parts shall be rounded by grinding so that there are no sharp edges.

12. Confined Elastomer Bearings-Tolerances for Flatness:

Flatness of bearing surfaces shall be determined by the following method:

a. A precision straightedge longer than the nominal dimension to be measured shall be placed in contact with the surface to be measured as parallel to it as possible.

b. An attempt shall be made to insert a feeler gauge, equal to the tolerance allowed and having an accuracy of ± 0.001 inch (± 25 μm), under the straightedge.

c. Plates are "acceptable" if the feeler gauge does not pass under the straightedge.

d. Flatness tolerances shall be as follows:

(1) Class "A": $0.0005 \times$ "Nominal Dimension".

(2) Class "B": $0.001 \times$ "Nominal Dimension".

(3) Class "C": $0.002 \times$ "Nominal Dimension".

e. "Nominal Dimension" shall be interpreted as the actual dimension of the plate, in inches (millimeters), under the straightedge where the straightedge is not parallel to any plan dimension of the plate being measured.

f. In determining the flatness, the straightedge may be located in any position on the surface being measured.

13. Metallizing:

a. (1) All exposed carbon steel surfaces shall be blasted clean to a near white finish, degreased, and zinc metallized to a minimum uniform thickness of 8 mil (0.2 mm).

(2) All interior surfaces, including the pot and piston assembly and masonry plate recess, shall receive no less than 1 mil (25 μm) nor more than 3 mil (75 μm) thickness of zinc metallizing.

(3) All metallizing must be performed with good work quality in accordance with American Welding Society Specification AWS C 2.2.

b. Anchor bolts, nuts, and washers shall conform to ASTM A 307 and shall be galvanized in accordance with ASTM A 153.

14. Confined Elastomer Bearing - Testing:

a. The bearing manufacturer shall notify the Department's Materials and Research Division at least 10 NDOT work days before the time of the required bearing tests. The Engineer shall be allowed to witness all testing and approve the testing agency or other parties involved in the testing operation.

b. The coefficient of friction shall be determined for at least one sample chosen at random from the production lot. Specially made or test bearings shall not be used. Other than these requirements, the test shall be conducted in accordance with the requirements of AASHTO *Standard Specifications for Highway Bridges*.

c. A proof load test shall be performed on at least one sample of each type (fixed, non-guided expansion, and guided expansion) selected at random from the production lot. Each bearing tested shall be loaded to 150% of the maximum vertical design load for a period of one hour. The fixed and guided expansion bearings shall also be loaded as follows:

(1) 100% of the minimum vertical design load in combination with 150% of the maximum horizontal load, whether lateral or longitudinal.

(2) These loadings shall be maintained for at least 1 hour.

d. All bearing devices tested shall show no signs of failure or any other defects while under load or subsequently upon disassembly.

e. Elastomer Seal Test:

(1) Where the Engineer requires the efficacy of any particular sealing system of different design or material than those detailed in the contract to be demonstrated, an additional elastomeric seal test shall be made.

(2) This test shall be witnessed and certified by a registered Professional Engineer.

f. The bearing to be tested shall be selected at random from the production lot and tested as follows:

(1) The test equipment and test method shall be approved by the Engineer.

(2) A bevel plate equal to the design rotation of the bearing shall be inserted between the test machine and the test bearing.

(3) The load shall be applied to the test bearing uniformly and smoothly over a period of 5 minutes up to the full test load.

(4) The test load shall be 3 times the capacity of the bearing and shall be maintained for a period of 6 hours with no change in the load.

(5) During the test, the bearing shall be carefully examined for any sign of extrusion of the elastomer.

(6) After removal of the test load, the bearing shall be disassembled and examined for any sign of damage or permanent deformation of the sealing system. Bearings which show no sign of extrusion of the elastomer and no deformation of the sealing system may be considered acceptable.

15. Certification:

a. A copy of the test certificates documenting tests performed and mill tests for all materials used in the bearing fabrication shall be submitted to the Department’s Materials and Research Division for review and approval.

b. In addition, the manufacturer or their representative must contact the Department’s Materials & Research Division to confirm materials are approved one week before shipping the bearings.

16. Inspection:

Before installation, confined elastomeric bearing devices will be disassembled on the project site by Department personnel to inspect for conformance with the approved shop drawings and contract specifications.

713.03 -- Construction Methods

1. The Contractor shall install elastomeric bearing devices in accordance with the manufacturer's recommendation and as described in the contract.

713.04 -- Method of Measurement

1. "Fixed Bearing Devices, Type I", "Guided Bearing Devices, Type II", and "Non-Guided Bearing Devices, Type III" are measured by the each.

713.05 -- Basis of Payment

1. Pay Item	Pay Unit
Fixed Bearing Device, Type I	Each (ea)
Guided Bearing Device, Type II	Each (ea)
Non-Guided Bearing Device, Type III	Each (ea)
2. Payment is full compensation for all work described in this Section.	

SECTION 714 -- MECHANICALLY STABILIZED EARTH (MSE) WALLS WITH CONCRETE FACING PANELS

714.01 -- Description

1. This work shall consist of designing, furnishing materials, excavation, and constructing mechanically stabilized earth (MSE) walls with concrete facing panels in accordance with these Specifications and with the lines, grades, dimensions, and details shown in the contract.

2. The excavation for the MSE wall shall consist of excavation for the leveling pads and "Excavation for Soil Reinforcement". The excavation may consist of existing ground and/or newly constructed fill. The contractor shall excavate to the dimensions shown in the working drawings. The contractor shall also follow the manufacturer's recommendations with concurrence of the Department.

3. The MSE walls shall consist of a nonstructural leveling pad, concrete face panels, and soil reinforcement elements mechanically connected to each facing panel. Soil reinforcement shall have sufficient strength, frictional resistance, and length as required by the design and as outlined in these Specifications.

4. Only the approved proprietary mechanically stabilized earth retaining wall systems that are shown on the Department's Approved Products List shall be used.

5. All appurtenances behind, in front of, under, mounted upon, or passing through the wall, such as drainage structures, utilities, or other appurtenances shown in the contract, shall be accounted for in the stability design of the wall.

6. The MSE wall design shall follow the general dimensions of the wall envelope shown in the contract. The contract will locate the theoretical leveling pad elevation. The minimum wall embedment below the finished ground surface shall be 2 feet (600 mm) or as shown in the contract. The top of the face panels shall be at or above the top of the panel elevation shown in the contract. Where coping or barrier is used, the wall face panel shall extend up into the coping or barrier a minimum of 2 inches (50 mm). The top of the face panels may be level or sloped to meet the top of the wall line noted. Cast-in-place concrete will be allowed for minor grouting of pipe penetrations and leveling required for coping or traffic barrier.

7. Where walls or wall sections intersect at an angle of 130 degrees or less, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner and allow for independent movement of the abutting panels.

8. The face panels shall be designed to accommodate differential settlements along the length of the wall and normal to the wall alignment. Differential settlements along the length of the wall shall not exceed 1 foot per 100 feet (1m per 100m) of wall length. When the expected differential settlements normal to the wall exceed 3 inches (75 mm), the lower level reinforcement facing connections shall be designed to accommodate the increased tensile forces due to the settlement. Where shown in the contract, or determined by the MSE wall supplier, vertical joints to accommodate excessive differential settlement shall be included.

9. Working Drawings:

a. The Contractor shall submit to the Engineer for review:

- (1) 6 sets of working drawings.
- (2) 6 sets of design calculations.
- (3) Explanatory notes.
- (4) Specifications.
- (5) Proposed component materials for the wall system.

b. The working drawings and design calculations shall be signed, sealed, and dated by a Professional Engineer registered in Nebraska.

c. These drawings shall include a numbered panel layout for fabrication and erection purposes, as well as for any required coping when it is prefabricated.

d. They shall further include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines, all as shown in the contract.

e. The drawings will also reflect:

(1) All information needed to fabricate and erect the walls including the proposed leveling pad elevations.

(2) The shape and dimensions of panels.

(3) The size, number, and details of the reinforcing steel.

(4) The number, size, type, and details of the soil reinforcing system and anchorage.

(5) The size, details, and manufacturer of all fillers and filter cloth.

(6) The size of leveling pad.

(7) The dimensions of structural backfill required.

(8) Any additional details pertaining to coping, railing, drainage, or electrical conduit required by the contract.

f. Leveling pad elevations may vary from footing elevations shown in the contract. However, the leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown in the contract and shall provide 2 foot (600 mm) minimum cover from the top of the leveling pad to finish grade.

g. The Contractor shall not start work on any earth retaining system until the working drawings are reviewed and returned by the Engineer.

h. It is expressly understood that the review of the Contractor's drawings shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the contract.

i. The Contractor shall allow 30 calendar days for the review of the contractor's MSE wall design details and drawings by the Engineer.

714.02. -- Design Requirements

1. The design, by the wall system supplier, shall include the internal stability of the wall's retained mass. In conjunction with these Specifications, the following publications shall be used by the wall system supplier when designing the wall system:

a. FHWA NHI-10-024 Vol I and NHI-10-025 Vol II, "Design of MSE Walls and Reinforced Slopes," (Berg et al., 2009);

b. Latest edition of AASHTO LRFD Bridge Design Specifications including Interims.

(1) The mechanical wall height for the purposes of design calculations shall be from the top of the leveling pad to the top of the ground surface where the potential failure surface intercepts the ground surface. The Contractor is solely responsible for the satisfactory construction and performance of the wall and the internal stability of the wall's retained mass. The Contractor shall submit a certification to the Department that the wall is designed in accordance with the current AASHTO LRFD Specifications for Highway Bridges.

2. The Engineer shall indicate in the contract the "external site factors" which include:

a. Settlement both along and perpendicular to the MSE structure alignment.

b. Allowable bearing capacity of the foundation soil.

c. External drainage beneath and behind the MSE volume.

d. The design parameters for the foundation soils (cohesion and friction angle).

(1) Global Stability

3. Maximum reinforcement loads shall be calculated using the method presented in the current AASHTO and as per the requirements specified herein. No other design method will be allowed. Unless otherwise specified in the contract, all structures shall be designed to conform to the requirements provided in the current edition of AASHTO LRFD Bridge Design Specifications.

4. When a highwater surface elevation is shown in the contract at the wall face, the design stresses calculated from that elevation to the bottom of the wall must include a minimum differential hydrostatic pressure equal to 40 inches (1 m) of water. Effective unit weights from the saturated soil condition shall be used to calculate external and internal stability.

5. The friction angle of the select backfill used in the reinforced fill zone for the internal stability design of the wall shall be 34 degrees unless shown otherwise in the contract. Before construction begins, the selected backfill shall be subject to approval to show conformance with this frictional requirement. The approval shall be based on the results of the standard direct shear test, AASHTO T 236, utilizing a sample of the material compacted to 95% maximum density as determined by NDOT T 99, at optimum moisture content. Compliance with the test requirements shall be the responsibility of the Contractor. The wall supplier shall be furnished a

copy of the test results before construction. The friction angle of the foundation soils and random backfill shall be 28 degrees unless otherwise shown in the contract.

6. The optimum moisture content shall be determined in accordance with NDOT T 99.

7. All structural connections shall be subject to the same metal loss rates and allowable tension requirements as outlined in this Subsection.

8. The soil reinforcement shall be the same length from the bottom to the top of the wall. The reinforcement length defining the width of the entire reinforced soil mass may vary with wall height. The minimum length of the soil reinforcement shall be 0.7H for walls with level surcharges, or 0.7H₁ for walls with a sloped surcharge or supporting an abutment. The mechanical height, H₁, shall be the vertical difference between the leveling pad and the elevation at which the failure surface, as described above, intercepts the ground surface supported by the wall.

9. Steel Reinforcement:

a. Steel reinforcement shall be designed for a minimum service life of 75 years unless otherwise indicated in the contract. Time dependent corrosion rates for soil reinforcing and attachment services shall be considered. For steel reinforcements, including tie strips and loop inserts, the metal loss rates shown in Table 714.01 shall be assumed.

Table 714.01

Metal Loss Rates	
Metal	Rate
Zinc (first 2 years):.....	15 µm/year/side
Zinc (subsequent years to depletion):.....	4 µm/year/side
Carbon Steel (after depletion of zinc):	12 µm/year/side
Carbon Steel (75 to 100 years):.....	7 µm/year/side

b. The allowable tensile stress in steel reinforcement and connections including tie strips and loop inserts, F^t, at the end of the service life, shall conform to the following:

(1) Systems using linear reinforcement (strips):

(i) F^t = 0.55 F_y at the reduced gross section (minimum cross section).

(ii) F^t = 0.50 F_u at the net section at a bolt hole (applicable to bolted connections only).

(2) Systems with bar mats or welded wire mesh:

F^t = 0.47 F_y at all sections.

c. F_y used for design shall not exceed 65,000 psi (445 MPa). Maximum allowable tension in reinforcements shall consider any reduction in cross sectional area of reinforcement due to punching and corrosion losses and shall not exceed 50% of pullout capacity of the connection devices embedded in facing panels.

714.03 -- Material Requirements

1. The Contractor shall make arrangements to purchase the material covered by this Section of the *Specifications*, including concrete panels, reinforcing mesh or strips, attachment devices, fasteners, joint materials, and all necessary incidentals from the wall system supplier or suppliers approved by the wall system supplier. The Contractor shall furnish the Engineer a Certificate of Compliance certifying that all materials comply with Section 714 of the *Specifications*. Materials not conforming to Section 714 of the *Specifications* shall not be used.

2. Concrete Facing Panels:

a. Concrete facing panels shall have a minimum thickness of 5 1/2 inches (140 mm) and a minimum concrete cover on reinforcing steel of 1 1/2 inches (38 mm). Cement shall be Types I, II, or III and shall conform to the requirements of AASHTO M 85. Concrete shall have a compressive strength at 28 days as described in this Subsection. Additives containing chloride shall not be used without the approval of the Engineer. Attachment devices, connecting pins, PVC pipe, and lifting devices shall be set in place to the dimensions and tolerances shown on the working drawings and called out in these Specifications before casting.

b. Testing and Inspection: Acceptability of the precast units shall be determined on the basis of compressive strength tests and visual inspection. The precast units shall be considered acceptable regardless of curing age when compressive strength test results indicate that the compressive strength will conform to the 28-day requirements. The Contractor or supplier shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner. Panels utilizing Type I or II cement shall be considered acceptable for placement in the wall when the 7-day initial strength equals or exceeds 85% of the 28-day strength (4,000 psi) (27.6 MPa).

c. Casting: The panels shall be cast face down in level forms supported on a flat working surface. Guides shall be used to locate and support attachment devices set in the back face of the panel. The concrete in each panel unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and to prevent the formation of rock pockets or cleavage planes. The same type of clear form oil or release agent shall be used throughout the casting operation.

d. Curing: The units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength.

e. Removal of Forms: The forms shall remain in place until they can be removed without damage to the units.

f. Concrete Finish: Unless otherwise indicated in the contract or elsewhere in the specifications, the concrete surface for the front face shall have an ordinary steel form finish; and for the rear face, an unformed finish. The rear face of the panel shall be free of open pockets of aggregate and surface distortions in excess of 1/4 inch (6 mm).

g. Tolerances: All units shall be manufactured within the following tolerances with respect to the dimensions shown in the working drawings:

(1) Attachment Device Locations and Alignment -- Lateral position of reinforcing strip attachment devices shall be within 1 inch (25 mm). Embedment measured from the back face of the panel shall be within 1/4 inch (6 mm) and -1/2 inch (-0.12 mm). Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 1/16 inch (1.5 mm).

(2) Panel Dimensions -- All panel dimensions shall be within 1/4 inch (6 mm). All hardware embedded in the panel, with the exception of attachment devices, shall be within 1/4 inch (6 mm).

(3) Panel Squareness --, as determined by the difference between the 2 diagonals, shall not exceed 1/2 inch (13 mm).

(4) Panel Surface Finish -- Surface defects on smooth-formed surfaces, measured on a length of 5 feet (1.5 m), shall not exceed 1/4 inch (6 mm). Surface defects on textured-finished surfaces, measured on a length of 5 feet (1.5 m), shall not exceed 5/16 inch (8 mm).

h. Compressive Strength: Acceptance of the concrete panels, with respect to compressive strength, shall be determined on the basis of production lots. A production lot is defined as a group of panels that shall be represented by a single set of compressive strength samples and shall consist of not more than 40 panels or a single day's production, whichever is less.

i. Compressive strength tests shall be performed on prepared cylinders in accordance with AASHTO T 23. During the production of the concrete panels, the manufacturer shall randomly sample the concrete in accordance with AASHTO T 141. A single set of compressive strength samples, consisting of a minimum of 4 cylinders, shall be made for every production lot.

j. For every compressive strength sample, a minimum of 2 cylinders shall be cured in the same manner as the panels and tested at 7 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T 22, will determine the initial strength of the concrete. In addition, a minimum of 2 cylinders shall be cured in accordance with AASHTO T 23 and tested at 28 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T 22, will determine the compressive strength of the production lot.

k. If the initial strength test results indicates a compressive strength greater than or equal to 4,000 psi (27.6 MPa), then this test result will be utilized as the compressive strength test result for that production lot and the requirement for testing at 28 days will be waived for that particular production lot.

l. Acceptance of a production lot will be made if the 28-day compressive strength test result is greater than or equal to 4,000 psi (27.6 MPa). If the 28-day compressive strength test result is less than 4,000 psi (27.6 MPa), the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

(1) 90% of the compressive strength test results for all of the production lots shall exceed 3,815 psi (26.3 MPa).

(2) The average of any 6 consecutive compressive strength test results, including the one in question, shall exceed 3910 psi (27.0 MPa).

(3) No individual compressive strength test result shall fall below 3,600 psi (24.8 MPa).

m. The date of manufacture, the production lot number, and the structure component shall be clearly indicated on each cylinder.

n. All units shall be handled, stored, and shipped in such a manner as to minimize the danger of chipping, cracks, fractures, and excessive bending stresses.

(1) Panels shall be stored and shipped in stacks, front face down.

(2) Firm blocking of sufficient thickness to prevent damage to the stacked panels shall be provided.

(3) Lifting inserts shall be installed on the top edge of the precast panels to allow lifting at the project site.

(4) Reinforcement connection inserts (tie strips or loop inserts) shall not be used for lifting or handling the panel.

o. Acceptance Criteria: Units shall be subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all of the following defects may be sufficient cause for rejection:

(1) Defects that indicate imperfect molding.

(2) Defects indicating honeycombed or open-texture concrete.

(3) Defects in the physical characteristics of the concrete, such as broken or chipped concrete.

p. The Engineer shall determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection.

(1) Repair of concrete, if allowed, shall be done in a manner satisfactory to the Engineer.

(2) Repair to concrete surfaces which will be exposed to view after completion of construction must be approved by the Engineer.

3. Reinforcement and Attachments:

a. All reinforcing and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

b. Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall

conform to ASTM A 572/A 572M Grade 65 minimum. Galvanization shall conform to the minimum requirements of AASHTO M 111 (ASTM A 123 and shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on the working drawings. A minimum galvanization coating of 2.0 oz/ft² (605 g/m²) or 3.4 mils (85µm) thickness is required.

c. Reinforcing mesh and bar mats shall be shop fabricated from cold drawn steel wire conforming to the minimum requirements of AASHTO M 32, and welded into the finished mesh fabric in accordance with AASHTO M 55. Galvanization shall conform to the minimum requirements of AASHTO M 111 (ASTM A 123) and shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on the working drawings. A minimum galvanization coating of 2.0 oz/ft² (605 g/m²) or 3.4 mils (85µm) thickness is required.

d. The tie strips shall be shop fabricated from hot rolled steel conforming to the minimum requirements of ASTM A 1101, Grade 50 or equivalent. The minimum bending radius of the tie strips shall be 3/8 inch. Galvanization shall be applied after the strips are fabricated, inclusive of punch holes for bolts and shall conform to AASHTO M 111 (ASTM A 123).

e. Fasteners shall consist of hexagonal cap screw bolts and nuts which are galvanized and conform to the requirements of AASHTO M 164 or equivalent.

f. Connector bars and pins shall be fabricated from cold drawn steel wire conforming to the requirements of AASHTO M 32 and be galvanized in accordance with AASHTO M 164.

g. Structural plate connectors and fasteners used for yokes to connect reinforcements to wall panels around pile or utility conflicts shall conform to the material requirements for reinforcing strips and fasteners in Paragraphs 3.a., 3.d., and 3.e. of this Subsection.

h. Geostap reinforcements shall be fabricated of high tenacity polyester yarns woven into a strap configuration and coated while under tension with polyvinylchloride (PVC).

i. Geogrid reinforcements shall be of the type and size designated in the approved plans. Polyester geogrids shall be fabricated of high tenacity polyester yarns woven into a geogrid structure. The geogrid shall be coated with either polyvinylchloride (PVC) or latex. Polyolefin geogrids shall be fabricated of high density polyethylene (HDPE) resin and shall be extruded into a geogrid configuration.

4. Joints:

a. Horizontal and vertical joints between panels shall be covered by a geotextile approved by the wall supplier and meeting the requirements for filtration applications as specified by AASHTO M 288. The minimum width of geotextile shall be 1.0 foot. Adhesive used to hold the geotextile filter fabric material to the rear of the facing panels before backfill placement shall be approved by the wall supplier.

b. The back face of vertical and horizontal joints shall be covered with geotextile filter. Joint filler, bearing pads, and geotextile filter shall be as

recommended by the wall manufacturer and shall meet the requirements shown on the approved working drawings.

c. Where the wall wraps around an inside corner, a corner block panel shall be provided with flange extensions that will allow for differential movement without exposing the panel joints.

d. Bearing pads shall meet or exceed the following material requirements:

(1) Preformed EPDM (Ethylene Propylene Diene Monomer) rubber pads conforming to ASTM D 2000 Grade 2, Type A, Class A with a Durometer hardness of 70.

(2) Preformed HDPE (High Density Polyethylene) pads with a minimum density of 0.946 grams per cubic centimeter in accordance with ASTM D 1505.

(3) The stiffness (axial and lateral) size, and number of bearing pads shall be determined such that the final joint opening shall be $3/4 \pm 1/8$ inch unless otherwise shown on the contract. The MSE Wall designer shall submit supportive calculations that verify the stiffness (axial and lateral), size, and number of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2 times the weight of facing panels directly above that level.

5. Backfill:

a. The select granular backfill material used in the MSE structure shall be free from organic and otherwise deleterious materials as defined by Section 1033 and shall conform to the gradation limits as determined by AASHTO T 27 and shown in Table 714.02.

Table 714.02

Facing Panel Select Granular Backfill Gradation	
Sieve Size	Percent Passing
4 inch (100 mm)(Note 1)	100
No. 40 (4.74 mm)	0 to 60
No. 200 (75 μ m)	0 to 15

Note 1: Maximum particle size shall be limited to 3/4 inch for geosynthetics and epoxy- or PVC-coated reinforcements unless the contractor provides tests, acceptable to the Engineer, that have evaluated the extent of construction damage anticipated for the specific fill material and reinforcements combination. Construction damage testing shall be performed in accordance with the requirements of Chapter 5 of Publication No. FHWA NHI-09-087, dated 2009 (“Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Slopes.”)

b. In addition, the backfill shall conform to all of the following requirements:

(1) The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed 6.

(2) The material shall be substantially free of shale or other soft, poor durability particles. The material shall have a magnesium sulfate

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soundness loss of less than 30% after 4 cycles, as determined by AASHTO T 104. Alternatively, the material shall have a soundness loss of 15% or less when tested in accordance with AASHTO T 104 using a sodium sulfate solution with a test duration of five cycles.

(3) The backfill material shall conform to the electrochemical requirements in Table 714.03 for use with metallic soil reinforcement and Table 714.04 when geosynthetic soil reinforcement is used. For all soil reinforcements, the organic content of backfill shall be less than 1%, determined in accordance with AASHTO T 267.

Table 714.03

Electrochemical Requirements for Metallic Reinforcements

Property	Requirement	Test Method
Resistivity	Minimum 3000 ohm-cm, at 100% saturation	AASHTO T 288
ph	Acceptable Range 5-10	AASHTO T 289
Chlorides	Maximum 100 ppm	AASHTO T 291
Sulfates	Maximum 200 ppm	AASHTO T 290

Table 714.04

Electrochemical Requirements for Geosynthetic Reinforcements

Base Polymer	Property	Requirement	Test Method
Polyolefin (PP and HDPE)*	pH	>3	AASHTO T 289
Polyester	pH	>3 and <9	AASHTO T 289

* PP: Polypropylene and HDPE: High Density Polyethylene

(4) Chloride and sulfate content shall be determined by the indicated ASTM test method. However, in each method, the select granular backfill material shall be prepared for testing by first accomplishing the following extraction procedure: Dry the sample material in an oven at 212°F (100°C) for 8 hours. Measure 100 g of the material and transfer to a 500 mL Erlenmeyer flask. Add 300 mL of distilled water and shake the mixture for 5 minutes. Repeat the shaking after 1 hour. Allow the mixture to settle for 8 hours. Vacuum filter the liquid layer through a filter apparatus containing a No. 42 Whatman filter paper. Pour the remaining solid material into the filter paper without the use of an additional water rinse. Reserve the filtrate for testing.

(5) The material, when compacted to 95% of maximum density, as determined by NDOT T 99, at optimum moisture content, shall exhibit an angle of internal friction of not less than 34 degrees, or if the contract allows a lower friction angle, at the lower friction angle required by the wall system supplier, as determined in a standard direct shear test (AASHTO T 236).

c. The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be as directed by the Department's Materials and Sampling Guide or as directed by the Engineer. The Contractor shall furnish to the Engineer a Certificate of

Compliance certifying that the select granular backfill material complies with this Section of the *Specifications*.

(1) A copy of all test results performed by the Contractor, which includes: AASHTO T 27, AASHTO T 90, AASHTO T 104, AASHTO T 236, AASHTO T 288, AASHTO T 289, AASHTO T 290, and AASHTO T 291, shall also be furnished to the Engineer 30 days prior to beginning construction.

(2) The construction of MSE Wall structures shall not begin until the Certifications of Compliance for Select Granular Backfills has been reviewed and verified by the Department.

(3) Representative samples of select granular backfill shall be sampled in accordance with Department's Materials Sampling Guide and submitted to the Department.

(4) For cohesionless soils such as Select Granular Backfill, if the moisture density curve shows a well-defined peak, the maximum dry density and optimum moisture content shall be determined based upon this peak. If no well-defined peak in the moisture density curve is observed, the soil shall be compacted at increasing intervals of moisture content until the maximum water content that can be retained in the compaction mold is achieved (saturation). The maximum dry density and optimum moisture content shall then be determined based on the point on the curve 1% below the point of saturation. The direct shear test specimen shall then be fabricated and tested at 95% compaction and at optimum moisture based on the moisture density relationship. Adequate moisture content of the backfill is necessary in the field to prevent post-construction settlements.

(5) The direct shear tests performed shall be based on wall heights for each specific project. All select granular backfill submittals from the contractor shall be from tests made specifically for each project. No test data from previous or multiple projects will be allowed.

(6) The direct shear test is a drained test and therefore shall be sheared at a rate between 0.004 to 0.008 in/min. The rate of shear shall also be noted on the direct shear test report. Testing procedures that do not follow these guidelines will not be accepted.

(7) In addition to the Certification of Compliance for Select Granular Backfill, a 60 lb sample of the proposed material shall be submitted to Department 30 days prior to construction of the MSE Wall.

(8) If the Select Granular Backfill material changes or a new material is used, construction of the MSE Wall shall be halted until the material has been approved by Department.

714.04 -- Construction Methods

1. Excavation shall be in accordance with the requirements of the contract.

2. Foundation Preparation: In the absence of specific ground improvement requirements in the contract the following applies:

a. The foundation for the reinforced fill and retained backfill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits as shown in the contract.

b. Before wall construction, the foundation, if not in rock, shall be compacted in accordance with Subsection 205.03. Any foundation soils found to be unsuitable shall be removed and replaced as directed by the Engineer.

3. Proof Rolling

a. The contractor shall perform proof-rolling to evaluate the stability and uniformity of the subgrade on which the MSE structure will be constructed. Proof rolling shall be performed on the entire areas at the following locations:

(1) At the bottom of the over excavation and recompaction zones; if specified in the contract.

(2) At the bottom of the over excavation and replacement zones, if specified in the contract,

(3) At the base of all walls or at the top of native soil.

b. Proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum, or at the moisture content that was used to achieve the required compaction.

c. Proof-rolling shall not be used within 1 1/2 feet of any underdrains.

d. Proof-rolling shall be performed on the exposed surface with a loaded dump truck or similar piece of construction equipment. Proof-rolling shall be performed in the presence of the Engineer. Any unstable material should be removed and replaced.

(1) Proof-rolling equipment shall have an axle weight of 20,000 for a single axle or 34,000 for tandem axle.

(2) Any deformations greater than 1 1/2 inches after one pass as measured with a 10 foot straightedge will be considered unstable.

e. The contractor shall be responsible for maintaining the condition of the approved proof-rolled soils throughout the duration of the MSE wall construction. Wall construction shall not commence until the foundation has been approved by the Engineer.

4 Leveling Pads:

a. At each panel foundation level, an unreinforced concrete leveling pad shall be provided as shown in the contract. The leveling pad shall have nominal dimensions of 6 inch (150 mm) thickness and 12 inch (300 mm) width and shall be cast using concrete which achieves a compressive strength of 2,175 psi (15 MPa) in 28 days. The leveling pad shall be cast to the design elevations shown on the working drawings. Allowable elevation tolerances are + 1/8 inch (+3 mm) and - 1/4 inch (-6 mm) from the design elevation.

b. The leveling pad shall be cured a minimum of 24 hours before placement of wall panels. A geotextile shall be applied over the back of the area of any openings between the facing units and leveling pad steps. The geotextile shall extend a minimum of 6 inches beyond the edges of the opening. The opening shall be filled with concrete, conforming to Subsection 4a, or shall be concurrently backfilled on both sides of the wall.

5 Erection:

a. For erection of walls with rigid facing, panels shall be handled by means of lifting devices set into the upper edge of the panels. Panels shall be placed in successive horizontal lifts in the sequence shown in the contract as backfill placement proceeds. As backfill material is placed behind the panels, the vertical panel joints shall be maintained in a plumb position by means of temporary wooden wedges, clamps, or bracing as recommended by the manufacturer. A minimum of two, but not more than three, rows of panel wedges shall remain in place at all times during wall erection. Wedges shall be removed from the lower rows as panel erection progresses. The contractor shall repair any damages to erected concrete panels as directed by the Engineer and to the Engineer's satisfaction. No external wedges in front of the wall shall remain in place when the wall is complete. External bracing is required for the initial lift.

b. Erection of walls with panel facing shall be in accordance with the following tolerances at the time of wall construction:

(1) Vertical and horizontal alignment of the wall face shall not vary by more than 3/4 inch when measured along a 10-foot straightedge.

(2) The overall vertical tolerance (plumbness) shall not exceed 1/2 inch per 10 feet of wall height. Negative (outward) batter is not acceptable.

(3) The maximum permissible out of plane offset at any panel joint shall not exceed 3/8 inch.

(4) The final horizontal and vertical joint gaps between adjacent facing panel units shall be within 1/8 and 1/4 inch, respectively, of the design final joint opening per the approved calculations required in 714.02 Section 4.

(5) Wall sections that do not conform to these tolerances shall be reconstructed at no additional cost to the Department.

6. Erection of permanent walls with flexible facing (such as welded wire mesh) shall be in accordance with the following tolerances:

a. Vertical and horizontal alignment of the wall face shall not vary by more than 2 inches when measured along a 10-foot straightedge, or as shown in the contract.

b. The overall vertical tolerance (plumbness) of the wall shall not exceed 1 inch per 10 feet of wall height. Negative (outward) batter is not acceptable.

c. The offset limit between consecutive rows of facing shall not exceed 1 inch from planned offset in the outward direction.

7. Placement of Metallic Reinforcement:

a. Before placing the first layer of reinforcements (strips or mats), backfill shall be placed and compacted.

b. Bending of reinforcements in the horizontal plane that results in a permanent deformation in their alignment shall not be allowed.

c. Connections of reinforcement to piles or bending of reinforcements around piles shall not be allowed. Cutting of longitudinal or transverse reinforcement bars to avoid conflicts with piles or utility obstructions shall not be allowed.

d. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcements due to pile or utility conflicts.

e. Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown in the contract or directed by the Engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable bolted connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position except in the case of acute corners where redundant reinforcements are used.

f. All joints between precast concrete panels shall be covered with geotextile on the backside of the wall. Adhesive shall be applied to the panels only and not within 2 inches of a joint. The geotextile shall have a minimum width of 12 inches and shall overlap fabric a minimum of 4 inches.

g. The contractor shall install joint pads and fillers as shown on the working drawings.

8. Placement of Geosynthetic Reinforcement:

a. Geosynthetic reinforcement shall be installed in accordance with the manufacturer's site-specific wall erection instructions.

b. Geosynthetic reinforcement shall be placed in continuous longitudinal rolls in the direction of the main reinforcement. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

c. Reinforcement coverage shall be 100% of embedment area unless otherwise shown in the working drawings. Adjacent sections of geosynthetic reinforcement need not be overlapped except when exposed in a wrap-around face system, at which time the reinforcement rolls shall be overlapped or mechanically connected per the manufacturer's requirements.

d. Geosynthetic reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geosynthetic reinforcement in place until the subsequent soil layer can be placed.

e. During construction, the surface of the fill shall be kept approximately horizontal. Geosynthetic reinforcement shall be directly placed on the compacted horizontal fill surface. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement

elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

9. Backfill Placement:

a. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. The contractor shall place backfill to the level of the connection and in such a manner as to ensure to no voids exist directly beneath the reinforcing elements.

b. Any wall elements which become damaged during backfill placement shall be either repaired or replaced by the Contractor at no additional cost to the Department. Any wall elements which become disturbed during backfill placement shall be reset by the Contractor at no additional cost to the Department.

c. For metallic reinforcements, the fill shall be spread by moving machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of 3 inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

d. For geosynthetic reinforcements, the fill shall be spread by moving machinery parallel to or away from the wall facing and in such a manner that the geosynthetic reinforcement remains taut. Construction equipment shall not operate directly on the geosynthetic reinforcement. A minimum fill thickness of 6 inches over the geosynthetic reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

e. Any backfill material placed within the reinforced soil mass which does not meet these Specifications shall be corrected or removed and replaced by the Contractor at no additional cost to the Department.

f. Backfill shall be compacted to 95% of the maximum density as determined by NDOT T 99.

g. The moisture content of the backfill material before and during compaction shall be uniform throughout each layer.

h. Backfill material shall have a placement moisture content less than or equal to the optimum moisture content.

i. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniform and acceptable throughout the entire lift.

j. The optimum moisture content shall be determined in accordance with NDOT T 99.

k. The frequency of sampling of the backfill material necessary to assure gradation control throughout construction shall be as directed by the Engineer.

l. The maximum lift thickness after compaction shall not exceed 10 inches (250 mm), regardless of the vertical spacing between layers of soil

reinforcements. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

m. Before placement of the soil reinforcements, the backfill elevation, after compaction, shall be 2 inches (50 mm) above the attachment device elevation from a point approximately 1 foot (300 mm) behind the back face of the panels to the free end of the soil reinforcements, unless otherwise shown in the contract.

n. Compaction within 40 inches (1 m) of the back face of the panels shall be achieved by at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used, but no soil density tests need be taken in this area.

o. Care shall be exercised in the compaction process to avoid misalignment of the panels or damage to the attachment devices.

p. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

6. When shoring for phased construction is shown in the contract, the Contractor shall design and install the shoring. The type of shoring used shall be determined by the Contractor. Design calculations for the shoring shall be prepared by a Professional Engineer registered in the State of Nebraska. Before construction begins, 4 sets of the calculations and shoring plans shall be submitted to the Department for informational purposes only. The Contractor is solely responsible for the construction and performance of the shoring. All shoring shall remain in place and shall be cut off 2 feet (600 mm) below finish grade.

714.05 -- Method of Measurement

1. The quantity of excavation for the leveling pads is not measured directly.

2. The quantity of "Excavation for MSE Wall" is measured by the cubic yard (cubic meter) and computed using the contract dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity.

a. The quantity shown in the contract is calculated using the average end area method based on preliminary cross sections of the existing ground and the calculated final cross sections. The excavation width limit is equal to 70% of the height of the wall plus the width required to step back the excavation as shown in Figure 714.01.

b. Preliminary cross sections will include new fill if it is a required surcharge.

EXCAVATION CALCULATION LIMITS

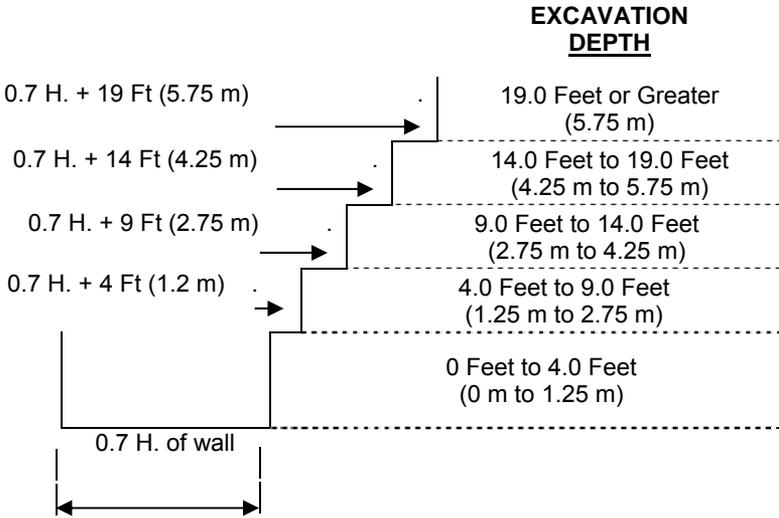


Figure 714.01

3. Dewatering, replacement of unsuitable soil or other unforeseen conditions will be paid as Extra Work described in SSHC Section 104.

4. The quantity of concrete face panels is measured by the square foot (square meter) and is computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity. The wall surface area, as shown on the contract, includes the surface area of nominal panel joint openings and wall penetrations such as pipes and other utilities.

5. The quantity of concrete leveling pads shall be measured by the foot (meter) and is computed using the contract dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity.

6. Backfill:

a. The quantity of "Select Granular Backfill for MSE Walls" is measured by the cubic yard (cubic meter) and computed using the contract dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity. The quantity shown in the contract is based on a volume equal to the height of the wall times the length of the wall times a width equal to 70% of the height.

b. The Random Backfill shown in the contract will not be measured for payment, but shall be considered subsidiary to the item "Select Granular Backfill for MSE Walls".

7. The quantity of "Coping" is measured by the linear foot (meter) and is computed using the contract dimensions. No adjustment in the pay

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quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity. The coping quantity shall be based on the coping cross-section shown in the contract.

8. "Shoring For Mechanically Stabilized Earth Structures" is measured by the lump sum. Items that are included in the lump sum price are the shoring design, plan preparation and submittals, and all labor, materials, and equipment necessary to construct the shoring.

714.06 -- Basis of Payment

1. Pay Item	Pay Unit
Excavation for MSE Wall	Cubic Yard (CY) [Cubic Meter (m ³)]
Concrete Face Panels	Square Foot (SF) [Square Meter (m ²)]
Concrete Leveling Pads	Linear Foot (LF) [Meter (m)]
Select Granular Backfill for MSE Walls	Cubic Yard (CY) [Cubic Meter (m ³)]
Coping	Linear Foot (LF) [Meter (m)]
Shoring For Mechanically Stabilized Earth Structures	Lump Sum (LS)

2. Excavation for the leveling pads will not be measured and paid for separately, but shall be subsidiary to the appropriate pay item requiring the excavation.

3. Construction of the V-ditch shown in the contract at the top of wall is subsidiary to the pay item "Coping".

4. Payment is full compensation for all work described in this Section.

SECTION 715 -- MECHANICALLY STABILIZED EARTH (MSE) WALLS WITH MODULAR BLOCK FACING UNITS

715.01 -- Description

1. This work shall consist of designing, furnishing materials, and constructing mechanically stabilized earth (MSE) modular concrete block facing unit walls in accordance with these Specifications and with the lines, grades, dimensions, and details shown in the contract.

2. The excavation for the MSE wall shall consist of excavation for the leveling pads and "Excavation for Soil Reinforcement". The excavation may consist of existing ground and/or newly constructed fill. The contractor shall excavate to the dimensions shown in the shop drawings. The contractor shall also follow the manufacturer's recommendations with concurrence of the Department.

3. The MSE wall shall consist of a nonstructural leveling pad, modular block facing units, and soil reinforcement elements. Soil reinforcement shall have sufficient strength and frictional resistance and length as required by the design and as outlined in these Specifications.

4. Only the approved proprietary mechanically stabilized earth retaining wall systems are shown on the Department's Approved Products List shall be used.

5. All appurtenances behind, in front of, under, mounted upon, or passing through the wall, such as drainage structures, utilities, or other appurtenances shown in the contract, shall be accounted for in the stability design of the wall.

6. The MSE wall design shall follow the general dimensions of the wall envelope shown in the contract. The wall envelope will include the minimum 2 feet below ground or as shown in the contract. The contract will locate the theoretical leveling pad at or below the theoretical leveling pad elevation. The minimum wall embedment below ground shall be 2 feet (600 mm) or as shown in the contract. The top of the block units shall be at or above the top of the wall elevation shown in the contract. The front face of walls may employ a setback or an incline from the vertical. The maximum slope on the front face of the wall shall be 11 degrees unless otherwise required by the Engineer. Cast-in-place concrete will not be an acceptable replacement for block areas noted by the wall envelope, except for minor grouting of pipe penetrations and leveling required for traffic barriers. For walls with metallic reinforcement elements, the design height of the wall shall be from the top of the leveling pad to the top of the potential surface where the failure surface intercepts the ground surface. For walls with polymeric soil reinforcement elements in the design, wall height shall be the vertical distance from the top of the leveling pad to the point where the finish ground surface meets the back face of the wall. The failure plane for such a wall shall rise at an angle of 45 degrees + $\phi/2$ from the intersection of the back face of the wall with the leveling pad.

7. The block units shall be designed to accommodate differential settlements along the length of the wall and transverse to the wall alignment. Differential settlements along the length of the wall shall not exceed 1 foot per 100 feet (1m per 100m) of wall length. When differential settlements transverse to the wall exceed 3 inches (75 mm), the lower level reinforcement connections shall be designed to accommodate the increased

tensile forces due to the settlement. Where shown in the contract or determined by the MSE wall supplier, vertical joints to accommodate excessive differential settlement shall be included.

8. Working Drawings :

a. The Contractor shall submit to the Engineer for review:

- (1) 6 sets of working drawings.
- (2) 6 sets of design calculations.
- (3) Explanatory notes.
- (4) Specifications.
- (5) Proposed component materials for the wall system.

b. The working drawings and design calculations shall be signed, sealed, and dated by a Professional Engineer registered in Nebraska.

c. These drawings shall include a block unit layout for fabrication and erection purposes, as well as for any required coping when it is prefabricated.

d. They shall further include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines, all as shown in the contract.

e. The drawings will also reflect:

(1) All information needed to fabricate and erect the walls including the proposed leveling pad elevations.

(2) The shape and dimensions of the modular blocks.

(3) The size, number, and details of the reinforcing steel.

(4) The number, size, type, and details of the soil reinforcing system and anchorage.

(5) The size, details, and manufacturer of all fillers and filter cloth.

(6) The size of leveling pad.

(7) The dimensions of structural backfill required.

(8) Limitations which shall be observed when extending the limits vertically and horizontally.

(9) Any additional details pertaining to coping, railing, drainage, or electrical conduit required by the contract.

f. Leveling pad elevations may vary from footing elevations shown in the contract. However, the leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown in the contract and shall provide 2 feet (600 mm) minimum cover from the top of the leveling pad to finish grade.

g. The Contractor shall not start work on any earth retaining system until the working drawings are reviewed and returned by the Engineer.

h. It is expressly understood that the review of the Contractor's drawings shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the contract.

i. The Contractor shall allow 30 calendar days for the review of the drawings and MSE wall design details by the Engineer.

j. Minor changes as defined in the working drawings may be allowed in the field after review by the Engineer without a revised Working Drawing or Shop Drawing.

715.02 -- Design Requirements

1. a. The design, by the wall system supplier, shall consider the internal stability of the wall's retained mass. In conjunction with these Specifications, the following publications shall be used by the wall system supplier when designing the wall system:

(1) FHWA NHI-10-024 Vol I and NHI-10-025 Vol II, "Design of MSE Walls and Reinforced Slopes," (Berg et al., 2009);

(2) Latest edition of AASHTO LRFD Bridge Design Specifications including Interims;

(3) *Design Manual for Segmental Retaining Walls National Concrete Masonry Association*, Washington, D.C.

b. Design Height: The structure's design height, H, shall be from the top of the leveling pad to the top of the wall where the ground surface intercepts the wall facing.

c. The Contractor is solely responsible for the satisfactory construction and performance of the wall and the internal stability of the wall's retained mass. The Contractor shall submit a certification to the Engineer that the wall is designed in accordance with the current AASHTO Standard Specifications for Highway Bridges.

d. The Engineer shall indicate in the contract the "external site factors" which include:

(1) Settlement both along and perpendicular to the MSE structure alignment;

(2) Allowable bearing capacity of the foundation soil;

(3) External drainage beneath and behind the MSE volume;

(4) The design parameters for the foundation soils (cohesion and friction angle).

(5) Global Stability

e. Soil Reinforcement Length: The soil reinforcement length shall be the same length from top to bottom of the wall. The minimum soil reinforcement length shall be greater than or equal to 70% of the design height as measured from the front face of the wall to the end of the soil reinforcements.

f. Maximum reinforcement loads shall be calculated using the method presented in the latest AASHTO and as per the requirements

specified herein. No other design method will be allowed. Unless otherwise specified in the contract, all structures shall be designed to conform to the requirements provided in the latest edition of AASHTO LRFD Bridge Design Specifications.

g. When a highwater surface elevation is shown in the contract at the wall face, the design stresses calculated from that elevation to the bottom of the wall must include a minimum differential hydrostatic pressure equal to 40 inches (1 m) of water. Effective unit weights from the saturated soil condition shall be used to calculate external and internal stability.

h. The friction angle of the select backfill used in the reinforced fill zone for the internal stability design of the wall shall be 34 degrees unless shown otherwise in the contract. Before construction begins, the selected backfill shall be subject to approval to show conformance with this frictional requirement. The approval shall be based on the results of the standard direct shear test, AASHTO T 236, utilizing a sample of the material compacted to 95% maximum density as determined by NDOT T 99, at optimum moisture content. Compliance with the test requirements shall be the responsibility of the Contractor. The wall supplier shall be furnished a copy of the test results before construction. The friction angle of the foundation soils and random backfill shall be 28 degrees unless otherwise shown in the contract.

i. The optimum moisture content shall be determined in accordance with NDOT T 99.

j. All structural connections shall be subject to the same metal loss rates and allowable tension requirements as outlined in this Subsection.

k. Steel Reinforcement:

(1) Steel reinforcement shall be designed for a minimum service life of 75 years unless otherwise indicated in the contract. Time dependent corrosion rates for soil reinforcing and attachment services shall be considered. For steel reinforcements, including tie strips and loop inserts, the metal loss rates shown in Table 714.01 shall be assumed.

Table 714.01

Metal Loss Rates	
Metal	Rate
Zinc (first 2 years):.....	15 µm/year/side
Zinc (subsequent years to depletion):....	4 µm/year/side
Carbon Steel (after depletion of zinc): ...	12 µm/year/side
Carbon Steel (75 to 100 years):.....	7 µm/year/side

(2) The allowable tensile stress in steel reinforcement and connections including tie strips and loop inserts, F^t , at the end of the service life, shall conform to the following:

(i) Systems using linear reinforcement (strips):

(a) $F^t = 0.55 F_y$ at the reduced gross section (minimum cross section).

(b) $F^t = 0.50 F_u$ at the net section at a bolt hole (applicable to bolted connections only).

- (ii) Systems with bar mats or welded wire mesh:

$$F^t = 0.47 F_y \text{ at all sections.}$$

(3) F_y used for design shall not exceed 65,000 psi (445 MPa). Maximum allowable tension in reinforcements shall consider any reduction in cross sectional area of reinforcement due to punching and corrosion losses and shall not exceed 50% of pullout capacity of the connection devices embedded in facing panels.

l. The soil reinforcement lengths and percent coverage at a given level shall be in accordance with the contract. All soil reinforcement shall be positively connected to the modular block facing units that is capable of resisting 100% of the maximum tension in the soil reinforcements at any level within the wall. Detailed documentation for connection strength shall be submitted as noted in Section 714.02. The vertical spacing of the soil reinforcement for walls with modular block facing units shall be as follows:

(1) The first (bottom) layer of soil reinforcement shall be no further than 16 inches above the top of the leveling pad.

(2) The last (top) layer of soil reinforcement shall be no further than 20 inches on the average below the top of the uppermost unit.

(3) The maximum vertical spacing between layers of adjacent soil reinforcement shall not exceed 32 inches. For walls deriving any part of their connection capacity by friction the maximum vertical spacing of the reinforcement should be limited to two times the block depth (front face to back face) to assure construction and long-term stability. The top row of reinforcement should be one-half the vertical spacing.

m. The initial batter of the wall, both during construction and upon completion, shall be within the vertical and horizontal alignment tolerances included in this Specification. The initial batter of the wall at the start of construction and the means and methods necessary to achieve the batter shall be provided in the working drawings. Subject to the Engineer's approval, the initial batter may be modified at the start of construction by the manufacturer's field representative based on the evaluation of the backfill material selected by the contractor. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer who is a registered Civil Engineer in the State of Nebraska. Details of the wedges or shims or other devices such as clamps and external bracing used to achieve or maintain the wall batter, shall be as shown on the working drawings and/or accompanying the construction manual. Permanent shims shall comply with the design life criteria, and shall maintain the design stress levels required for the walls.

715.03 -- Material Requirements

1. The Contractor shall provide all materials necessary to construct the specified walls. The Contractor shall ensure that temporary slopes are safe during the period of wall construction, and shall adhere to all applicable local, state, and federal regulations. The Contractor shall furnish the Engineer a Certificate of Compliance certifying that all materials comply with

Section 715 of the *Specifications*. Materials not conforming to Section 715 of the *Specifications* shall not be used.

2. Modular Concrete Block Units:

a. Minimum face shell thickness of the modular concrete block units shall be 3 inches (75 mm) except at holes for connection pins. Minimum rear and side shell thickness shall be 3 inches (75 mm). Block dimensions shall be within 0.125 inch (3 mm) except for height, which shall be within 0.0625 inch (1.5 mm).

b. Cement shall be Type I, II, or III in accordance with ASTM C 150.

c. Aggregates used in concrete blocks shall conform to ASTM C33 for normal weight concrete.

d. At the time of delivery to the work site, the modular block facing units shall conform to the following physical requirements:

(1) Minimum required compressive strength of 4,000 psi (average 3 coupons).

(2) Minimum required compressive strength of 3,500 psi (individual coupon).

(3) Minimum oven dry unit weight of 125 pcf.

(4) Minimum water absorption of 5% after 24 hours.

(5) Maximum number of blocks per lot of 2,000. Tests on blocks shall be submitted at the frequency of one set per lot.

e. Acceptance of the concrete block, with respect to compressive strength, water absorption and unit weight will be determined on a lot basis. The lot shall be randomly sampled and tested in accordance with ASTM C 140. At no additional expense to the Department, the manufacturer shall perform the tests at an Agency approved laboratory and submit the results to the Engineer for approval. Compressive strength test specimens shall be cored or shall conform to the saw-cut provisions of ASTM C 140. Block lots represented by test coupons that do not reach an average compressive strength of 4,000 psi will be rejected.

f. The units shall be tested to demonstrate freeze-thaw durability in accordance with Test Method ASTM C 1262. Freeze-thaw durability shall be based on tests from five specimens made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 18 months prior to delivery. Specimens used for absorption testing shall not subsequently be used for freeze-thaw testing. Specimens shall comply with either or both of the following acceptance criteria depending on the severity of the project location as determined by the Engineer:

(1) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed 1% of its initial weight when tested in water.

(2) The weight loss of each of four out of five test specimens at the conclusion of 50 cycles shall not exceed 1.5% of its initial mass when tested in a saline (3% sodium chloride by weight) solution.

g. Units that indicate flawed molding, honeycomb or open texture concrete and color variation on front face of block due to excess form oil or other reasons shall be rejected. All units shall be visibly efflorescence free. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. At the discretion of the Engineer, minor cracks no greater than 1/50 inch in width and no longer than 25% of the unit height are considered incidental to the manufacturing method or minor chipping resultant from shipping and delivery, are not grounds for rejection.

h. If pins are required to align modular block facing units, they shall consist of a non-degrading polymer or hot-dipped galvanized steel and be made for the express use with the modular block units supplied. Connecting pins shall be capable of holding the geogrid in the proper design position during backfilling.

i. The cap unit connection to the block unit immediately under it shall be of positive interlocking type and not frictional. Cap units shall be cast to or attached to the top of modular block facing units in strict accordance with the requirements of the manufacturer of the blocks and the adhesive. The surface of the block units under the cap units shall be clear of all debris and standing water before the approved adhesive is placed. The contractor shall provide a written 10-year warranty, acceptable to the Department, that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks.

3. Soil Reinforcements and Attachment Devices:

a. Ladder and mesh reinforcing strips shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 and welded into the finished strip configuration in accordance with AASHTO M 55. Galvanizing shall conform to the minimum requirements of AASHTO M 111 (ASTM A 123).

b. Geostap reinforcements shall be fabricated of high tenacity polyester yarns woven into a strap configuration and coated while under tension with polyvinylchloride (PVC).

c. Geogrid reinforcements shall be of the type and size designated in the approved contract. Polyester geogrids shall be fabricated of high tenacity polyester yarns woven into a geogrid structure. The geogrid shall be coated with either polyvinylchloride (PVC) or latex. Polyolefin geogrids shall be fabricated of high density polyethylene (HDPE) resin and shall be extruded into a geogrid configuration.

d. Connector pins shall be fabricated from cold drawn steel wire conforming to the requirements of AASHTO M 322 and shall be galvanized in accordance with AASHTO M 111.

e. U-shape reinforcement connectors used as yokes to connect geostap reinforcements to modular blocks shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32. Geostap connector plates shall be shop fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 1101, Grade 50, or equivalent. Galvanizing shall conform to the minimum requirements of AASHTO M 111.

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f. Fiberglass alignment pins shall be fabricated of thermoset polyester resin and shall be of a diameter and length recommended by the wall manufacturer.

4. Backfill:

a. Reinforced backfill and modular block drainage fill shall be select granular backfill materials free from organic and otherwise deleterious materials as defined by Section 1033.01, and shall conform to the gradation limits as determined by AASHTO T 27 and shown in Table 715.02.

Table 715.02

Modular Block Select Granular Backfill Gradations			
Reinforced Backfill		Modular Block Drainage Fill	
Sieve Size	Percent Passing	Sieve Size	Percent Passing
3/4 inch	100	3/4 inch	100
No. 40	0 - 60	(19 mm)	
No. 200	0 - 15	No. 200	0 - 5
		(75 µm)	

b. Unit (core) fill is defined as free-draining, coarse grained material that is placed within the empty cores of the modular block facing units. Unit (core) fill shall be a well graded crushed stone or granular fill meeting the gradation requirements shown in Table 715.03. Gradation for unit fill shall be tested at the frequency of 1 test per 50 yd³ at the job site and for every change in the material source.

Table 715.03

Gradation for Unit (Core) Fill

U.S. Sieve Size	Percent Passing
1 1/2-inch	100
1-inch	75-100
3/4-inch	50-75
No. 4	0-60
No. 40	0-50
No. 200	0-5

c. In addition, the backfill material must conform to all of the following additional requirements:

(1) The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed 6.

(2) The material, when compacted to 95% of maximum density as determined by NDOT T 99 at optimum moisture content, shall exhibit an angle of internal friction of not less than 34 degrees as determined in a standard direct shear test (AASHTO T 236) or, if the contract allows, at the lowered minimum friction angle required by the wall system supplier.

d. Select granular backfill shall also conform to the following criteria:

(1) Soundness -- The materials shall be free of shale or other soft, poor durability particles, and shall have a magnesium sulfate soundness loss of less than 30% after 4 cycles, as determined by

AASHTO T 104. Alternatively, the material shall have a soundness loss of 15% or less when tested in accordance with AASHTO T 104 using a sodium sulfate solution with a test duration of five cycles.

(2) The backfill material shall conform to the electrochemical requirements in Table 715.04 for use with metallic soil reinforcement and Table 715.05 when geosynthetic soil reinforcement is used. For all soil reinforcements, the organic content of backfill shall be less than 1%, determined in accordance with AASHTO T 267.

Table 715.04

Electrochemical Requirements for Metallic Reinforcements

Property	Requirement	Test Method
Resistivity	Minimum 3000 ohm-cm, at 100% saturation	AASHTO T 288
ph	Acceptable Range 5-10	AASHTO T 289
Chlorides	Maximum 100 ppm	AASHTO T 291
Sulfates	Maximum 200 ppm	AASHTO T 290

Table 715.05

Electrochemical Requirements for Geosynthetic Reinforcements

Base Polymer	Property	Requirement	Test Method
Polyolefin (PP and HDPE)*	pH	>3	AASHTO T 288
Polyester	pH	>3 and <9	AASHTO T 289

* PP: Polypropylene and HDPE: High Density Polyethylene

(3) Electrochemical Requirements -- The backfill material shall have a minimum resistivity of 3000 ohm-cm at 100% saturation when tested in accordance with ASTM G 57. In addition, the pH of the backfill material shall be in the range of 5 to 10 as determined in accordance with ASTM G 51. The maximum soluble salt content of the reinforced backfill material shall not exceed 100 ppm chlorides and 200 ppm sulfates as determined in accordance with ASTM D 512 and ASTM D 516, respectively. For polymeric materials, the requirements for resistivity, chlorides, and sulfates shall be waived. All other backfill requirements of this Subsection shall be met.

(4) Chloride and sulfate content shall be determined following the required ASTM test method. However, in each method, the select granular backfill material shall be prepared for testing by first accomplishing the following extraction procedure. Dry the sample material in an oven at 110°C for 8 hours. Measure 100 g of the material and transfer to a 500 mL Erlenmeyer flask. Add 300 mL of distilled water and shake the mixture for 5 minutes. Repeat the shaking after 1 hour. Allow the mixture to settle for 8 hours. Vacuum filter the liquid layer through a filter apparatus containing a No. 42 Whatman filter paper. Pour the remaining solid material into the filter paper without the use of an additional water rinse. Reserve the filtrate for testing.

(5) The material, when compacted to 95% of maximum density, as determined by NDOT T 99, at optimum moisture content, shall

exhibit an angle of internal friction of not less than 34 degrees as determined in a standard direct shear test (AASHTO T 236).

e. Sampling and Testing:

(1) The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be as directed by Department's Materials and Sampling Guide or as directed by the Engineer. The Contractor shall furnish to the Engineer a Certificate of Compliance certifying that the select granular backfill material complies with this Section of the *Specifications*.

(2) A copy of all test results performed by the Contractor, which includes: AASHTO T 27, AASHTO T 90, NDOT T-99, AASHTO T 104, AASHTO T 236, AASHTO T 288, AASHTO T 289, AASHTO T 290, and AASHTO T 291, shall also be furnished to the Engineer 30 days prior to beginning construction.

(3) The construction of MSE Wall structures shall not begin until the Certifications of Compliance for Select Granular Backfills has been reviewed and verified by the Department.

(4) Representative samples of select granular backfill shall be sampled in accordance with Department's Materials Sampling Guide and submitted to the Department.

(5) The direct shear test specimen shall then be fabricated and tested at 95% compaction of NDOT T-99 at optimum moisture based on the moisture density relationship. Adequate moisture content of the backfill is necessary in the field to prevent post-construction settlements. The Select Granular Backfill Internal Friction Angle required is 34 degrees according to AASHTO T 236 on samples compacted to 100% of the maximum density according to NDOT T 99. If the contract allows, the vendor may utilize a friction angle less than 34 degrees, this lower value shall be taken as the minimum friction angle required for this specific wall location. The vendor shall provide to the Department, certified documentation stating the design parameters are acceptable for the internal stability of the MSE Wall.

(6) The direct shear tests performed shall be based on wall heights for each specific project. All select granular backfill submittals from the contractor shall be from tests made specifically for each project. No test data from previous or multiple projects will be allowed.

(7) The direct shear test is a drained test and therefore shall be sheared at a rate between 0.004 to 0.008 in/min. The rate of shear shall also be noted on the direct shear test report. Testing procedures that do not follow these guidelines will not be accepted.

f. A minimum width of 1-ft of gravel fill shall be provided behind solid (non-hollow) modular block units. A minimum volume of 1-ft³/ft² of drainage fill shall be provided. Gravel fill shall meet the requirements of the unit (core) fill. A suitable geotextile fabric between the gravel fill and reinforced fill shall be used to meet the filtration requirements if the gravel fill does not meet the filtration criteria. The selection of a suitable geotextile for filtration purposes shall be supported by design computations taking in to account the actual gradations of the gravel fill and reinforced wall fill to be

used on the project. Gradation for gravel fill shall be tested at the frequency of 50 yd³ at the job site and for every change in the material source.

g. A certification of analysis for modular block connection shall be provided with detailed calculations according to AASHTO (2007) and the results of laboratory test results performed in accordance with Section C.3 in Appendix B of FHWA NHI-10-025, dated 2009 ("Mechanically Stabilized Earth Walls and Reinforced Slopes – Volume II"). Such certification shall demonstrate that all connections, including block-to-reinforcement and block-to-block connections, and all related components meet or exceed the current AASHTO 75 year design life requirements and are capable of resisting 100% of the maximum tension in the soil reinforcements at any level within the wall. Long-term connection testing for extensible reinforcements is also required. The effect of wall batter and normal pressures representative of the full range of wall configurations and heights shall be incorporated in the tests.

h. The Contractor shall furnish to the Engineer a Certificate of Compliance certifying that the select granular backfill materials comply with this section of the Specifications. A copy of all test results performed by the Contractor which are necessary to assure compliance with the *Specifications* shall also be furnished to the Engineer. Backfill not conforming to this Specification shall not be used without the written consent of both the Engineer and the wall supplier. The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be as directed by the Engineer.

715.04 -- Construction Methods

1. Wall Excavation: Excavation shall be in accordance with the requirements of the specifications and in reasonably close conformity with the limits shown in the contract.

2. Foundation Preparation: In the absence of specific ground improvement requirements in the contract, the following applies:

a. The foundation for the reinforced fill and retained backfill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits as shown in the contract.

b. Before wall construction, the foundation, if not in rock, shall be compacted in accordance with Subsection 205.03, Paragraph 14.b.(3). Any foundation soils found to be unsuitable shall be removed and replaced as directed by the Engineer.

3. Proof Rolling

a. The contractor shall perform proof-rolling to evaluate the stability and uniformity of the subgrade on which the MSE structure will be constructed. Proof rolling shall be performed on the entire areas at the following locations:

(1) At the bottom of the over excavation and recompaction zones; if specified in the contract.

(2) At the bottom of the over excavation and replacement zones, if specified in the contract.

(3) At the base of all walls or at the top of native soil.

b. Proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum, or at the moisture content that was used to achieve the required compaction.

c. Proof-rolling shall not be used within 1 1/2 feet of any underdrains.

d. Proof-rolling shall be performed on the exposed surface with a loaded dump truck or similar piece of construction equipment. Proof-rolling shall be performed in the presence of the Engineer. Any unstable material should be removed and replaced.

(1) Proof-rolling equipment shall have an axle weight of 20,000 for a single axle or 34,000 for tandem axle.

(2) Any deformations greater than 1 1/2 inches after one pass as measured with a 10 foot straightedge will be considered unstable.

e. The contractor shall be responsible for maintaining the condition of the approved proof-rolled soils throughout the duration of the MSE wall construction. Wall construction shall not commence until the foundation has been approved by the Engineer.

4. a. At each foundation level, an unreinforced concrete or a compacted granular leveling pad shall be provided as shown in the contract. The leveling pad shall be constructed to the design elevations shown on the working drawings. Allowable elevation tolerances are + 1/8 inch (3 mm) and - 1/4 inch (6 mm) from the design elevation.

b. The concrete leveling pad shall be cured a minimum of 24 hours before placement of wall panels. A geotextile shall be applied over the back of the area of any openings between the facing units and leveling pad steps. The geotextile shall extend a minimum of six (6) inches beyond the edges of the opening. The opening shall be filled with concrete, conforming to Subsection 4a, or shall be concurrently backfilled on both sides of the wall.

5. Prior to wall erection, the contractor shall install a subsurface drainage system as shown on the working drawings.

6. Erection of walls with Modular Block Units shall be as per the following requirements:

a. Vertical and horizontal alignment of the wall face shall not vary by more than 3/4-inch when measured along a 10-foot straightedge.

b. Overall vertical tolerance (plumbness) of the wall shall not exceed 1 1/4-inch per 10-ft of wall height from the final wall batter. Negative (outward) batter is not acceptable.

c. The first row of units shall be level from unit-to-unit and from front to back. Use the tail of the units for alignment and measurement.

d. All units shall be laid snugly together and parallel to the straight or curved line of the wall spanning the joint in the row below (running bond). Shimming or grinding shall control the elevations of any two adjacent blocks within 1/16 inch.

e. The top of blocks shall be checked with a 3 foot long straight edge bubble level. Any high points identified by the straight edge shall be ground flat. Block front to back tilting shall be checked frequently. Correction by shimming shall be done no later than 3 completed courses.

f. Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

7. Placement of Metallic Reinforcement Elements:

a. Before placing the first layer of reinforcements (strips or mats), backfill shall be placed and compacted.

b. Bending of reinforcements in the horizontal plane that results in a permanent deformation in their alignment shall not be allowed.

c. Connections of reinforcement to piles or bending of reinforcements around piles shall not be allowed. Cutting of longitudinal or transverse reinforcement bars to avoid conflicts with piles or utility obstructions shall not be allowed.

d. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcements due to pile or utility conflicts.

e. Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown in the contract or directed by the Engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable bolted connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position except in the case of acute corners where redundant reinforcements are used.

f. The contractor shall install joint pads and fillers as shown on the working drawings.

8. Placement of Geosynthetic Reinforcement:

a. Geosynthetic reinforcement shall be installed in accordance with the manufacturer's site-specific wall erection instructions.

b. Geosynthetic reinforcement shall be placed in continuous longitudinal rolls in the direction of the main reinforcement. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

c. Reinforcement coverage shall be 100% of embedment area unless otherwise shown in the working drawings. Adjacent sections of geosynthetic reinforcement need not be overlapped.

d. Geosynthetic reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geosynthetic reinforcement in place until the subsequent soil layer can be placed.

e. During construction, the surface of the fill shall be kept approximately horizontal. Geosynthetic reinforcement shall be directly placed on the compacted horizontal fill surface. The reinforcement shall bear uniformly on the compacted reinforced soil from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement

elevation shall be at the connection elevation to 2 inches higher than the connection elevation.

9. Backfill Placement:

a. Backfill placement shall closely follow erection of each course of facing blocks. Backfill material placed within the reinforced soil mass which does not meet the requirements of this Specification shall be corrected or removed and replaced at no additional cost to the Department as directed by the Engineer. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing panels. The contractor shall place backfill to the level of the connection and in such a manner as to ensure that no voids exist directly beneath the reinforcing elements.

b. Any wall elements which become damaged during backfill placement shall be either repaired or replaced by the Contractor at no additional cost to the Department. Any wall elements which become disturbed during backfill placement shall be reset by the Contractor at no additional cost to the Department.

c. For metallic reinforcements, the fill shall be spread by moving machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of 3 inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

d. For geosynthetic reinforcements, the fill shall be spread by moving machinery parallel to or away from the wall facing and in such a manner that the geosynthetic reinforcement remains taut. Construction equipment shall not operate directly on the geosynthetic reinforcement. A minimum fill thickness of 6 inches over the geosynthetic reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

e. Backfill shall be compacted to 95% of the maximum density as determined by NDOT T 99.

f. The moisture content of the backfill material before and during compaction shall be uniform throughout each layer.

g. Backfill material shall have a placement moisture content less than or equal to the optimum moisture content.

h. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniform and acceptable throughout the entire lift.

i. The optimum moisture content shall be determined in accordance with NDOT T 99.

j. The maximum lift thickness after compaction shall not exceed 10 inches (250 mm), regardless of the vertical spacing between layers of soil reinforcements. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

k. Before placement of the soil reinforcements, the reinforced backfill elevation, after compaction, shall be 2 inches (50 mm) above the connection elevation from a point approximately 1 foot (300 mm) behind the back face of the facing blocks to the free end of the soil reinforcements, unless otherwise shown in the contract. Modular block drainage fill shall be placed and tamped directly behind, between, and within the cells of the facing units. Granular fill shall not be placed within the holes provided for the connection pins. Compaction of modular block fill shall be achieved by hand tamping or rodding.

l. Compaction within 40 inches (1 m) of the back face of the facing blocks shall be achieved by at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used, but no soil density tests need be taken in this area.

m. Care shall be exercised in the compaction process to avoid misalignment of the facing blocks.

n. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

10. When shoring for phased construction is shown in the contract, the Contractor shall design and install the shoring. The type of shoring used shall be determined by the Contractor. Design calculations for the shoring shall be prepared by a Professional Engineer registered in the State of Nebraska. Before construction begins, 4 sets of the calculations and shoring plans shall be submitted to the Department for informational purposes only. The Contractor is solely responsible for the construction and performance of the shoring. All shoring shall remain in place and shall be cut off 2 feet (600 mm) below finish grade.

11. The wall shall be constructed according to the working drawings. Any field changes shall be reviewed by the engineer to determine if a revised working drawing is required.

715.05 -- Method of Measurement

1. The quantity of excavation for the leveling pads is not measured for directly.

2. The quantity of "Excavation for Soil Reinforcement" is measured by the cubic yard (cubic meter) and computed using the contract dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity.

a. The quantity shown in the contract is calculated using the average end area method based on preliminary cross sections of the existing ground and the calculated final cross sections. The excavation width limit is equal to 70% of the height of the wall plus the width required to step back the excavation as shown in Figure 715.01.

b. Additional "Excavation for Soil Reinforcement" may be needed to adjust the length of the wall to fit field conditions. Overruns of "Excavation for Soil Reinforcement", beyond that required from the original shop

drawings, will be measured by the cubic yard (cubic meter). The additional quantity is calculated using the method in Section 715.05 2. a. for the additional length.

c. Preliminary cross sections will include new fill if it is a required surcharge.

EXCAVATION CALCULATION LIMITS

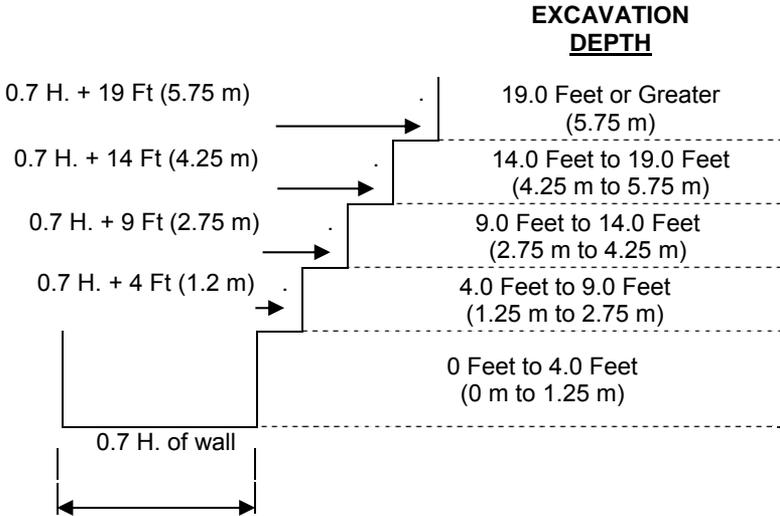


Figure 715.01

3. Dewatering, replacement of unsuitable soil or other unforeseen conditions will be paid as Extra Work described in SSHC Section 104.

4. The quantity of wall materials is measured by the square foot (square meter) and computed using the plan dimensions. The contract dimensions will include the envelope above the natural ground surface and a fixed area below the natural ground line a minimum of 2 foot (600 mm) for the length of the wall unless otherwise shown on the contract. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity. The wall surface area, as shown in the contract, includes wall penetrations such as pipes and other utilities.

a. Additional wall material may be needed to adjust the contract dimensions to fit field conditions. Overruns of wall material, beyond that required from the original shop drawings, will be measured by the square foot (square meter) of each additional block used.

5. The quantity of compacted earth leveling pads is measured by the linear foot (meter) and is computed using the contract dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity.

a. Additional compacted earth leveling pads may be needed to adjust the contract dimensions to fit field conditions. Overruns of compacted earth leveling pads, beyond that required from the original shop drawings, will be measured by the linear foot (meter).

6. The quantity of granular backfill is measured by the cubic yard (cubic meter) and is computed using the contract dimensions. The "Select Granular Backfill for Retained Earth Structures" shall include both reinforced backfill and modular block/drainage fill. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the contract quantity. The quantity shown in the contract is based on a volume equal to the height of the wall times the length of the wall times a width equal to 70% of the height.

a. Additional granular backfill may be needed to adjust the contract dimensions to fit field conditions. Overruns of granular backfill, beyond that required from the original shop drawings, shall be measured by the cubic yard (cubic meter). The quantity is based on a volume equal to the area of the additional blocks times 70% of the height of the wall.

715.06 -- Basis of Payment

1. Pay Item	Pay Unit
Excavation for Soil Reinforcement	Cubic Yard (CY) [Cubic Meter (m ³)]
Wall Materials	Square Foot (SF) [Square Meter (m ²)]
Compacted Earth Leveling Pad	Linear Foot (LF) [Meter (m)]
Select Granular Backfill for Retained Earth Structure	Cubic Yard (CY) [Cubic Meter (m ³)]

2. Excavation for the leveling pads will not be measured and paid for separately, but shall be subsidiary to the appropriate pay item requiring the excavation.

3. Revised Working Drawing or Shop Drawing will be paid for as extra work.

4. Additional quantities of Wall Materials, Compacted Earth Leveling Pad, and Select Granular Backfill for Retained Earth Structure required due to field changes will be paid at contract unit prices.

5. Payment is full compensation for all work described in this Section.

SECTION 716 -- STEEL RAILINGS

716.01 -- Description

1. This work shall consist of furnishing, erecting and painting steel handrail, bridge rail, rail elements, rail posts, barrier rail, pedestrian railing, and all connecting bolts and anchors in accordance with the requirements of the contract.

2. The plans shall be supplemented by working drawings submitted in accordance with the requirements of Subsection 105.02.

716.02 -- Material Requirements

1. The materials shall conform to the requirements in Table 716.01.

Table 716.01

Material Requirements	
Applicable Materials	Section
Structural Steel.....	1045
Structural Threaded Fasteners.....	1057, 1058
Steel Pipe for Rails and Posts.....	ASTM A 53, Grade B
Chain Link Fence and Hardware.....	1064
Steel Tubing.....	ASTM A 500, Grade B

2. Anchor bolts shall meet the requirements of Section 1058 unless otherwise specified in the contract. The bolt projection shall be galvanized.

716.03 -- Construction Methods

1. The Contractor shall build railing to the lines, grades, and vertical and horizontal curves shown in the contract.

2. The Contractor shall set rail posts plumb. Concrete areas upon which railing posts are to be set shall be dressed to provide even bearing.

3. The Contractor shall paint all exposed metal except galvanized and weathering grade steel as described in Section 709.

4. The Contractor shall repair galvanized coating which has been scarred, burned, or otherwise damaged in accordance with Section 1061 at no additional expense to the Department.

716.04 -- Method of Measurement

1. Structural steel for handrails and bridge rails is measured by the pound (kilogram).

2. Pedestrian barrier rail, pedestrian handrail, and pedestrian railing (chain link type) shall be measured by the foot (meter). The quantity to be paid will be the distance in feet (meters) between centers of end posts, with no allowance for splices, joints, overhangs, or end sections.

3. The Department computes plan quantities from end post to end post, measured horizontally, with no adjustments made for changes in elevation.

716.05 -- Basis of Payment

- | 1. Pay Items | Pay Unit |
|---|---------------------------------|
| Structural Steel for Handrail | Pound (lb)
[Kilogram (kg)] |
| Structural Steel for Bridge Rail | Pound (lb)
[Kilogram (kg)] |
| Pedestrian Barrier Rail | Linear Foot (LF)
[Meter (m)] |
| _____ Pedestrian Railing
(Chain Link Type) | Linear Foot (LF)
[Meter (m)] |
| Pedestrian Handrail | Linear Foot (LF)
[Meter (m)] |
2. Payment is full compensation for all work described in this Section.

SECTION 717 -- CONCRETE BOX CULVERTS

717.01 -- Description

1. This work shall consist of the construction of concrete box culverts. Concrete Box Culverts shall be constructed in accordance with these Specifications and in conformity with the lines, grades, dimensions, and designs shown in the contract.

717.02 -- Material Requirements

1. Concrete shall meet requirements of Section 1002.
2. Reinforcement shall be furnished, handled, and placed in accordance with the requirements of Section 707.
3. Crushed rock shall meet the general aggregate requirements of Section 1033.

717.03 -- Construction Methods

1. The Contractor shall not order box culvert materials like reinforcing steel and form lumber until the Engineer provides a field checked order list.
2. Excavation and backfilling shall be performed by the Contractor in accordance with the requirements of Section 702.
3. Concrete construction shall be performed by the Contractor in accordance with the requirements of Section 704.
4. Foundation excavations shall be as dry as practicable before concrete is placed.
 - a. The Contractor may elect to use crushed rock or crushed concrete as a base for the floor of the box culvert. Riprap Filter Fabric shall be placed under all rock.
 - b. Any unsuitable material encountered during the box culvert construction shall be excavated and removed from the site. The resulting void may be filled with crushed rock or crushed concrete as directed by the Engineer.
5. Dirt, mud, or other foreign material shall not become mixed with concrete which is being placed in footings and curtain walls.
6. Fence Connections:
 - a. Fence connections require that a 3/4 inch (19 mm) diameter hole shall be cast through each wing of new or extended concrete box culverts with rises of 5 feet (1.5 m) or greater.
 - b. This hole shall be located 4 feet (1.2 m) above the box flowline near the end of the wing and shall be a minimum of 4 inches (100 mm) from the end and top surfaces of the wing.
7. Extensions:
 - a. When box culverts are extended, if the existing thickness is different than the new, the new shall be adjusted by forming a variable thickness in the first 2 feet (600 mm) of the extension.

717.04 -- Method of Measurement and Basis of Payment

- 1. **Pay Item** **Pay Unit**
 Crushed Rock for Base Course Cubic Yards (CY)
[Cubic Meters (m³)]

2. Measurement and payment for the quantities involved in the construction of concrete box culverts shall be made in accordance with the provisions in Table 717.01.

Table 717.01

Measurement and Payment	
Requirement	Section
Excavation for Structures	702
Concrete Construction.....	704
Reinforcement.....	707

3. No payment will be made for concrete placed outside the dimensions shown in the contract.

4. The work of providing fence connection holes shall not be paid for directly but shall be considered subsidiary to the construction of the box culvert.

5. No additional compensation will be made for the additional work of forming the taper as described in Subsection 717.03, Paragraph 7.a. or for the concrete required.

6. Crushed Rock for Base Course shall include the crushed rock or crushed concrete, filter fabric, excavation and any additional labor or materials necessary to construct the base.

a. The limits for payment will be 6 inch depth and 18 inches outside any concrete face, including aprons. No adjustment in plan quantity will be made unless the dimensions of the box are changed. Any crushed rock or crushed concrete, fabric, or excavation outside of the limits described will be at no cost to the Department.

b. Excavation will not be paid directly but shall be considered subsidiary other items to which direct payment is made.

- 7. Payment is full compensation for all work described in this Section.

SECTION 718 -- CULVERT PIPE

718.01 -- Description

1. This work shall consist of furnishing and installing culvert pipe of the various types shown in the contract.

718.02 -- Material Requirements

1. The Contractor shall not order the culvert pipe until a list of sizes and lengths is furnished by the Engineer.

2. Reinforced concrete pipe shall conform to the requirements of Section 1037.

3. Corrugated metal pipe shall conform to the requirements of Sections 1035 and 1036.

4. Plastic pipe shall conform to the requirements of Section 1038.

5. Slotted pipe shall conform to the requirements shown in the contract.

6. Granular material for bedding shall conform to the requirements shown in the contract.

7. Flap gates shall conform to the requirements of Section 1043.

718.03 -- Construction Methods

1. Excavation and backfilling shall be performed by the Contractor in accordance with the applicable requirements of Section 702 and the contract.

2. The installation of Culvert Pipe shall be in accordance with Sections 701, 702, 719, 720, 721, 722, 724, 725, and 726.

3. Deflection Testing:

a. When plastic pipe is used or when corrugated metal pipe 48" (1200 mm) and larger is used, the Contractor shall periodically check for pipe deflection during pipe installation and again not less than 30 days following completion of the roadway embankment. The internal diameter of plastic pipe shall not be reduced by more than 5% of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5% of its design diameter. If the installation does not meet these requirements, the pipe shall be removed and replaced at no additional cost to the Department.

b. During the required 30-day reinspection of the culverts, the Contractor must treat the culvert as a "confined space". Appropriate safety procedures shall be followed. The Contractor shall provide the appropriate safety equipment.

c. Optional devices for deflection testing include electronic deflectometers, calibrated television or video cameras, or properly sized "go, no-go" mandrels. Deflection measurements can be made directly with extension rulers or tape measures at 10' feet (3 m) increments in pipes that allow safe entry. To ensure accurate measurements, the pipe should be cleaned before testing.

d. Deflection testing will not be required on corrugated metal pipe extensions of less than 25 feet (7.6 m).

4. Granular bedding and backfill is required for all flexible pipe installed under the roadway prism. Granular bedding and backfill will not be required for drop pipes, temporary pipes or corrugated metal pipe extensions unless called for in the contract. Granular bedding and/or backfill will be optional for concrete pipe when the Contractor selects the Type 3 Installation.

5. The Contractor shall install flap gates on the ends of culvert pipe when required in the contract. They shall be installed in accordance with the manufacturer's recommendations and standards.

6. When polymer pre-coated pipe is used, in order to protect the coated pipe, the Contractor shall use padded or nonmetallic slings and padded straps when handling the pipe. This includes unloading, moving and installation.

718.04 -- Method of Measurement

1. a. All pipe (round, elliptical, arched, or slotted) is measured in linear feet (meter) along the longitudinal axis once in place and accepted. In no case will the measured length be greater than the order length.

b. Each type and size of pipe is measured separately.

c. The additional length due to connections will not be measured for payment.

d. Granular bedding will not be measured for payment, but shall be considered subsidiary to the type of pipe being installed.

2. The length of round, arched, or elliptical pipe with elbows will be provided an additional length allowance to cover the cost of each elbow. The allowance is shown in Table 718.01.

Table 718.01

Elbow Allowances	
Pipe Diameter or Round Equivalent Size	Pipe Length Allowance for Each Elbow
Less than 36 inches (900 mm)	7 feet of pipe (2.1 m)
36 to 54 inches (900 mm to 1350 mm)	6 feet of pipe (1.8 m)
Greater than 54 inches (1350 mm)	5 feet of pipe (1.5 m)

3. When flexible pipe connections are required by the Engineer, an additional allowance to cover the cost of each connection shall be made as shown in Table 718.02.

Table 718.02

Connection Allowances	
Pipe Diameter or Round Equivalent Size	Pipe Length Allowance for Each Connection
Less than 21 inches (530 mm)	3 feet of pipe (900 mm)
21 inches (530 mm) or larger	4 feet of pipe (1200 mm)

4. Flap gates shall be measured for payment by the each, complete in place. The pay item is "_____ inch (mm) Automatic Flood Control Gate".

718.05 -- Basis of Payment

1. Pay Item	Pay Unit
____ inch (mm) Culvert Pipe, Type_____	Linear Foot (LF) [meter (m)]
____ inch (mm) Automatic Flood Control Gate	Each (ea)
____ inch (mm) Slotted Culvert Pipe, Type_____	Linear Foot (LF) [meter (m)]
____ inch (mm) Round Equivalent Culvert Pipe, Type_____	Linear Foot (LF) [meter (m)]

2. Flap Gates shall be paid for at the contract unit price per each under the item, "_____ inch (mm) Automatic Flood Control Gate". Each different size is a separate pay item.

3. Granular bedding for culvert pipe shall be subsidiary to the appropriate culvert pipe pay item.

4. Payment is full compensation for all work described in this Section.

SECTION 719 -- FLEXIBLE PIPE CULVERTS (CORRUGATED METAL AND PLASTIC)

719.01 -- Description

1. This work shall consist of furnishing and installing new corrugated metal pipe, helical corrugated metal pipe, slotted pipe, pipe-arches, high density polyethylene (corrugated interior), high density polyethylene (smooth interior), and polyvinyl chloride pipe, and the relaying of existing corrugated metal pipe, helical corrugated metal pipe, slotted pipe, pipe-arches, high density polyethylene (corrugated interior), high density polyethylene (smooth interior), and polyvinyl chloride pipe at the locations shown in the contract or ordered by the Engineer in accordance with the requirements of these Specifications.

719.02 -- Material Requirements

1. Flared end sections for flexible pipe shall be metal and shall conform to the requirements of Section 1036.

2. Approved water-tight and soil-tight joints are shown on the Department's Approved Products List.

3. Flap gates shall conform to the requirements of Section 1043.

4. Corrugated metal pipe, helical corrugated metal pipe, and pipe-arches shall be Zinc Coated (Galvanized) Pipe, Aluminum Coated Pipe, or Polymer Coated Pipe and shall conform to the requirements of Section 1035.

5. Slotted pipe shall conform to the requirements shown in the contract.

6. Unless otherwise specified in the contract, the minimum gage or sheet thickness shall conform to Sections 1035 and 1036.

7. Plastic pipe shall conform to the requirements of Section 1038.

8. The Contractor shall not order or deliver the pipe until a list of sizes and lengths is furnished by the Engineer.

719.03 -- Construction Methods

1. Excavation and backfilling shall be performed by the Contractor in accordance with the requirements of Section 702 and the contract.

2. The Contractor shall lay the pipe true to the lines and grades shown in the contract or as directed by the Engineer. Any pipe which is not true in alignment or to the established grade or which shows any settlement after laying shall be taken up and relaid by the Contractor at no additional cost to the Department.

3. Deflection Testing:

a. When plastic pipe is used or when corrugated metal pipe 48 inch (1200 mm) or larger is used, the Contractor shall periodically check for pipe deflection during pipe installation and again not less than 30 days following completion of the roadway embankment. The internal diameter of plastic pipe shall not be reduced by more than 5% of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5% of its design diameter. If the installation does not meet these requirements, the pipe shall be removed and replaced at no additional cost to the Department.

b. During the required 30-day reinspection of the culverts, the Contractor must treat the culvert as a "confined space". Appropriate safety procedures shall be followed. The Contractor shall provide the appropriate safety equipment.

c. Optional devices for deflection testing include electronic deflectometers, calibrated television or video cameras, or properly sized "go, no-go" mandrel. Deflection measurements can be made directly with extension rulers or tape measures at 10 feet (3 m) increments in pipes that allow safe entry. To ensure accurate measurements, the pipe should be cleaned before testing.

d. Deflection testing will not be required on corrugated metal pipe extensions of less than 25 feet (7.6 m).

4. Pipe Joints:

a. All flexible pipe installed under the roadway prism shall be connected with an approved water-tight joint. All flexible pipe installed outside of the roadway prism shall be connected with an approved soil-tight joint.

b. If the contract calls for the extension of a corrugated metal pipe culvert, the pipes shall be connected with an approved water-tight connecting band. In all cases where an existing concrete headwall is in place, the old concrete shall be completely removed.

5. The Contractor shall clean accumulations of soil and debris, haul, and relay all culvert pipe designated to be relaid in accordance with the methods herein described for installing new pipe.

The Contractor shall carefully remove the pipe from its existing location, transport it to and install it in the new location in accordance with the methods herein described for installing new pipe. Pipe damaged by the Contractor shall be replaced with pipe of similar type by the Contractor without additional compensation.

New metal bands or joint material shall be supplied and installed when necessary.

6. The Contractor shall strut or take other action recommended by the manufacturer for all corrugated metal culverts with diameters greater than 48 inches (1200 mm) to insure that the pipe's final shape is properly aligned.

7. Instead of strutting corrugated metal pipe 48 inches (1200 mm) or larger in diameter, the Contractor may furnish corrugated metal pipe with the vertical axis fabricated out of round 5% of the normal diameter from end to end of the pipe. The elongation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced. If helical metal pipe 48 inches (1200 mm) or larger in diameter is furnished with the vertical axis fabricated out of round instead of strutting, then field connections shall be made with match-marked connecting pipe to assure that the helical sections match when the vertical axis of the pipe sections are brought together.

8. All flexible pipe installed under the roadway prism shall be bedded and backfilled as shown in the contract. Granular bedding and backfill will not be required for corrugated metal pipe extensions unless called for in the contract.

9. Plastic pipe shall be installed by the Contractor in accordance with the contract, ASTM D 2321, and the manufacturer’s recommendations.

10. When polymer pre-coated pipe is used, in order to protect the coated pipe, the Contractor shall use padded or nonmetallic slings and padded straps when handling the pipe. This includes unloading, moving and installation.

719.04 -- Method of Measurement

1. Excavation, concrete, and reinforcement for headwalls will be measured for payment in accordance with the provisions in Table 719.01.

Table 719.01

Method of Measurement	
Requirement	Subsection
Excavation for Structures.....	702.04
Concrete	704.04
Reinforcement	707.04

2. Flexible pipe shall be measured as described in Subsection 718.04.

3. Granular bedding and backfill will not be measured for payment, but shall be considered subsidiary to the pipe being installed.

719.05 -- Basis of Payment

- | Pay Item | Pay Unit |
|--|---------------------------------|
| ___inch (mm) ___Pipe | Linear Foot (LF)
[meter (m)] |
| Relaying Corrugated Metal Pipe | Linear Foot (LF)
[meter (m)] |
| ___inch (mm) Round Equivalent
Corrugated Metal Pipe | Linear Foot (LF)
[meter (m)] |
| ___inch (mm) Corrugated
Metal Slotted Pipe | Linear Foot (LF)
[meter (m)] |

Table 719.02

Basis of Payment	
Requirement	Subsection
Excavation for Structures.....	702.05
Concrete	704.05
Reinforcement	707.05

2. Payment for excavation, concrete, and reinforcement for headwalls shall be made in accordance with the provisions shown in Table 719.02.

3. Payment is full compensation for all work described in this Section.

SECTION 720 -- CONCRETE PIPE CULVERTS

720.01 -- Description

1. This work shall consist of furnishing and installing new reinforced concrete culvert pipe (round, pipe-arch, and elliptical) and reinforced concrete slotted pipe and the relaying of existing reinforced concrete pipe at locations shown in the contract and in accordance with the requirements of these Specifications.

720.02 -- Material Requirements

1. The Contractor shall not order the pipe until a list of sizes and lengths is furnished by the Engineer.

2. Reinforced concrete culvert pipe shall conform to the requirements of Section 1037.

3. Reinforced concrete slotted pipe shall conform to the requirements shown in the contract.

4. Approved preformed plastic gaskets are shown in the Department's Approved Products List.

720.03 -- Construction Methods

1. Excavation and backfilling shall be performed by the Contractor in accordance with the requirements of Section 702.

2. Joints:

a. The Contractor shall lay the pipe true to established lines and grades with groove ends upstream and tongue ends fully entered into the adjacent sections of pipe.

b. All reinforced concrete pipe under the roadway prism shall be tongue and groove (T&G) or modified tongue and groove type, and have water-tight joints using fibered roof coating or gaskets.

c. Bell And Spigot Pipe:

(1) When a bell and spigot section of pipe is laid, the lower portion of the hub, bell, or groove of the preceding pipe shall be filled on the inside with sufficient mortar to bring the inner surface of the abutting pipes flush and even.

(2) After the pipe is laid, the remainder of the joint shall be filled and packed with cement mortar; and sufficient additional material shall be used to form a bead around the joint.

(3) The inside of the joint shall be wiped and finished smooth.

(4) After the initial set, the cement mortar on the outside shall be protected from the sun with a moist earth covering.

d. As an alternate to mortared joints, rubber gaskets or flexible plastic gaskets meeting the specification requirements of AASHTO M 198 may be used if the design of the joints is in conformance with this AASHTO designation.

e. After the pipe is laid, all lift holes shall be filled with cement mortar (1 part cement and 2 parts sand).

3. Irrigation Structures:

a. When concrete pipe is laid for an irrigation structure, full compression gaskets conforming to the requirements of ASTM C 361 shall be used and installed on each section of the pipe as per the manufacturer's recommendations and standards.

b. In the event that full compression gaskets are not available for the type of pipe specified, a preformed plastic gasket for concrete pipe joints shall be supplied meeting Federal Specification SS-S-00210, "Sealing Compound, Preformed Plastic for Pipe Joints" Type 1, Rope Form.

c. Hydrostatic Testing:

(1) The Contractor shall hydrostatically test all precast concrete pipe laid for irrigation structures. Where the bottom grade of the pipeline at the outlet is less than 4 feet (1.2 m) above the inside top of the pipe at its lowest point, no test will be required. Water for making the tests shall be furnished by the Contractor and shall be introduced into the siphons and pipelines in such a manner as to prevent rapid temperature drops in the pipe.

(2) Tests shall be made as soon after completion of construction of the structure as practicable, but in no event sooner than 20 days after the placing of any concrete that will be subject to hydrostatic pressure during the test. Testing under full operating head or to heads designated by pipe classification will not be required, but the lines shall be tested to the maximum practical head by filling with water to the elevation of the bottom grade of the outlet end or by other methods as directed by the Engineer. After the pipe has been filled to the specified elevation, it may be allowed to stand for a period not to exceed 15 days to saturate the pipe before testing. The test period shall be for 24 consecutive hours during which time the water surface in the structure shall be maintained at the specified test elevation.

(3) The total amount of leakage during this 24 hour test period shall not exceed 215 gal/inch (20 L/mm) of internal diameter per mile (kilometer). If the leakage exceeds 60% of the maximum allowed, the Engineer may require the water to be maintained at the limiting elevation stated above for an additional period of 10 days to allow evidence of excessive leakage at any point to become apparent. Individual leaks, evidenced by appearance of moisture, shall be repaired.

(4) The Contractor shall furnish all labor, equipment, materials, tools, water, and water-measuring apparatus required for making the tests; and the cost thereof shall be included in the unit bid price for the size of pipe being tested.

d. The Contractor shall make all repairs or replacements, or both, that are necessary to secure the required watertightness.

e. The Contractor shall be responsible for any damage to the structures or adjacent work due to testing.

4. Any pipe which is not true in alignment or to the established grade or which shows any settlement shall be removed and reinstalled by the Contractor at no additional cost to the Department.

5. When the contract designates the extension of a concrete pipe culvert, the connection shall be made by enclosing the connecting joint with a concrete collar. The collar shall be constructed in accordance with the requirements of Section 704; and the steel reinforcement shall be furnished, handled, and placed in accordance with the requirements of Section 707. In all cases where a concrete headwall is in place, it shall be completely removed.

6. Concrete culvert pipe which is designated to be relaid shall be cleaned of accumulations of soil and debris, hauled, and relaid in accordance with the methods herein described for installing new pipe.

720.04 -- Method of Measurement

1. Excavation and concrete and reinforcement for headwalls and collars will be measured for payment in accordance with the provisions in Table 720.01.

Table 720.01

Method of Measurement	
Requirement	Subsection
Excavation for Structures.....	702.04
Concrete.....	704.04
Steel Reinforcement.....	707.04

2. See Subsection 718.04 for the methods to measure concrete pipe.

3. Concrete pipe collar connections are measured by the cubic yard (cubic meter) of concrete and pounds (kilograms) of reinforcing steel used.

4. At the junction of new concrete pipes, the measurement shall be extended to the center of the pipe being tapped. This extension shall be the total allowance for building the junction.

720.05 -- Basis of Payment

1. Payment for excavation and for concrete and reinforcement for headwalls and collars shall be made in accordance with the provisions in Table 720.02.

Table 720.02

Basis of Payment	
Requirement	Subsection
Excavation for Structures	702.05
Concrete.....	704.05
Steel Reinforcement.....	707.05

2. Pay Item	Pay Unit
_____ inch Reinforced Concrete Pipe	Linear Foot (LF) [Meter (m)]
_____ inch Round Equivalent Reinforced Concrete Pipe	Linear Foot (LF) [Meter (m)]
_____ inch Reinforced Concrete Slotted Pipe	Linear Foot (LF) [Meter (m)]
Relaying Reinforced Concrete Pipe	Linear Foot (LF) [Meter (m)]
Class _____ Concrete for Concrete Collars	Cubic Yard (CY) [Cubic Meter (m ³)]
Reinforcing Steel for Collars	Pound (lb) [Kilogram (kg)]

3. The cleaning and the hauling of the pipe from the site of removal or from the place where it is stored to the point or points at which it is to be relaid will not be paid for directly, but shall be considered subsidiary to the work of relaying the pipe.

4. Payment is full compensation for all work described in this Section.

SECTION 721 -- DRIVEWAY CULVERT PIPE

721.01 -- Description

1. This work shall consist of furnishing and installing new pipe culverts, typically in round, pipe-arch, or elliptical shapes, of the various types at the locations shown in the contract or designated by the Engineer.

721.02 -- Material Requirements

1. The pipe furnished shall conform to the requirements in Table 721.01.

Table 721.01

Material Requirements	
Applicable Materials	Section
Corrugated Metal Pipe	1035
Reinforced Concrete Culvert Pipe.....	1037
Plastic Pipe	1038

721.03 -- Construction Methods

1. The Contractor shall not order or deliver the pipe until a list of sizes and lengths are furnished by the Engineer.

2. The corrugated metal pipe and reinforced concrete pipe for driveways shall be installed in accordance with the applicable portions of Sections 718, 719, and 720. Plastic pipe for driveways shall be installed in accordance with the contract, ASTM D 2321, and the manufacturer's recommendations.

3. Deflection Testing:

a. When plastic pipe is used or when corrugated metal pipe 48 inch (1200 mm) and larger is used, the Contractor shall periodically check for pipe deflection during pipe installation and again not less than 30 days following completion of the roadway embankment. The internal diameter of plastic pipe shall not be reduced by more than 5% of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5% of its design diameter. If the installation does not meet these requirements, the pipe shall be removed and replaced at no additional cost to the Department.

b. During the required 30-day reinspection of the culverts, the Contractor must treat the culvert as a "confined space". Appropriate safety procedures shall be followed. The Contractor shall provide the appropriate safety equipment.

c. Optional devices for deflection testing include electronic deflectometers, calibrated television or video cameras, or properly sized "go, no-go" mandrel. Deflection measurements can be made directly with extension rulers or tape measures at 10 feet (3 m) increments in pipes that allow safe entry. To ensure accurate measurements, the pipe should be cleaned before testing.

4. Granular bedding and backfill will not be required for driveway culvert pipe unless called for in the contract.

5. When polymer pre-coated pipe is used, in order to protect the coated pipe, the Contractor shall use padded or nonmetallic slings and padded straps when handling the pipe. This includes unloading, moving and installation.

721.04 -- Method of Measurement

1. All driveway culvert pipe shall be measured as described in Subsection 718.04.

721.05 -- Basis of Payment

1. Pay Item	Pay Unit
____ inch (mm) Driveway Culvert Pipe, Type ____	Linear Foot (LF) [Meter (m)]
____ inch (mm) Round Equivalent Driveway Culvert Pipe, Type ____	Linear Foot (LF) [Meter (m)]
Relaying Driveway Culvert Pipe	Linear Foot (LF) [Meter (m)]

2. Excavation and backfilling for driveway culvert pipe will not be measured for payment, but shall be considered subsidiary to the appropriate pipe bid item.

3. Payment is full compensation for all work described in this Section.

SECTION 722 -- SEWERS

722.01 -- Description

1. This work shall consist of excavating sewer trenches, constructing and laying pipe sewers, and backfilling sewer trenches to the dimensions shown in the contract.

722.02 -- Material Requirements

1. The type of sewer pipe allowed shall be designated in the bid proposal Schedule of Items. When the type of pipe is not designated in the Schedule of Items, the Contractor may use either Reinforced Concrete Sewer Pipe, High Density Polyethylene Pipe (Smooth Interior), or Polyvinyl Chloride Pipe.

2. All sewer pipes shall conform to the requirements in Table 722.01.

Table 722.01

Material Requirements	
Applicable Materials	Section
Reinforced Concrete Sewer Pipe.....	1037
Plastic Pipe	1038
Cast Iron Pipe	1039
Ductile Iron Pipe.....	1039
Acrylonitrile-Butadiene-Styrene (ABS) Composite Sewer Pipe	1038

3. The Contractor shall not order any pipe until a list of sizes and lengths is furnished by the Engineer.

4. Approved water-tight joints for plastic pipes are shown on the Department's Approved Products List.

722.03 -- Construction Methods

1. Except for plastic sewer pipe installations under the roadway prism, all excavation, bedding and backfill shall be performed in accordance with the requirements of Section 702 and the contract.

2. Plastic pipe shall be installed in accordance with the contract, ASTM D 2321, and the manufacturer's recommendations.

3. Granular bedding and backfill are required for all plastic pipe installed for use in sewers under the roadway prism (or back of curb to back of curb). Plastic pipe installed beyond these limits will not require granular bedding and backfill, but will require installation in accordance with the contract, ASTM D 2321, and the manufacturer's recommendations.

4. When the Contractor selects the Type 3 Installation shown in the contract, granular bedding and backfill will be optional for concrete pipe.

5. The Contractor shall lay all pipes to the line and grade established in the contract.

6. The Contractor shall inspect and sound all pipes for cracks or other defects and report to the Engineer.

7. Pipe alignments shall be marked by the Contractor so that, when joined in the ditch, a smooth tube will be formed.

8. All reinforced concrete sewer pipe connections shall be tongue and groove (T&G), or modified tongue and groove type, and have approved water-tight joints. The general method of laying concrete pipe, as required in Section 720, shall apply to the Contractor when laying reinforced concrete sewer pipe, with the exception of the joints. When reinforced concrete sewer pipe is used, the following methods shall be used for sealing joints:

a. When called for in the contract, full compression gaskets conforming to the requirements of ASTM C 361/C 361M or distorted-type flexible rubber gaskets conforming to the requirements of ASTM C 443/C 443M shall be used and installed on each section of the pipe in accordance with the manufacturer's recommendations and standards.

b. When the use of gaskets is not called for in the contract, all joints shall be sealed with a full compression gaskets described above or filled and pointed both inside and outside of the pipe with a troweling grade of fibered roof coating complying with the requirements of Federal Specification SS-C-153 for Bituminous Plastic Cement, Type I, Asphaltic Base.

9. All plastic pipe installed for sewers shall be connected with an approved water-tight joint.

10. The Engineer shall approve the Contractor's method for drawing the pipes together to close the gap.

11. Deflection Testing:

a. When plastic pipe is used, the Contractor shall periodically check for pipe deflection during pipe installation and again not less than 30 days following completion of the roadway embankment. During the required 30-day reinspection of the culverts, the Contractor must treat the culvert as a "confined space". Appropriate safety procedures shall be followed. The Contractor shall provide the appropriate safety equipment.

b. Optional devices for deflection testing include electronic deflectometers, calibrated television or video cameras, or properly sized "go, no-go" mandrels. Deflection measurements can be made directly with extension rulers or tape measures at 10 feet (3 m) increments in pipes that allow safe entry. To ensure accurate measurements, the pipe should be cleaned before testing.

722.04 -- Method of Measurement

1. Sewer pipe shall be measured in place by the linear foot (meter) along the axis of the pipe, and the measurement shall be taken between centers of new manholes, flush tanks, cleanouts, inlets, junctions with other sewers, or dead ends, as the case may be; except that in the case of installation of flared-end sections, the measurement shall be taken to the point at which the pipe is joined to the flared-end section.

2. When tapping a structure is called for in the contract, measurement for sewer pipe will terminate where the farthest extension of the pipes intersect the inside face of the structure.

3. Where a sewer reduces to a smaller size, the larger sewer will be measured to the point where the sewer is the exact size of the smaller sewer, unless otherwise provided in the contract.

4. Additional allowances for elbows and connecting bands will be made as provided in Tables 718.01 and 718.02.

5. Excavation for sewers shall not be measured for payment.

6. At the junction of a new sewer pipe and a new box culvert, measurement will terminate where the farthest extension of the new pipe intersects the inside wall of the new box culvert; and this extension shall be the total allowance for building the junction.

7. At the junction of sewers, measurement shall be taken along the axis of the pipe and shall extend to the points of intersection of the two sewers; and this measurement shall be the total allowance for building the junction.

8. Granular bedding and backfill will not be measured for payment.

722.05 -- Basis of Payment

1. Pay Item	Pay Unit
____inch (mm) Storm Sewer Pipe, Type____	Linear Foot (LF) [Meter (m)]
____inch (mm) Sanitary Sewer Pipe, Type____	Linear Foot (LF) [Meter (m)]
____inch (mm) Round Equivalent Storm Sewer Pipe, Type____	Linear Foot (LF) [Meter (m)]

2. Excavation and backfill for sewers shall be subsidiary to the appropriate sewer pipe pay item.

3. Granular bedding and backfill for sewers shall be subsidiary to the appropriate sewer pipe pay item.

4. If unsuitable material is encountered, it's removal and backfill will be paid for as extra work as stipulated in Subsection 109.05.

5. Payment is full compensation for all work described in this Section.

**SECTION 723 -- TAPPING EXISTING DRAINAGE
AND SEWER FACILITIES**

723.01 -- Description

1. This item shall consist of all work that is necessary to provide openings in the existing drainage or sewer facilities and for new connections into these structures at the locations and to the dimensions specified in the contract or ordered by the Engineer.

723.02 -- Construction Methods

1. The Contractor shall tap, seal, and connect pipes to pipes and/or structures in a neat and professional manner as shown in the contract.

723.03 -- Method of Measurement

1. This work will be measured by the each.

723.04 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|-----------------|
| Tapping Existing _____ | Each (ea) |
| 2. Payment is full compensation for all work described in this Section. | |

SECTION 724 -- INSTALLATION AND REMOVAL OF FLARED-END SECTIONS

724.01 -- Description

1. As described in the contract, the Contractor shall:
 - a. Furnish and install new flared-end sections.
 - b. Remove, salvage, and reinstall flared-end sections.
 - c. Remove and dispose of flared-end sections.
 - d. Reinstall Department furnished flared-end sections.
2. Flared-end sections shall be manufactured as integral units so they may be readily installed and joined with the culvert pipe as shown in the contract.
3. The Contractor shall stockpile and reinstall concrete and metal flared-end sections and bar grates at the locations shown in the contract.

724.02 -- Material Requirements

1. Metal flared-end sections for culvert pipe shall conform to the applicable requirements of Section 1036 for the diameter of pipe on which they are to be installed.
2. Concrete flared-end sections for use on concrete pipe shall conform to the applicable requirements of AASHTO M 170/M 170M-95, M 206/M 206M-95, or M 207/M 207M-95, for Class II pipe.
3. The Contractor shall not order any flared-end section until a correct list of sizes is provided by the Engineer.

724.03 -- Construction Methods

1. The Contractor shall excavate and backfill in accordance with the requirements of Section 702.
2. Flared-end sections to be removed and salvaged shall be removed in such a manner as to avoid damage to the flared-end section and the pipe when the pipe is salvaged. The salvaged flared-end sections shall be cleaned to remove accumulations of dirt and debris and stored at a location designated by the Engineer.
3. The Contractor shall install flared-end sections in accordance with the requirements of Section 719 or 720, depending on the type of end section.
4. Flared-end sections with bar grates may be removed as a unit; or, at the Contractor's option, the bar grate may be removed before the removal of the flared-end section.

724.04 -- Method of Measurement

1. A new flared-end section is measured by the each as "_____ inch (mm) _____ Flared-End Section". Included is a new flared-end section and its installation.
2. Flared-end section removal is measured by the each as "Remove Flared-End Section".
3. Flared-end section removal and salvage is measured by the each as "Remove and Salvage Flared-End Section."

4. Installation of salvaged or State furnished flared-end sections is measured by the each as "Install _____ inch (mm) _____ Flared-End Section".

5. New flared-end sections for culverts are measured by the each as "_____ inch (mm) Flared-End Section" when the Contractor has an option as to the type of pipe to use.

6. The cost of necessary connection bands are subsidiary to the appropriate flared-end section pay item.

724.05 -- Basis of Payment

1. Pay Item	Pay Unit
_____ inch (mm) Flared-End Section	Each (ea)
Install _____ inch (mm) _____ Flared-End Section	Each (ea)
Remove Flared-End Section	Each (ea)
_____ inch (mm) _____ Flared-End Section	Each (ea)
Remove and Salvage Flared-End Section	Each (ea)

2. Excavation required for the work of removing or installing the flared-end sections which is beyond the pay limits of excavation for installing or removing the culvert pipe in Figure 701.01 will not be measured or paid for directly, but shall be considered subsidiary to the flared-end section removal and/or installation pay item.

3. Removal and reinstallation of bar grates is subsidiary to the appropriate flared-end section pay item.

4. Flared-end sections for the pay item "Install _____ inch (mm) _____ Flared-End Section" shall be either salvaged or State furnished.

5. The cost of necessary connection bands except concrete collars are subsidiary to the appropriate flared-end section pay item.

6. Collars required when a tongue and groove connection on concrete pipe is not possible or an annual end is not presented on corrugated metal pipe shall be paid for as described in Subsections 720.04 and 720.05.

7. Payment is full compensation for all work described in this Section.

SECTION 725 -- BAR GRATES FOR FLARED-END SECTIONS

725.01 -- Description

1. This work shall consist of furnishing, installing, and painting/galvanizing bar grates on concrete or metal flared-end sections at the locations shown in the contract.

725.02 -- Material Requirements

1. Unless otherwise specified, bars for bar grates shall be round, smooth bars conforming to the mechanical requirements of Section 1044.

2. Plates shall be structural steel conforming to the requirements of Section 1045.

3. Bar grates shall not be ordered until the Engineer provides the Contractor a complete list of all required bar grates.

725.03 -- Construction Methods

1. The Contractor shall accurately and neatly drill the holes and mount the bar grate in the flared-end sections. Holes required for installing the bar grate on the concrete flared-end section may be formed in the concrete during casting.

725.04 -- Method of Measurement

1. Bar grates of each different size and kind will be measured for payment by the each.

725.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|-----------------|
| Bar Grate for _____ inch (mm) Flared-End Section | Each (ea) |
| Bar Grate for _____ inch (mm) _____
Flared-End Section | Each (ea) |
| Bar Grate for _____ inch (mm) _____
Round Equivalent Flared-End Section | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 726 -- CULVERT SANDFILL

726.01 -- Description

1. This work shall consist of sealing existing culverts as shown in the contract or as directed by the Engineer. The Contractor shall construct bulkheads at the outlet ends and then filling the culvert with sand or flowable fill.

726.02 -- Material Requirements

1. Flowable fill shall meet the requirements of Section 1003.
2. Concrete shall meet the requirements of Section 1002.
3. Fly ash slurries will be approved based on mix submission to Materials & Research Division.
4. Sand shall meet the requirements of Subsection 1033.02, Paragraph 3.a.

726.03 -- Construction Methods

1. The Contractor shall plug the culvert at locations shown in the contract. The plug shall be a bulkhead or other structure as shown in the contract.
2. The Contractor shall fill the culvert with flowable fill, sand, or fine aggregate for concrete.

726.04 -- Method of Measurement

1. Culvert sandfill is measured by the cubic yard (m^3). The quantities will be based on the culvert dimensions.

726.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|------------------|---|
| Culvert Sandfill | Cubic Yard (CY) [Cubic Meter (m^3)] |
2. The plugs will not be paid for directly, but shall be considered subsidiary to the Culvert Sandfill.
 3. Payment is full compensation for all work described in this Section.

SECTION 727 -- SUBSURFACE DRAINAGE MATTING

727.01 -- Description

1. This work shall consist of furnishing and installing drainage matting at bridge ends as shown in the contract.

727.02 -- Material Requirements

1. The drainage matting to be used shall be on the Department's Approved Products List.

2. Materials that are not on the Department's Approved Products List may be considered for use provided a manufacturer's certificate of compliance for the proposed materials is provided to the Engineer. Material criteria are listed on the Department's Approved Products List.

727.03 -- Construction Methods

1. The Contractor shall place the matting at the location shown in the contract.

2. The matting shall be placed in accordance with the manufacturer's recommendation.

3. A 3 inch (75 mm) minimum lap shall be used when splicing the matting.

727.04 -- Method of Measurement

1. Subsurface drainage matting is measured by the square yard (square meter) of area covered with no allowance for overlaps.

727.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|-----------------------------|--|
| Subsurface Drainage Matting | Square Yard (SY)
[Square Meter (m ²)] |
2. Payment is full compensation for all work described in this Section.

SECTION 728 -- RIPRAP FILTER FABRIC

728.01 -- Description

1. This work shall consist of furnishing and installing a riprap filter fabric at the locations shown in the contract and as directed by the Engineer.

728.02 -- Material Requirements

1. The filter fabric to be used shall be on the Department's Approved Products List.

2. Filter fabric materials that are not on the Department's Approved Products List may be considered for use provided a manufacturer's certificate of compliance for the proposed materials is provided to the Engineer. Material criteria are listed on the Department's Approved Products List.

728.03 -- Construction Methods

1. The surface underlying the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, and debris. Erosion features (i.e., rills, gullies, etc.) shall be graded out of the surface before geotextile placement.

2. The geotextile shall be placed on the underlying surface such that the geotextile is not damaged. The fabric shall be placed so that the upstream strip of fabric will overlap the downstream strip. Material overlap for unstitched seams shall be a minimum of 40 inches (1 m). The geotextile shall be laid smooth so as to minimize tension, stress, folds, wrinkles, and creases.

3. The geotextile shall be held in place by adequate pinning, selectively placed riprap, or a combination of pinning and riprap prior to placement of the specified riprap.

4. The geotextile shall be covered with the specified riprap within 5 days after placement of the geotextile. Placement of specified riprap onto the geotextile shall not rupture the geotextile.

728.04 -- Method of Measurement

1. The item, "Riprap Filter Fabric", shall be measured by the square yard (square meter) of the area covered by the fabric and accepted by the Engineer with no allowance for overlaps.

728.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|--|
| Riprap Filter Fabric | Square Yard (SY)
[Square Meter (m ²)] |
| 2. Payment is full compensation for all work described in this Section. | |

SECTION 729 -- DECK JOINT SEALS

729.01 -- Description

1. The item, "Deck Joint Seals", shall consist of furnishing and installing fabricated modular expansion joint systems of the general size and configuration shown in the contract. The seals shall be capable of the movement specified and shall be built to the lines and elevations shown in the contract.

2. Manufacturers producing acceptable items are shown in the contract.

729.02 -- Material Requirements

1. Structural Steel:

a. Structural steel for extrusions and support bars shall conform to the minimum requirements of ASTM A 709/A 709M, Grade 50 steel.

b. All exposed surfaces of the extrusions and support bars shall be painted with primer in accordance with Subsection 709.03; the finish coat is not required.

c. As an alternate, steel extrusions and support bars may be galvanized in accordance with ASTM A 123.

2. Stainless steel sheets for the sliding surfaces of support bars shall conform to the requirements of ASTM A 240/A 240M, Type 304, polished to a No. 8 mirror finish as established by the American Iron and Steel Institute Committee of Stainless Steel Producers "Finishes for Stainless Steel" at the completion of fabrication.

3. The elastomeric sealing element shall be a polychloroprene (neoprene) locking box seal that meets the requirements of ASTM D 2628, modified to omit the recovery test as noted below:

Hardness (Shore A Durometer) 60 ± 5 ASTM D 2240 (modified)

4. The seal shall be one piece full length over the entire expansion joint, including curb or parapet units.

5. Support bar bearings shall incorporate a polytetrafluorethylene surface and a stainless steel surface to minimize resistance to joint movements.

6. Suitable equilibrium type springs, which work counter to compression forces of the sealing elements, shall be used to maintain equalized expansion properties for each element across the joint.

7. Slider plates shall be provided at the curbs as part of the completed joint assembly in accordance with the details shown in the contract.

8. The manufacturer of the expansion joint assembly shall supply shop drawings showing details of the assembly and installation.

729.03 -- Construction Methods

1. The Contractor shall provide and assemble the expansion joints in accordance with approved shop drawings, joint setting data, contract, and the specifications.

2. The assembly shall be properly secured for shipping and shall contain provisions for final field adjustment at the time of installation.

3. All movements due to factors such as shrinkage, creep, and mid-span deflection shall be properly accounted for before the final adjustment.

4. The prefabricated joint assembly shall be properly positioned and attached to the superstructure using anchorages provided with the assembly as shown in the contract.

729.04 -- Method of Measurement

1. The expansion joint system shall be measured for payment by the linear foot (meter) of joint properly installed and accepted by the Engineer.

2. Pay limits for expansion joints shall be the horizontal distance from end to end along the centerline of the joint assembly at the locations shown in the contract and 12 inches (300 mm) upward at the gutter lines.

729.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|---------------------------------|
| Deck Joint Seal, Type _____ | Linear Foot (LF)
[Meter (m)] |
| 2. Payment is full compensation for all work described in this Section. | |

SECTION 730 -- STRIP SEALS

730.01 -- Description

1. The item, "Strip Seals", shall consist of furnishing and installing prefabricated steel extrusions supporting neoprene seal inserts, including integral curb units where specified, at the locations and limits shown in the contract. The seals shall be standard prefabricated products corresponding to the types and sizes shown in the contract.

2. Manufacturers producing such items are shown in the contract.

730.02 -- Material Requirements

1. Expansion and contraction movements shall be entirely taken by the neoprene.

2. Strip seals shall be complete with curb units, where specified in the contract, and shall be integral with the deck units or otherwise so designed and installed to thoroughly seal the joint against leakage.

3. Structural Steel:

a. Structural steel for extrusions shall conform to the minimum requirements of ASTM A 709/A 709M, Grade 36, Grade 50, or Grade 50W steel.

b. All exposed surfaces of the extrusions (except weathering grade steel surfaces) shall be painted with a primer in accordance with Section 709. The finish coat is not required.

c. As an alternate, steel extrusions may be galvanized in accordance with ASTM A 123.

4. The steel extrusions shall be made of one continuous piece unless approved by the engineer. If the steel extrusions are made of more than one piece, they shall be welded at the joints or otherwise adequately bonded together so as to obtain a tight seal.

5. The neoprene seal shall be made of one continuous length, and no splicing shall be allowed except where specifically called for in the contract.

6. The neoprene seal shall be manufactured from polychloroprene, meeting the physical property requirements in Table 730.01.

730.03 -- Construction Methods

1. The Contractor shall provide setting or installation plans for the Engineer's approval. The Contractor shall install the strip seals in accordance with the manufacturer's instructions and recommendations.

2. The Contractor shall install strip seals on a properly prepared surface.

3. The Contractor shall protect the installed seals against damage from equipment by placing wood planks along the seals or by other suitable methods.

730.04 -- Method of Measurement

1. The expansion joint system shall be measured for payment by the linear foot (meter) of joint properly installed and accepted by the Engineer.

2. Pay limits for expansion joints shall be the horizontal distance from end to end along the centerline of the joint assembly at the locations shown in the contract and 12 inches (300 mm) upward at the gutter lines.

Table 730.01

Polychoroprene Requirements		
Property	ASTM Test	Requirements
Tensile Strength	D 412	2,030 psi (14
Elongation at Break	D 412	MPa), min.
Hardness	D 2240 (modified)	250% min.
		60±5 points Durometer A 20% max.
Compression Set	D 395	
70 hours at 212°F	Method B	
Ozone Resistance	(modified)	No Cracks
Exposed to 300 pphm ozone for 70 hours at 104°F. Sample under 20% strain.	D 1149	
Oil Deterioration		45% Max.
Weight increase after immersion in ASTM oil #3 for 70 hours at 212°F	D 471	

730.05 -- Basis of Payment

- | | |
|--------------------|------------------------------|
| 1. Pay Item | Pay Unit |
| Strip Seals | Linear Foot (LF) [Meter (m)] |
2. Payment is full compensation for all work described in this Section.

SECTION 731 -- JACKING CULVERT PIPE, SEWER PIPE, AND CASING

731.01 -- Description

1. This work consists of jacking culvert pipe, sewer pipe, or pipe for casings and other uses through an embankment at the locations shown in the contract.

731.02 -- Material Requirements

1. Pipe shall meet the Division 1000 requirements for the type shown in the pay item.

731.03 -- Construction Methods

1. The Contractor shall jack the pipe into the locations shown in the contract.

2. The limits of open trench excavation will be shown in the contract.

3. The Contractor shall excavate ahead of the pipe when necessary to the minimum diameter that will allow jacking the pipe through the embankment. The bottom of the excavation shall be to the exact grade for the bottom of the pipe, and clearance of the top shall not be more than 1 ½ inches (38 mm).

731.04 -- Method of Measurement

1. Jacking of pipe or casing will be measured and paid for by the linear foot (meter) of each respective size and type of pipe or casing jacked.

731.05 -- Basis of Payment

1. **Pay Item**

Jacking _____ inch (mm) _____ Pipe

Jacking _____ inch (mm) _____ Pipe,
Class _____

Jacking _____ inch (mm) _____ Pipe,
Type _____

Pay Unit

Linear Foot (LF)
[Meter (m)]

Linear Foot (LF)
[Meter (m)]

Linear Foot (LF)
[Meter (m)]

2. The pipe or casing is paid for separately.

SECTION 732 -- LEAD-BASED PAINT REMOVAL

732.01 -- Description

1. This work consists of lead-based paint and the removal of lead-based painted structural steel members which may involve abrasive removal of paint (i.e. sandblasting, scraping), the cutting of the members, and the collection, site storage, and disposal of all paint debris waste generated during the process of removal or modification of the existing structure. This work shall be done in accordance with this Specification and the method statement as approved by the Engineer. The collected paint debris waste will be characterized as hazardous waste and is subject to hazardous waste regulations.

2. In performing this work, the Contractor shall protect the environment, persons, and adjacent property from damage in accordance with the Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) standards, and all applicable Federal, State, and local regulations.

3. The Department will take samples of paint from the existing structure and analyze for the presence of toxic metals. The results of the analysis will be shown in the contract if the existing paint contains, lead, chromium or other toxic metals.

4. Removal of paint containing hazardous metals at the levels indicated by this analysis could create worker exposure conditions above regulatory limits for health and safety requirements.

5. Any test results provided by the Department are for bidding purposes only. The Contractor is required to conduct its own monitoring at project startup, and adjust worker protection and work practices according to the results.

732.02 -- Material Requirements

1. All materials used or removal of hazardous materials must be in compliance with all applicable laws and regulations.

732.03 -- Construction Methods

1. The contractor shall submit a method statement detailing removal methods and methods for capturing and disposing of all collected waste material where paint is removed from the existing structural steel members. This method statement shall be prepared by a certified Industrial Hygienist (CIH) holding valid certification from the American Board of Industrial Hygiene or other Qualified Person (QP). The definition of a competent or qualified person is one who by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, and the project.

2. The qualified person must be capable of identifying existing and predictable hazards in the surroundings, working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

3. The qualified person shall have a thorough knowledge of all applicable OSHA, EPA, state and local regulations as they pertain to the protection of the environment and the safety and health of the workers. The

basis for this person's qualifications shall be included in the method statement. The Contractor shall provide certification that the person is qualified according to the definition. The method statement shall cover production methods, worker protection and environmental protection and shall be specific to the methods chosen. The method statement shall include references to at least one previous plan, prepared by the CIH or QP, for cutting of painted structural steel members, lead based paint removal, collection, site storage, and disposal of waste generated.

4. The Contractor shall provide certification indicating that the procedures, protection and work described in the method statement are in accordance and comply with the OSHA and EPA standards and applicable federal, state and local regulations.

5. The method statement and the certifications shall be submitted to the Engineer as the Contractor's work plan for these operations.

6. Disposal of Hazardous Waste

a. The Contractor shall dispose of materials generated and collected during the work at a hazardous waste facility.

b. The waste materials shall be transported to a hazardous waste facility in accordance with the following requirements.

(1) The Contractor shall make a written request to the Department to provide the EPA identification number required for transportation and disposal of the hazardous waste.

(2) The Contractor shall designate in writing to the Engineer a permitted Treatment, Storage, and Disposal Facility (TSDF). This designation submittal shall include a letter of tentative commitment from the TSDF to accept and dispose of the project's waste. Disposal shall be only to a permitted TSDF which has obtained and currently holds an EPA TSDF identification number.

(3) Prior to disposal of hazardous waste material, the Contractor shall begin the formal process of obtaining final disposal permits which may be required by the TSDF. The Contractor shall provide copies to the Engineer of all final documents pertaining to the disposal permit.

(4) The Contractor shall obtain a Uniform Waste Manifest from the EPA or appropriate agency before transporting hazardous waste to the selected TSDF.

c. When material is being transported or readied for transport, the Contractor shall be responsible for properly labeling and marking all hazardous waste containers in accordance with federal regulations 40 CFR 262 and 49 CFR 171-179. Wastes shall be shipped with a permitted transporter holding a current EPA transporter's identification number. It shall be the Contractor's responsibility to provide the required emergency response telephone number to the Engineer for the Uniform Hazardous Waste Manifest.

d. It shall be the Contractor's responsibility to ensure that no waste leaves the site without a properly prepared Uniform Hazardous Waste Manifest. The contractor shall provide the manifest to the Engineer, to sign prior to shipment, in accordance with 40 CFR 262. At the conclusion of each shipment, the contractor shall deliver to the engineer and appropriate

agencies copies of the required pages from the Uniform Hazardous Waste Manifests in accordance with the instructions included on the manifest.

e. The Contractor shall maintain a file of all waste shipped. The Contractor shall immediately notify the Engineer if a hazardous waste shipment does not reach the TSDF within 48 hours after departure from the job site. The Contractor shall coordinate with the Engineer to assure that the signed original of each Uniform Hazardous Waste Manifest is received from the TSDF by the Engineer within 35 days of the date the waste was accepted by the initial transporter. If the signed form is not received in 10 additional days (45 calendar days total), the Contractor shall immediately prepare and submit an Exception Report to the EPA Region VII Administrator. A copy of this report shall be provided to the Engineer.

732.04 -- Method of Measurement

1. No measurement required.

732.05 -- Basis of Payment

1. The work described in Section 732 shall not be measured and paid for directly, but shall be considered subsidiary to the items "Preparation of Bridge at Station _____," (see Subsection 704.05) and "Remove Structure at Station _____" (see Subsection 203.04). The transportation to and disposal at the selected TSDF shall be considered "Extra Work", and shall be paid for in accordance with Subsection 109.05.

SECTION 733 -- BRIDGE DECK AND APPROACH SLAB SMOOTHNESS

733.01 -- Description

1. This Specification applies when a new bridge deck is constructed and when an existing deck is replaced. It also applies to bridge ramps when the ramp is an additional paved surface bridging an obstruction. This Specification does not apply to overlays of existing bridge decks or to bridges built on gravel roads.

2. This Specification establishes a standard for bridge deck and approach slab smoothness. It is intended that the bridge deck placement operation and the approach slab placement operation produce a finished driving surface with a profile index no greater than 0.50 inch/100 feet (12 mm/30 m). The smoothness test will be conducted by Department personnel using a 12-foot (4 m) California type profilograph.

733.02 -- Equipment

1. The 12-foot (4 m) California type profilograph will record the pavement profile by measuring the vertical movement of a sensing wheel, attached to the frame at mid-point, with reference to the mean elevation of the support wheels at each end. The profilograph will produce a profilogram with a vertical scale of 1 inch (25 mm) equals 1 inch (25 mm) vertically and 1 inch (25 mm) equals 25 feet (7.6 m) longitudinally.

733.03 -- Test Procedure

1. The profilograph test will be run after completion of the bridge deck and the approach slabs. In the case of a bridge contract which does not include the approach slabs, but which will be let to contract at a future date, the profilograph test will be run on the bridge deck only.

2. In the case where the approach slabs are not part of the bridge contract but are part of another concurrent contract, the profilograph test will be run after the bridge deck and the approach slabs are completed. In this case, if the approach slabs and the bridge are constructed by separate Contractors, both Contractors will receive a profilogram.

3. If the paving or approach slabs are not part of the bridge contract or part of another concurrent contract, the profile of the first and last 6 feet (2 m) (longitudinally) of the surface being tested may not be able to be obtained with the profilograph. These areas will be measured for bumps with a 10 foot (3 m) straightedge according to Paragraph 9.b. of Subsection 603.03 of the Standard Specifications. Areas showing high spots in excess of 1/8 inch (3 mm) in the 10 foot (3 m) span shall ground to the required profile.

4. One profile will be obtained in each lane and shoulder approximately 3 feet from the outside lane line. The profiles will be divided into test sections each 100 feet (30 m) in length with any remaining short length also considered a test section. The profilogram will be labeled with the stationing, lane designation, position on the pavement, and the direction of travel. All station references used on the profilograms will be actual project stationing.

733.04 -- Evaluation

1. A profile index will be calculated for each section. Results will be furnished to the Contractor within 72 hours of the completion of the tests.

The index is calculated by summing the vertical deviations outside of a 0.2 inch (5 mm) blanking band. The units for this measurement are inches (mm) per 100 feet (30 m).

2. Bumps will be identified separately. These appear as high points on the profile trace and correspond to high points or bumps on the pavement surface. They are identified by locating vertical deviations exceeding 0.15 inch (3.8 mm) for a 12 foot (3.6 m) span as indicated on the profile trace.

3. When surface correction is required, this will be considered a preliminary profile index.

733.05 -- Surface Correction

1. All corrective work shall be done with the approval and in the presence of the Engineer.

2. Correction of the concrete surface will be done by diamond grinding. Grinding equipment shall be power driven, self-propelled units specifically designed to grind and texture concrete pavements. The cutting head shall be at least 36 inches (900 mm) wide and consist of diamond blades with spacers. The Engineer may approve smaller equipment.

3. Each profile will represent a surface width, extending from the centerline of the bridge to 3 feet (900 mm) in front of the curb or rail, and surface correction will be made over this entire width.

4. The grinding shall be performed so that the cement-aggregate bond will not be broken.

5. The maximum depth of grinding that will be permitted is ½ inch (12.5 mm).

6. Residue from grinding operations shall not be permitted to flow across shoulders or lanes occupied by public traffic or to flow into streams, gutters, or other drainage facilities. Solid residue resulting from grinding operations shall be removed from pavement surfaces before such residue is blown by action of traffic or wind.

7. After all required correction work is completed, another profile index will be run and recorded as the final profile index for the segment.

733.06 -- Acceptance

1. All bumps exceeding a vertical height of 0.15 inch (3.81 mm) in a 12 foot (3.65 m) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurement by the profilograph shows that the bumps are 0.15 inch (3.81 mm) or less in a 12-foot (3.65 m) span.

2. The Contractor, at his/her expense, shall correct the surface profile of all pavement which has a profile index greater than 0.50 inches (12.5 mm) per 100 feet (30 m) after bump removal. The surface profile of any such section shall be corrected to an index less than 0.50 inches/100 feet (12.5 mm/30 m).

3. If the profile index cannot be corrected by grinding, to less than 0.50 inches/100 feet (12.5 mm/30 m), those areas will be removed and replaced or overlaid with high density-low slump concrete.

4. All surface profile corrective work and remedial work will be at no additional cost to the Department.

5. Bump and smoothness correction work shall be for a width and length satisfactory to the Engineer.

SECTION 734 -- PRECOMPRESSED POLYURETHANE FOAM (PPF) JOINT

734.01 -- Description

1. This work shall consist of providing and installing a Preformed Expansion Joint in a preformed gap at the locations and limits shown in the contract.

2. The Preformed Expansion Joint shall be either a Precompressed Polyurethane Foam Joint or a Preformed Silicone Joint, as indicated in the contract.

a. When the item is "Precompressed Polyurethane Foam Joint, Type ____" the joint shall be a Precompressed Polyurethane Foam Joint of the type indicated in the contract.

b. When the item is "Preformed Silicone Joint, Type ____", the joint shall be a Preformed Silicone Joint of the type indicated in the contract.

c. When the item is "Preformed Expansion Joint, Type ____", the joint may be either a Precompressed Polyurethane Foam Joint or a Preformed Silicone Joint of the type indicated in the contract.

734.02 -- Material Requirements

1. Precompressed Polyurethane Foam Joints:

a. PPF Joint shall be precompressed self-expanding polyurethane foam with factory applied silicone facing on top of the foam.

b. PPF joints shall be ordered for the joint material dimension shown in the contract.

c. Approved PPF Joint systems are shown on the Department's Approved Products List under Precompressed Polyurethane Foam Joint, Type A or B.

2. The approved Preformed Silicone Joint systems are shown on the Department's Approved Products List under Preformed Silicone Joint, Type A or B.

3. Primers, epoxy adhesives, and silicone sealants shall comply with the manufacturer's recommendations.

4. Materials shall be resistant to ozone, ultraviolet rays, petroleum products, solvents, industrial cleaners, corrosive vapors and acids.

5. Joint material shall be delivered to the Contractor's storage area and to the job site in the Manufacturer's original undamaged containers with wrapping intact. Storage of joint material shall be in a dry, enclosed area, off the ground, between 60°F (16°C) and 75°F (24°C) and out of direct sunlight until immediately prior to installation.

734.03 -- Construction Methods

1. The installation of the Preformed Expansion Joint and the adhesives shall be completed according to the manufacturer's specifications. Additional field applied silicone is required on both sides of the top of the joint. Any installation that fails to meet the manufacturer's specifications shall be removed and replaced at no cost to the Department.

2. The installation instructions and specifications shall be given to the Engineer 7 days prior to the installation.

3. The Preformed Expansion Joint shall be installed in the presence of the Engineer.

4. The joint opening in the concrete shall be cleaned by sandblasting and shall be dry and free of oil and other deleterious materials before the installation of the Preformed Expansion Joint.

5. The installation of the Preformed Expansion Joint shall be completed between 45°F (7°C) and 90°F (32°C).

6. Any joint material damaged during corrective grinding shall be replaced at no cost to the Department.

734.04 -- Method of Measurement

1. The Preformed Expansion Joint shall be measured for payment by the linear foot (meter) of joint properly installed and accepted by the Engineer.

2. Pay limits for Preformed Expansion Joint shall be the horizontal distance from end to end along the centerline of the joint assembly at the locations shown in the contract and 1 foot (0.3 m) upward at the gutter lines.

734.05 -- Basis of Payment

1. Pay Item	Pay Unit
Preformed Expansion Joint, Type ____	Linear Foot (LF) [Meter (m)]
Precompressed Polyurethane Foam Joint, Type_____	Linear Foot (LF) [Meter (m)]
Preformed Silicone Joint, Type ____	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for furnishing and installing the Preformed Expansion Joint and for all labor, equipment, tools and incidentals necessary to complete the work.

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SECTION 801 -- PERMANENT SEEDING

801.01 -- Description

1. Permanent seeding consists of furnishing and placing the seed and fertilizer at locations shown in the contract.

801.02 -- Material Requirements

1. No seed shall be mixed until the Engineer provides the Contractor with a seed order list and acres to be seeded.

a. The Contractor shall obtain from the seed dealer, a laboratory analysis of each type and lot of seed proposed for use. The analysis shall be furnished to the Engineer.

b. The analysis shall contain complete information pertaining to the seed as required by State and Federal laws.

c. The Engineer will approve use of the seed if the information on the analysis is satisfactory.

2. The seed shall be mixed, bagged, and tagged at the seed company after the Engineer approves the analysis and gives the seed company written authorization to mix the seed for each project. Seed shall be bagged separately when specified in the contract.

a. The Engineer will furnish tags to be attached by the supplier to each bag of seed.

b. The Contractor is not allowed to attach the tags to the bags.

c. The seed shall be delivered to the project with tags attached to the bags. The seed shall not be used until the Engineer collects the tags from the bag immediately prior to use.

3. Fertilizer type and quantity shall be specified in the contract and shall comply with the applicable requirements of Section 804.

4. Mulch shall be as described in Section 806.

801.03 -- Construction Methods

1. Seeding methods, rates of application, and seed mixtures shall comply with the contract.

2. Type "B" seeding work shall be performed for a width of up to 16 feet (5 m) adjacent to the edge of the pavement or surfaced shoulder of the roadways and ramps and in the median areas. Type "A" seeding work shall be performed on all other areas within the limits of the project, except areas designated with specialty mixtures.

3. Areas not seeded with cover crop or that have been slope tracked shall be permanent seeded within seven days, or as directed by the Engineer.

4. Planting Season:

a. Seeding operations shall be performed only during the periods March 1 to June 15 and August 1 to December 1.

b. No seeding operations shall be performed when the ground is frozen, wet or otherwise untillable, or when even distribution of materials cannot be obtained.

5. Site Preparation:

a. The Contractor shall mow prior to permanent seeding. Mowing shall be no higher than 5 inches. The Contractor shall rake and remove the mowing residue before the preparation of the seed bed.

b. The Contractor shall prepare the seed bed not more than 5 days before sowing the seed by loosening the soil to a depth of not less than 3 inches (75 mm) with a disc, harrow, rake, or by other approved means. Several passes may be required, depending on soil conditions, to provide a satisfactory seedbed. Discing, harrowing, and raking shall be performed parallel to the land contour.

c. Hand work may be required around signs, delineators, guardrail, or other highway appurtenances as part of seed bed preparation and is considered subsidiary to the seeding operation.

d. The Engineer may direct that areas of desirable vegetation be preserved. Care shall be exercised to avoid injury to trees and shrubs that have been designated by the Engineer to be preserved.

6. The fertilizer shall be applied prior to seeding and incorporated into the soil in accordance with Section 804.

a. No fertilizer shall be applied within 50 feet of a wetland, lake or stream.

7. Seeding Equipment:

a. Seed drills, hydraulic seeders, gravity broadcast seeders, or aerial seeding may be used for planting seed. The contract may indicate the type of seeding equipment to be used on the project.

b. Seed Drills:

(1) Seed drills shall be equipped with press wheels or drag chains. The seed delivery system shall space rows no greater than 8 inches apart, shall include a seed box agitation system, and shall be capable of metering seed at the rate specified in the contract. Seed shall not be planted greater than 1/2 inch deep.

c. Hydraulic Seeders:

(1) Use hydraulic seeding equipment with a pump rated at no less than 100 gallons (350 L) per minute. The equipment shall have suitable working pressure and a nozzle adapted for hydraulic seeding.

(2) The supply and/or storage tanks shall have a means of mechanical agitation. The tanks shall be calibrated, and have a means of measuring the volume used or remaining in the tank.

(3) When using a hydraulic seeder, the fertilizer shall be applied separately from the seed.

d. Gravity Broadcast Seeders:

(1) In areas inaccessible to field machinery, implement mounted or handheld broadcast seeders may be permitted at the discretion of the Engineer.

(2) Gravity broadcast seeders shall provide agitation of the seed, have a functioning adjustable gate opening, and uniformly distribute seed on the seedbed.

(3) Implement mounted broadcast seeders shall be equipped with seed hopper baffle plates.

(4) Implement mounted broadcast seeders shall be equipped with a shielded front to prevent the spreading of material in front of the spreader.

e. Aerial Seeding:

(1) When aerial application of seed and fertilizer is specified, aerial equipment shall be capable of providing a uniform distribution of seed and fertilizer on the specified area.

801.04 -- Method of Measurement

1. The work of seeding will be surface measured by the acre (hectare). The area will be given to the Contractor either before the work begins or during construction. The total area given to the Contractor is the final measurement on which payment is based.

2. The surface measurement will not exclude areas of intersection or driveway surfacing. The Engineer may elect to exclude isolated areas of approximately 10,000 square feet (929 m²) or less upon which erosion control blankets or netting have been or will be placed.

3. Mulch shall be measured in accordance with Section 806.

801.05 -- Basis of Payment

- | | |
|---------------------|-------------------------|
| 1. Pay Item | Pay Unit |
| Seeding, Type _____ | Acre (A) [Hectare (ha)] |
2. Mowing, raking, and removing vegetation growth shall be subsidiary to the seeding item.
 3. Fertilizer and its placement are subsidiary to the seeding operation.
 4. Payment is full compensation for all work described in this Section.

SECTION 802 -- COVER CROP SEEDING

802.01 -- Description

1. Cover crop seeding consists of furnishing and applying the appropriate cover crop seed as shown in Table 802.01 and fertilizer as shown below.

2. Cover crop seeding shall be applied in phased construction areas, surcharge areas, other disturbed areas that have not been permanently seeded, or as directed by the Engineer.

802.02 -- Material Requirements

1. The cover crop seed shall comply with the following requirements and shall be applied at the rates shown in Table 802.01.

Table 802.01

Cover Crop Seed Requirements				
Cover Crop Seed and Limitations	Minimum Purity (%)	Minimum Germination (%)	Approved Broadcast Application Rate	Approved Mech. Drill Application Rate
Oats: Jan. 1 – Aug. 31	80	80	96 lbs/acre (107 Kg/ha)	96 lbs/acre (107 Kg/ha)
Foxtail Millet: May 2 – July 15	80	80	25 lbs/acre (27 Kg/ha)	25 lbs/acre (27 Kg/ha)
Winter Wheat: Sept. 1 - Dec. 31	80	80	120 lbs/acre (134 Kg/ha)	120 lbs/acre (134 Kg/ha)
Annual Ryegrass Urban Areas: Jan. 1 - Dec. 31	80	80	50 lbs./acre (55 Kg/ha)	50 lbs./acre (55 Kg/ha)

2. The seed for cover crop shall be delivered in bags and tagged with the purity and germination shown on the tag. Bulk seed may be used. Bulk seed shall have a current purity and germination test.

3. Fertilizer shall be required for cover crop seeding. Rate of application of commercial inorganic fertilizer shall be:

$$\frac{\text{Rate of Application}}{\text{Available Nitrogen (N}_2\text{)}} = 60 \text{ lbs/Acre}$$

802.03 -- Construction Methods

1. The work of cover crop seeding shall be started within 24 hours and completed within seven calendar days following the finish grading operation.

b. The Engineer may designate other areas that are to be cover crop seeded earlier than shown above.

2. Preparation:

a. The Contractor shall prepare the seed bed to a minimum of 1-1/2 inch (38 mm) of loose soil. This requirement is dependent upon soil type and may be altered at the direction of the Engineer so that a lesser thickness of loose earth may be acceptable.

3. Seeding:

a. The Contractor shall apply the seed at the rate shown in Table 802.01.

b. The cover crop seed shall be drilled.

(1) The cover crop seed may be broadcast and harrowed in areas inaccessible by drilling equipment.

(i) If the seed is broadcast, a light harrowing shall be required to incorporate the seed into the soil.

(ii) The harrow may be attached to the broadcast seeder.

c. If the cover crop fails to sprout, develop a root system and produce vigorous growth, reseeding shall be required and shall be performed at the contractor's expense.

d. The seeding equipment shall be calibrated in accordance with the manufacturer's recommended procedures.

5. Mulching:

a. When soil and weather conditions exist that it is anticipated that the cover crop seed will not germinate within 10 calendar days, the Engineer will direct that Temporary Mulch shall be applied in accordance with Section 806.

6. The fertilizer shall be applied prior to seeding and incorporated into the soil.

a. No fertilizer shall be used within 50 feet of a wetland, lake or stream.

802.04 -- Method of Measurement

1. Cover crop seeding is measured by the acre of ground surface seeded. The areas will be calculated from surface measurements of the length and width.

2. Mulching directed by the Engineer will be measured as Temporary Mulch in accordance with Section 806.

802.05 -- Basis of Payment

1. **Pay Item**

Pay Unit

Cover Crop Seeding

Acre (A) [Hectare (ha)]

2. The quantity shown in the contract includes the necessary additional cover crop seeding due to anticipated phased construction in the contract.

a. Certain areas may require cover crop seeding more than once, either because the Contractor disturbs the area as a consequence of contract phasing or as directed by the Engineer.

(1) If the re-seeding is a result of disturbance as directed by the Engineer or contract phasing, it will be paid for by the Department.

(2) If the cover crop is disturbed through the Contractor's action contrary to contract requirements, the Contractor shall re-seed the disturbed cover crop at no additional cost to the Department.

3. Mulching directed by the Engineer will be paid for as Temporary Mulch as described in Section 806.

4. Payment is full compensation for all work described in this Section.

SECTION 803 -- TEMPORARY SEEDING

803.01 -- Description

1. Temporary seeding consists of furnishing and applying the appropriate seed as shown in Table 803.01, fertilizer as shown below and hydromulch.

2. Temporary seeding can be used on embankments or cuts that are temporary in nature, stockpiles of soil, and other places that require soil stabilization. These areas may be shown in the contract or as directed by the Engineer.

803.02 -- Material Requirements

1. The seed shall comply with the following requirements and shall be applied at the rates shown in Table 803.01.

Table 803.01

Temporary Seed and Limitations	Minimum Purity (%)	Minimum Germination (%)	Approved Broadcast Application Rate
Oats: Jan. 1 - Aug. 31	80	80	96 lbs/acre (107 Kg/ha)
Foxtail Millet: May 2 - July 15	80	80	25 lbs/acre (27 Kg/ha)
Winter Wheat: Sept. 1 - Dec. 31	80	80	120 lbs/acre (134 Kg/ha)
Annual Ryegrass Urban Areas: Jan. 1 - Dec. 31	80	80	50 lbs./acre (55 Kg/ha)

2. The seed for temporary seeding shall be delivered in bags and tagged with the purity and germination shown on the tag. Bulk seed may be used. Bulk seed shall have a current purity and germination test.

3. Fertilizer shall be required for temporary seeding. Rate of application of commercial fertilizer shall be:

Available Nitrogen (N ₂)	<u>Rate of Application</u> 60 lbs/Acre
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4. The hydromulch shall be selected from the Department's Approved Products List categories Type HM2 or HM3.

803.03 -- Construction Methods

1. The work of temporary seeding shall be started within 24 hours and completed within seven calendar days following earth moving activities.

b. The Engineer may designate other areas that are to be temporary seeded earlier than shown above.

2. Preparation:

a. The Contractor shall prepare the seed bed to a minimum of 1-1/2 inch (38 mm) of loose soil. This requirement is dependent upon soil type and may be altered at the direction of the Engineer so that a lesser thickness of loose earth may be acceptable.

3. Application:

a. The Contractor shall apply the slurry of hydromulch in accordance with Subsection 807.03.

b. The seed shall be mixed in the hydromulch slurry.

c. The fertilizer shall be applied in accordance with Subsection 804.03.

d. If the temporary seed fails to sprout, develop a root system and produce vigorous growth, reseeding shall be required and shall be performed at the contractor's expense.

803.04 -- Method of Measurement

1. Temporary seeding is measured by the acre of ground surface seeded. The areas will be calculated from surface measurements of the length and width.

2. The mulch and fertilizer will not be measured for payment, but shall be considered subsidiary to the item Temporary Seeding.

803.05 -- Basis of Payment

1. **Pay Item**

Pay Unit

Temporary Seeding

Acre (A) [Hectare (ha)]

2. The quantity shown in the contract includes the necessary additional temporary seeding due to anticipated phased construction in the contract.

a. Certain areas may require temporary seeding more than once, either because the Contractor disturbs the area as a consequence of contract phasing or as directed by the Engineer.

(1) If the re-seeding is a result of disturbance as directed by the Engineer or contract phasing, it will be paid for by the Department.

(2) If the temporary seeding is disturbed through the Contractor's action contrary to contract requirements, the Contractor shall re-seed the disturbed area at no additional cost to the Department.

3. Payment is full compensation for all work described in this Section.

SECTION 804 -- FERTILIZING

804.01 -- Description

1. This work consists of furnishing and applying synthetic, organic or inorganic nutrients to the soil.

804.02 -- Material Requirements

1. Fertilizer bags shall have the fertilizer analysis attached and the DR Form 125 shall accompany bulk deliveries.

2. Fertilizer shall be a synthetic, organic or inorganic product containing nitrogen, phosphoric acid, and potash in a recognized plant nutrient form.

3. Fertilizer shall be furnished and delivered in standard weight bags or bulk. Each bag shall be clearly marked with the analysis of the contents. Each bulk fertilizer delivery shall have a completed DR Form 125, "Fertilizer Certification". The bag analysis or DR Form 125 shall be provided by the supplier and given to the Engineer.

804.03 -- Construction Methods

1. The Contractor shall apply the fertilizer uniformly with approved mechanical spreaders at the rates specified in the contract.

a. The fertilizer shall be applied prior to seeding and incorporated into the soil.

b. No fertilizer shall be used within 50 feet from a wetland, lakes or streams.

2. Separate application of individual components may be required to achieve the specified application rate. Field blending will not be allowed.

3. The fertilizer shall be incorporated into the soil to a depth of not more than 3 inches (75 mm) with a disc, harrow, rake, or by other approved means before seeding or sodding.

4. The fertilizer for cover crop seeding shall be incorporated into the soil to a depth of not more than 1 1/2 inches (38 mm) with a disc, harrow, rake, or by other approved means before cover crop seeding.

804.04 -- Method of Measurement and Basis of Payment

1. No measurement is required. This work will not be paid for directly but shall be considered as subsidiary to items that require fertilizer.

SECTION 805 -- SOIL AMENDMENT

805.01 -- Description

1. This work consists of furnishing and placing soil amendment on areas shown in the contract or as directed by the Engineer.

805.02 -- Material Requirements

1. Soil Amendment will be specified in the contract and selected from the Department's Approved Products List.

2. The soil amendment shall be delivered to the site in packaging that clearly identifies the manufacturer, type of soil amendment and weight per bag.

3. The Contractor shall provide the necessary water required for the operation of applying the soil amendment.

805.03 -- Construction Methods

1. The Contractor shall apply the soil amendment within 24 hours after planting the seed or as directed by the Engineer. The soil amendment shall be applied uniformly over prepared areas with a hydromulch machine or other equipment necessary to uniformly apply the product as described in Section 801.03.

2. Prior to the application of the Soil Amendment, drill one-half of the seed required per acre over an acre. The other one-half of the seed required per acre shall be incorporated into the soil amendment slurry and applied to the site.

3. Application Rates:

a. Soil Amendment shall be applied at 2 tons per acre.

b. The required tons of soil amendment will be determined by multiplying 2 tons per acre by the acres of application.

c. The Engineer may direct the Contractor, in writing, to adjust the application rate resulting in an increase or decrease of the required tons of soil amendment.

4. The Contractor shall refer to the manufacturer's recommendations for appropriate product to water ratios.

5. The soil amendment shall be applied in a manner that ensures complete and uniform coverage. The Contractor shall apply the soil amendment from opposing directions or as directed by the Engineer.

805.04 -- Method of Measurement

1. Soil Amendment is measured by the ton.

2. The weight of Soil Amendment applied will be computed on the basis of the weight per bag multiplied by the number of bags used.

805.05 -- Basis of Payment

1. Pay Item	Pay Unit
Soil Amendment	Ton

2. Final Quantity Determination:

a. If the computed tons of the soil amendment applied are within 5% (+/-) of the tons required as determined by the approved application rate, the final pay quantity will be the computed weight.

b. If the computed tons of the soil amendment applied are less than 95% of the tons required as determined by the approved application rate, the Contractor shall apply additional soil amendment at locations as directed by the Engineer. The final pay quantity will be the computed weight after the additional application has been applied and will not exceed 105% of the tons required as determined by the approved application rate.

c. If the computed quantity of the soil amendment applied exceeds 105% of the tons required as determined by the approved application rate, the final pay quantity will not exceed 105% of the tons required as determined by the approved application rate.

d. If upon visual inspection, the Engineer determines that the soil amendment application is "light" in some areas, even though the required tons as determined by the approved application rate was applied to the overall area of application, the Contractor shall apply additional soil amendment as directed by the Engineer. The final pay quantity will be the computed weight after the additional application has been applied and will not exceed 105% of the tons required as determined by the approved application rate. The quantity of soil amendment applied that is in excess of 105% of the tons required as determined by the approved application rate shall be at no additional cost to the Department.

3. Direct payment for water incorporated into the soil amendment will not be made. Water is subsidiary to the item of soil amendment.

4. Payment is full compensation for all work described in this Section.

SECTION 806 -- MULCHING

806.01 -- Description

1. This work consists of providing, placing, and securing mulch on areas shown in the contract or identified by the Engineer as being seeded in accordance with Section 801.

806.02 -- Material Requirements

1. Mulch shall be either dry cured native prairie hay, native grass hay from seed growing operations, native grass hay from planted warm season grass stands, or straw. Brome hay, rushes, cattails, Reed Canary Grass, wide-bladed grass or invasive species are not allowed.

2. Hay or straw in a stage of decomposition so advanced as to "powder" in the mulch blower will be rejected.

3. The Contractor shall notify the Engineer as to where he/she proposes to obtain the hay.

4. Straw shall be from threshed oats, wheat, or rye. Rye straw shall not be used in any wheat growing area. The straw shall be baled before the seasonal growth of annual weeds.

5. Certification and Scale Tickets:

a. The mulch shall be certified as "Noxious Weed Free" by the "County Weed Control Authority" or other authorized agents.

b. Scale Tickets:

(1) All mulch deliveries shall have scale tickets from a certified scale.

(2) The Contractor shall give the Engineer a scale ticket for each load of mulch delivered to the site before the mulch is unloaded for use on the project. The scale tickets shall indicate the weight and be dated and signed by the scale operator.

(3) The Engineer may, at any time, order the Contractor to reweigh the mulch as a check of the scale ticket.

c. The copy of the "Noxious Weed Free" certification and the scale ticket shall accompany each load of mulch.

(1) Upon delivery to the site, a copy of the certification shall be placed in a weather-proof container and attached to the load of mulch it represents.

(2) Prior to incorporation of the mulch, the Engineer will collect the copy of the certification from the load.

806.03 -- Construction Methods

1. The Contractor shall apply the mulch within 24 hours after planting the seed, unless otherwise directed by the Engineer. The mulch shall be applied uniformly over tilled areas with a mulch blowing machine.

2. Application Rates:

a. Hay mulch shall be applied at the rate of 2 tons/acre (4.5 Mg/ha) when used in conjunction with the permanent seed mixture.

b. Straw mulch shall be applied at 2.25 tons/acre (5 Mg/ha) when used in conjunction with the permanent seed mixture.

c. Mulch may be applied as a temporary cover, either alone or in conjunction with cover crop or a temporary seed mixture and shall be applied at a rate of 1.0 tons/acre (3.35 Mg/ha).

3. The mulch shall be applied loose enough to allow some sunlight to penetrate and air to slowly circulate, but thick enough to partially shade the ground, reduce water evaporation, and reduce wind and water erosion.

4. Securing:

a. Immediately after applying the mulch, the Contractor shall secure it to the soil using a mulch crimper with approximately 6 inch (150 mm) cleats or other approved equipment with perpendicular, dull, disc blades.

b. All mulch shall be crimped the same day it is applied.

c. The crimper shall be narrow enough or hinged to uniformly crimp the mulch into narrow and uneven areas. More than one crimping may be necessary if directed by the Engineer.

d. Proper installation will result in the mulch being a uniform cover with fibers being securely lodged within the soil.

806.04 -- Method of Measurement

1. The weight of the mulch is measured in tons (Megagrams).

2. The weight of the mulch required is calculated by multiplying the measured area times the specified application rate. The Engineer may direct in writing an application rate greater than the contract application rate.

3. Quantity Determination

a. When the total weight from the scale tickets is within 5% of the calculated weight, then the pay quantity will be the calculated weight.

b. When the Engineer directs in writing the application of a weight greater than the calculated weight, then the Department will pay for the revised calculated weight of mulch.

c. When the weight tickets show that the weight applied is less than 95% of the calculated weight, then the Department pay quantity will be the weight determined by adding the quantities on the scale tickets.

d. If the Contractor applies more mulch than directed by the Engineer, then the weight over 100% of the specified weight or the amount directed by the Engineer is provided at no additional cost to the Department.

806.05 -- Basis of Payment

1. **Pay Item**

Pay Unit

Mulch

Ton (Tn) [Megagram (Mg)]

Temporary Mulch

Ton (Tn) [Megagram (Mg)]

2. Payment is full compensation for all work described in this Section.

SECTION 807 -- HYDROMULCHING

807.01 -- Description

1. This work consists of furnishing and placing hydromulch on areas shown in the contract or as directed by the Engineer.

807.02 -- Material Requirements

1. Hydromulches will be specified in the contract and selected from the Department's Approved Products List.

a. Type HM1 is a hydromulch that may be applied dry or hydraulically. Upon wetting, the tacking agents are released to reduce sediment loss. The product is typically used in confined areas.

b. Type HM2 is hydraulically applied, wood mulch with tackifier, typically used on slopes 3.5:1 or flatter and urban areas.

c. Type HM3 is a hydraulically applied matrix containing organic fibers and tackifiers to provide erosion control and facilitate vegetation establishment on 2.5:1 slopes or flatter. The products are designed to be functional for a minimum of 6 months.

d. Type HM4 is a hydraulically applied, high performance matrix containing wood and other biodegradable or synthetic fibers, polymers and water absorbents that requires no curing period. The product promotes vegetation establishment and may be applied to slopes 1.5:1 or flatter.

2. The hydromulch shall be delivered to the site in packaging that clearly identifies the manufacturer, product name and weight per bag.

3. The Contractor shall provide the necessary water required for the hydromulching operation.

807.03 -- Construction Methods

1. The Contractor shall apply the hydromulch within 24 hours after planting the seed or as directed by the Engineer. The hydromulch shall be applied uniformly over tilled areas with a hydromulch machine.

2. Application Rates:

a. Hydromulch shall be applied at 1.5 tons per acre or as specified in the contract.

b. The required tons of hydromulch shall be determined by multiplying the amount applied per acre by the acres of application.

c. The Engineer may direct the Contractor, in writing, to adjust the application rate resulting in an increase or decrease the required tons of hydromulch.

3. The Contractor shall refer to the manufacturer's recommendations for appropriate matrix to water ratios.

4. To ensure complete and uniform coverage, the Contractor shall apply the hydromulch from opposing directions to prevent shadowing or as directed by the Engineer.

807.04 -- Method of Measurement

1. Hydromulch is measured by the ton.

2. The weight of hydromulch applied will be computed on the basis of the weight per bag multiplied by the number of bags used.

807.05 -- Basis of Payment

1. Pay Item	Pay Unit
Hydromulch "Type _____"	Ton

2. Final Quantity Determination:

a. If the computed tons of the hydromulch applied are within 5% (+/-) of the tons required as determined by the approved application rate, the final pay quantity will be the computed weight.

b. If the computed tons of the hydromulch applied are less than 95% of the tons required as determined by the approved application rate, the Contractor shall apply additional hydromulch at locations as directed by the Engineer. The final pay quantity will be the computed weight after the additional application has been applied and will not exceed 105% of the tons required as determined by the approved application rate.

c. If the computed quantity of the hydromulch applied exceeds 105% of the tons required as determined by the approved application rate, the final pay quantity will not exceed 105% of the tons required as determined by the approved application rate.

d. If upon visual inspection, the Engineer determines that the hydromulch application is "light" in some areas, even though the required tons as determined by the approved application rate was applied to the overall area of application, the Contractor shall apply additional hydromulch as directed by the Engineer. The final pay quantity will be the computed weight after the additional application has been applied and will not exceed 105% of the tons required as determined by the approved application rate. The quantity of hydromulch applied that is in excess of 105% of the tons required as determined by the approved application rate shall be at no additional cost to the Department.

3. Direct payment for water incorporated into the hydromulch will not be made. Water is subsidiary to the item.

4. Payment is full compensation for all work described in this Section.

SECTION 808 -- SLOPE PROTECTION

808.01 -- Description

1. This work shall consist of placing seed and a protective covering of mulch upon the completed shoulders, sideslopes, ditch bottoms, or backslopes as shown in the contract or as directed by the Engineer.

808.02 -- Material Requirements

1. The mulch being used for slope protection shall be as described in 806.02, except that straw will not be allowed.

2. The Material Requirements for Slope Protection seeding shall be as described in Subsection 801.02.

808.03 -- Construction Methods

1. The Contractor shall commence slope protection work within five calendar days after the finish grading operations have started.

2. The work on the project may be temporarily suspended for failure to initiate the finish grading and/or slope protection operation.

3. Seeding:

a. The initial seeding shall be drilled at the rate specified in the contract.

b. The remainder of the seed shall be broadcast over the mulch.

c. All seed may be broadcast if conditions preclude drilling, such as steep slopes or unsafe conditions.

4. Mulching:

a. The Contractor shall place mulch for the slope protection uniformly at 2 lbs/Sq Yd (1.1 Kg/m²).

b. Mulch may be applied either by hand or mechanically.

c. A machine that chops a bale apart shall not be used.

d. The Contractor shall place piles of soil on the mulch to hold it in place. The soil piles shall be placed at intervals of not more than 40 inches (1 m) in any direction over the surface of the area mulched. The piles of soil shall be of sufficient size to hold the mulch in place. The sources from which the Contractor obtains the soil shall be approved by the Engineer and shall be left in a condition which is satisfactory to the Engineer.

e. In lieu of securing the mulch with piles of soil, the Contractor may use a mechanical device to anchor the mulch. The mechanical device shall either be a drum roller with cleats or a crawler tractor with cleated tracks.

(1) The cleats on both the roller and the crawler tractor shall punch the mulch approximately 6 inches (150 mm) into the soil.

(2) Either device shall have sufficient cleats to anchor all of the mulch.

(3) Shoulders shall average ten cleat punches per square yard (12 cleat punches per m²).

(4) Areas other than shoulders shall average four cleat punches per square yard (five cleat punches per m²).

(5) More than one pass may be required to obtain the necessary rate of cleat punches to secure the mulch.

(6) The equipment shall not be operated perpendicular to any slope if such action will promote soil erosion.

5. Mulching Steep Areas:

a. Areas that are too steep for machine methods shall be performed by hand methods.

b. Steep areas are defined as slopes on which the mechanical devices being utilized would significantly disturb the finish grade.

808.04 -- Method of Measurement

1. The slope protection quantity measured is the number of square yards (square meters) of surface area seeded, mulched and anchored.

2. The measured area of the slope protection will be provided to the Contractor. The total area given to the Contractor is the final measurement.

3. Slope protection mulch is measured as described in Subsection 806.04.

808.05 -- Basis of Payment

1. Pay Item	Pay Unit
Slope Protection	Square Yard (SY) [Square Meter (m ²)]
Slope Protection Mulch	Ton (Tn) [Megagram (Mg)]
2. Payment is full compensation for all work described in this Section.	

SECTION 809 -- SODDING

809.01 -- Description

1. This work consists of furnishing, fertilizing, watering, and placing bluegrass sod in accordance with the contract.

809.02 -- Material Requirements

1. The sod shall be grown at a sod farm, licensed by the Department of Agriculture. A certification of origin shall accompany each load delivered to the project site.

2. The sod shall have been grown from more than one variety of bluegrass seed, grown specifically for the production of bluegrass sod, and maintained by accepted sod production methods.

3. Cutting:

a. Prior to harvesting, the sod shall be mowed uniformly at a height of 1 to 2.5 inches (25 to 60 mm).

b. The sod shall be machine cut at a uniform soil thickness of 0.60 inch (15 mm), plus or minus 0.25 inch (6 mm), at the time of cutting. Measurement for thickness shall exclude top growth and thatch.

c. All sod shall be free from all weeds.

d. Individual pieces of sod shall be cut to the supplier's standard width and length. Broken pads and those with torn or uneven ends will not be accepted.

e. The sod shall not have dry or dead edges.

4. Fertilizer:

a. The composition and rate of application of fertilizer shall be a minimum of 8 lbs of available Nitrogen (N₂) and 23 lbs of available Phosphoric Acid (P₂O₅) per 1000 square yards.

5. The acceptable pre-emergent weed control chemicals and their rate of application shall be as shown in the table below.

Acceptable Pre-emergent herbicides shall be:		
Chemical Name	Trade Names	Rate of Application
Pendimethalin	Pendulum	Midrange of manufacturer's suggested range
Proflam	Barricade	Midrange of manufacturer's suggested range
Dithiopyr	Dimension	Midrange of manufacturer's suggested range
Siduron	Tupersan	Midrange of manufacturer's suggested range
Other	Any other approved and equal weed control chemicals may be used.	

809.03 -- Construction Methods

1. The area to be sodded will be shown in the contract or as directed by the Engineer.

2. Sodding operations shall not be performed between June 1 and September 1, when the ground is frozen, or when weather conditions are not favorable for placement and growth as determined by the Engineer.

3. The sod shall be harvested, delivered, and installed within a period of 24 hours, unless a suitable preservation method is approved by the Engineer.

4. Subject to the dates established in this Section, the Contractor shall place the sod immediately after the finish grading work has been completed and approved by the Engineer for a section of the project.

5. Site preparation:

a. The Contractor shall clear all areas to be sodded of debris and dead vegetation before the sod bed is prepared.

b. The soil shall not be crusted.

c. All eroded areas shall be filled and loose earth firmed before laying the sod.

d. The area to be sodded shall be graded smooth and free of debris, including roots, stones and clods larger than 1 inch (25 mm) in their largest dimension.

e. Topsoil, when specified, shall be spread and tilled into the soil by discing or other methods to the depth shown in the contract.

6. The sod bed shall be approved by the Engineer before laying the sod.

7. The sod shall be laid over the area with strips edge to edge in a compact mass. The sod shall be laid approximately 1 inch (25 mm) below adjoining ground surfaces and flush with the adjoining sod.

8. All sod placed on slopes steeper than 1 vertical to 3 horizontal and in ditch bottoms shall be adequately staked by the Contractor to prevent slippage. The stakes shall be wood-lathe and shall be at least 8 inches (200 mm) in length. Stakes shall be driven flush with the sod line and with the broad face of the stake facing the slope. Other types of stakes may be used with the approval of the Engineer.

9. Fertilizer and Herbicide:

a. The Contractor shall apply fertilizer and/or a pre-emergent herbicide over the top of the sod immediately after laying the sod and before watering.

b. The pre-emergent is not required on sod laid after September 1.

c. All excess herbicide or fertilizer, which falls onto adjacent streets, sidewalks, parking or other pavements, shall be swept and/or removed to prevent it from being washed into adjacent drainages.

10. The Contractor shall thoroughly water all sod immediately after placing fertilizer and/or pre-emergent herbicide. Watering may also be required during the work operations to cool the sod.

11. Establishment Period:

a. The Establishment Period will begin upon installation of all sod in a section designated on the contract or agreed upon by the Engineer.

(1) The Establishment Period will be 30 days.

(2) Sod laid after November 15 will be inspected between April 1 and April 15 of the following year.

(3) All sod shall be growing at the time of acceptance.

b. The Contractor shall keep all sodded areas thoroughly watered for 30 calendar days after laying. Watering may be necessary multiple times within a day to ensure sod survivability.

c. If, at the end of the establishment period, the growth or stand of the sod is deemed unacceptable by the Engineer, the sod shall be rejected. The Engineer will determine whether the rejected sod is to be replaced or reseeded.

d. Rejected Sod:

(1) Rejected sod shall be replaced or overseeded with a mixture of rye and bluegrasses or other suitable mixtures as determined by the Engineer.

(2) The Contractor shall water replacement or overseeded sod for 30 calendar days.

12. The Contractor shall apply the post-sodding fertilizer on accepted sod at the end of the establishment period.

13. In the event the replaced or overseeded rejected sod fails, the Engineer may direct the Contractor to remove and replace the sod in the affected areas.

809.04 -- Method of Measurement

1. The sod shall be measured for payment by the number of square yards (square meters) of surface area of sod furnished and placed.

809.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

Sodding Square Yards (SY) [Square Meter (m²)]

2. Watering required by the Engineer except as noted above will be Extra Work.

3. Furnishing and placing of fertilizer, pre-emergent herbicide, and water, are subsidiary to the sodding operation.

4. There will be no extra compensation for replacement sod, overseeding, or watering the areas where the sod was rejected.

5. Removal and replacement of sod, as directed by the Engineer, after the failure of the original installation and replacement or reseeded of rejected sod, will be paid for at the contract unit price.

6. Payment is full compensation for all work described in this Section.

SECTION 810 -- EROSION CONTROL

810.01 -- Description

1. This work consists of the preparation of slopes and waterways and the furnishing and application of soil retention blankets at the locations shown in the contract or the temporary erosion control plan, or as directed by the Engineer. Seed and fertilizer are not required with Erosion Control "Class 1A" (Slope Protection Netting).

810.02 -- Material Requirements

1. The soil retention blanket shall be of the type specified in the contract and shall be on the Department's Approved Products List.

2. Soil retention blankets used in a temporary capacity shall be any product designated on the Department's Approved Products list as Erosion Control "Class 1".

3. Wire staples used for anchoring the soil retention blanket shall be from products designated on the Department's Approved Products List.

4. The seed shall comply with and be applied in accordance with the applicable portion of Section 801. The seed mixture shall be of the types and applied at the rate shown in the contract.

5. The fertilizer shall comply with the applicable portion of Section 804.

810.03 -- Construction Methods

1. This work shall be performed as soon as practicable after finish grading operations have been completed or as directed by the Engineer.

2. No restrictive seeding time periods will apply to this work.

3. Site Preparation:

a. The Contractor shall fill, tamp and shape earth to the finish grade as needed to repair erosion to the grades and conditions shown in the contract.

b. If additional fill dirt is required, it must be provided and placed at no additional cost to the Department.

c. The Contractor shall perform all work in the areas to be protected so that the land surface is graded smooth and free of all debris, including roots and stones larger than 1 inch (25 mm) in their largest dimension.

d. Vegetation shall be removed from these areas except for the desirable native vegetation that has been designated by the Engineer to remain undisturbed.

e. The soil in the areas to be protected by the soil retention blanket shall be loosened to a depth of not less than 1 inch (25 mm) by discing, harrowing, raking, or other approved methods.

f. The site shall be drill seeded and fertilized prior to the installation of the soil retention blanket. In the event that it is impractical to install seed or fertilizer by mechanical means due to safety concerns, size or accessibility of the location, the seed and/or fertilizer may be installed by manually broadcasting and lightly incorporating the seed into the soil in a uniform manner.

5. Covercrop Seed may be used in conjunction with soil retention blankets used in a temporary capacity. Seeding rates shall be as shown in Section 802 of the Standard Specifications.

6. The fertilizer shall be applied prior to seeding and incorporated into the soil in accordance with Section 804.

a. The fertilizer shall be of the types and applied at the rate shown in the special provisions.

b. Fertilizer is not required for soil retention blankets being used in a temporary capacity.

c. No fertilizer shall be used with 50 feet from a wetland, lakes or streams.

7. The Contractor shall obtain the Engineer's approval of all soil preparation work, fertilizer, and seed prior to the installation of the soil retention blanket.

8. Placement:

a. Upon obtaining the Engineer's approval of the soil preparation, the Contractor shall place the soil retention blankets immediately following fertilizing and seeding operations.

b. The blanket shall be laid out flat, parallel to the surface runoff flow direction, and secured as shown in the contract for each specific type of erosion control. Wire staples shall be used for anchoring the soil retention blanket.

c. The Contractor shall place Erosion Control "Class 1A" (Slope Protection Netting) immediately after the mulch or slope protection has been applied and anchored as per the specification for the mulching or slope protection operations.

d. The Erosion Control "Class 1A" (Slope Protection Netting) shall be installed as shown in the Standard Plans for Erosion Control.

e. Care shall be exercised in placing the blanket so as not to disturb previously seeded areas.

9. Erosion Control "Class 2C"

a. The area designated to be covered with Erosion Control "Class 2C" shall be shaped and graded as per the contract.

b. Place the Erosion Control "Class 2C" soil retention blanket over the area and trench edges into the soil as specified in the contract.

c. When placement is at a culvert location, cut a hole in the blanket for the culvert opening.

d. Seed and fertilize the area and soil fill with approximately 1/2 inch (12 mm) of soil, raking it into the material.

e. When items a. through d. above are completed to the satisfaction of the Engineer, the area shall be overlain with a soil retention blanket from the Department's Approved Products List under the item, Erosion Control "Class 1F". The Erosion Control "Class 1F" shall be pinned in place.

f. The installation of Erosion Control “Class 1F” as a component of the Class 2C System is considered subsidiary to the Erosion Control “Class 2C”.

810.04 -- Method of Measurement

1. Erosion control areas are measured by the square yard (square meter).
2. The areas are computed by multiplying the length times the nominal width at each location shown in the contract.

810.05 -- Basis of Payment

- | | |
|-----------------------------------|--|
| 1. Pay Item | Pay Unit |
| Erosion Control, Class_____ | Square Yard (SY)
[Square Meter (m ²)] |
| Temporary Erosion Control Blanket | Square Yard (SY)
[Square Meter (m ²)] |
2. Payment is full compensation for all work described in this Section.

SECTION 811 -- TRANSITION MAT

811.01 -- Description

1. This work consists of the furnishing and installation of transition mats as shown in the contract or as directed by the Engineer. A transition mat is a semi-rigid plastic, rubber mat or concrete blocks imbedded into a high strength geogrid that protects the soil from scour and erosion. It is placed in ditches or at the culvert outlets and is generally used in conjunction with a soil retention blanket.

811.02 -- Material Requirements

1. The Transition Mat shall be listed on the Department's Approved Products List.

2. Erosion Control Class 2A is required under all installations.

811.03 -- Construction Methods

1. This work shall be performed as soon as possible after the finish grading operations have been completed.

2. The Contractor shall install the soil retention blanket as detailed in Section 810.

3. The transition mat shall be placed as per the manufacturers recommended installation instructions at the locations as shown in the contract.

811.04 -- Method of Measurement

1. The quantity of transition mat for which payment will be made will be the number of square yards placed.

2. Sod placed will be paid for according to Section 809 – Sodding.

3. Soil retention blankets placed will be paid for according to Section 810 -- Erosion Control.

811.05 -- Basis of Payment

1. Pay Item	Pay Unit
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Transition Mat	Square Yard
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2. All anchoring devices shall be subsidiary to the item "Transition Mat".

3. Payment is full compensation for all work described in this Section.

SECTION 812 -- SILT CHECKS

812.01 -- Description

1. This work consists of furnishing and placing silt check devices at the locations shown in the contract or as directed by the Engineer.
2. There are two separate and distinct types of silt checks.
 - a. Silt Checks are placed as shown in the contract or as directed by the Engineer after final grading is complete in conjunction with the final stabilization.
 - b. Temporary Silt Checks are placed as shown in the Temporary Erosion Control plans or as directed by the Engineer throughout the construction process.

812.02 -- Material Requirements

1. Approved silt check devices are listed in and shall be selected from the Department's Approved Products List.
 - a. Silt Checks used for final stabilization shall be the type shown in the contract and selected from the Department's Approved Products List.
 - b. Temporary Silt Checks may be any product listed on the Department's Approved Products List. The following chart shall be used to determine the appropriate application of Temporary Silt Checks during construction.

Type	Material	Ditch Grade	Uses/Locations
1 – Low	9" Diameter Straw Wattle	< 2%	Medians, Slopes and Urban Ditches
1 – High	12" Diameter Straw Wattle	< 2%	Wetlands, Stream Banks, Slopes and Rural Ditches
2 – Low	9" Diameter Wood Fiber Wattle	All	Medians and Urban/Rural Ditches
2 - High	12" Diameter Wood Fiber Wattle	All	Wetlands, Stream Banks, and Rural Ditches
3 – Low	9" Diameter Coir Wattle	All	Slopes, and Rural Ditches
3 – High	12" Diameter Coir Wattle	All	Wetlands, Stream Banks, Slopes and Rural Ditches
4	Synthetic	All	Urban Ditches

2. All silt check devices have unique staking or pinning requirements based upon the Best Management Practices (BMPs) and its use. The hold down stakes and pins shall be as shown on the Silt Check All Types Special Plan.

812.03 -- Construction Methods

1. The silt checks shall be placed and secured as shown in the contract or as directed by the Engineer.
2. The limits of the completed silt check shall extend up the foreslope and backslope of the ditch to effectively contain the run-off and prevent

erosion and washout at the edges of the installation as shown on the Silt Check All Types Special Plan.

3. Temporary Silt Checks

a. The "Temporary Silt Checks" shall be installed at the locations shown in the contract, Temporary Erosion Control Plan or as directed by the Engineer.

b. The "Temporary Silt Checks" shall be installed immediately after the rough grading is completed in an area.

c. Temporary Silt Checks used as perimeter control shall be installed prior to grading operations.

d. The "Temporary Silt Check" shall be left in place until the finish grading begins. Reinstall the "Temporary Silt Checks" as soon as finish grading is done unless the permanent erosion control is initiated immediately after finish grading. "Temporary Silt Checks" shall be in place at all times after finish grading until permanent "Silt Check," are in place.

e. The Temporary Silt Check shall be removed and remain the property of the Contractor when it is no longer functional or needed.

812.04 -- Method of Measurement

1. All work involved in constructing silt checks as described above will be included and paid for per linear feet of devices used in the erosion checks.

2. "Temporary Silt Checks" will be measured by the linear foot (meter) for the initial installation. The removing or replacing of the temporary silt checks will not be measured for payment, but will be considered subsidiary to the initial installation.

3. Removal of sediment will be measured based on equipment rental. All incidentals associated with the cleanout will be subsidiary to the equipment rental items.

812.05 -- Basis of Payment

1. Pay Item	Pay Unit
Silt Check, Type _____	Linear Foot
Temporary Silt Check	Linear Foot
Rental of Skid Loader, Fully Operated	Hour
Rental of Loader, Fully Operated	Hour
Rental of Crawler Mounted Hydraulic Excavator, Fully Operated	Hour
Rental of Dump Truck, Fully Operated	Hour
Rental of Backhoe, Fully Operated	Hour
 2. Payment is full compensation for all work described in this Section.	

SECTION 813 -- MULCH PERIMETER CONTROL

813.01 -- Description

1. This work consists of grinding and placing slash mulch at locations as shown in the contract or as directed by the Engineer.

813.02 -- Material Requirements

1. All tree and shrub debris, generated during the clearing and grubbing operations, shall be ground by a mechanical chipper, hammermill, tub grinder, or other approved method.

2. Maximum length of individual pieces shall not exceed 20 inches. Maximum width shall not exceed 2 inches. Material shall be accepted based upon a visual inspection.

3. The Contractor shall be responsible for all labor, materials, equipment and services as may be necessary for the generation of the slash mulch.

813.03 -- Construction Methods

1. Slash mulch berms shall be constructed prior to grading activities occurring in the locations noted in the contract or as directed by the Engineer.

2. Mulch may be placed where mulch perimeter control or low porosity silt fence is indicated in the contract. The maximum height of the berm shall not exceed 36 inches.

3. Mulch may be placed where silt checks are indicated in the contract. The maximum height of the berm shall not exceed 24 inches.

4. In the event that the quantity of mulch generated exceeds the amount necessary to construct the berms shown in the contract, additional berms shall be constructed as an alternative to low porosity silt fence or erosion checks at locations approved by the Engineer.

5. In the event that the quantity of mulch generated under runs plan quantity, the Contractor shall place what is produced at locations approved by the Engineer. No off project mulch will be required to be furnished by the Contractor.

6. Upon completion of the project, all slash mulch berms shall be left in place or spread out around the area of their original placement.

813.04 -- Method of Measurement

1. Slash Mulch-Grinding will be measured by the amount produced after grinding in cubic yards.

2. Slash Mulch-Placement will be measured by the amount placed in cubic yards.

813.05 -- Basis of Payment

1. Pay Item	Pay Unit
Slash Mulch-Grinding	Cubic Yard (CY)
Slash Mulch-Placement	Cubic Yard (CY)

2. Stockpiling and rehandling of material is subsidiary to the Slash Mulch-Grinding item.

3. All labor, materials, equipment and services as may be necessary for the generation of the slash mulch are subsidiary to the slash mulch items.
4. Maintenance of the Slash Mulch berms will be paid with equipment rental.
5. Payment is full compensation for all work described in this Section.

SECTION 814 -- EARTH AND ROCK CHECKS

814.01 -- Description

1. This work consists of constructing earth and rock checks at the locations shown in the contract, Temporary Erosion Control Plans or as directed by the Engineer.

814.02 -- Material Requirements

1. Earth or rock may be used for the checks.

814.03 -- Construction Methods

1. The Contractor shall construct the checks with material located on the project or from locations as approved by the Engineer. The check shall be compacted with the equipment used to build it.

2. Locations

a. Checks shall be built to the dimensions as shown in the contract, or as directed by the Engineer. The limits of the completed checks shall extend up the foreslope and backslope of the ditch to effectively contain the run-off and prevent erosion and washout at the edges of the installation.

b. Checks used as a perimeter control shall be installed as needed to contain runoff, but shall not extend more than 6 feet beyond the Limits of Construction as shown in the contract unless otherwise directed by the Engineer.

3. Earth and Rock Checks

a. The checks shall be installed immediately after the rough grading or other soil disturbance activities are completed on a portion of the project.

b. The checks shall be left in place until the finish grading begins. Reinstall the checks as soon as finish grading is completed unless the permanent erosion control is initiated immediately after finish grading.

c. Checks used adjacent to wetlands, waterways and "Sensitive Areas" shall include a secondary BMP to prevent discharge of the check material.

4. The Contractor shall remove and dispose of sediment that accumulates behind the checks during construction and at completion of the project.

a. Sediment removal shall be initiated when sediment depth has reached one-half the height of the checks or as directed by the Engineer in conjunction with checks repairs.

b. Each time sediment is removed, the checks shall be repaired to a good working condition. Good working condition includes: repair of washouts, compaction of materials, and any associated handwork.

5. When the checks are determined to be no longer functional or needed, they shall be removed.

a. The earth shall be removed and may be incorporated with the finish grading, as determined by the Engineer.

b. The rock shall be removed and taken to other places on the project where rock is required, incorporated into the project at designated locations, or salvaged as directed by the Engineer.

814.04 -- Method of Measurement

- 1. All work involved in constructing checks as described above will be included and paid for per linear feet of devices used in the checks.
- 2. Earth and Rock Checks shall be measured by the linear foot (meter) for the initial installation.
- 3. Removal of sediment and repair of checks will be measured based on equipment rental.

814.05 -- Basis of Payment

1. Pay Item	Pay Unit
Temporary Earth Check	Linear Foot
Temporary Rock Check	Linear Foot
Rental of Skid Loader, Fully Operated	Hour
Rental of Loader, Fully Operated	Hour
Rental of Crawler Mounted Hydraulic Excavator, Fully Operated	Hour
Rental of Dump Truck, Fully Operated	Hour
Rental of Backhoe, Fully Operated	Hour

- 2. All incidentals associated with the cleanout shall be subsidiary to the equipment rental items.
- 3. Payment is full compensation for all work described in this Section.

SECTION 815 -- SILT TRAP

815.01 -- Description

1. This work consists of the construction, maintenance and removal of silt traps. A silt trap is a shallow excavation constructed in a drainage path to dissipate energy, induce sediment deposition and provide temporary storage.

815.02 -- Construction Methods

1. The silt trap shall be approximately 1 foot deep and of varying width and length. The shape should be rectangular with the longer dimension parallel to the flow of water. The size, shape and location of the silt trap shall be as shown in the contract or as directed by the Engineer.

2. Construction of the silt trap shall be accomplished by methods and equipment suitable for the purpose and acceptable to the Engineer.

3. The initial excavated material from the construction of the silt trap shall be incorporated into the grade or placed as directed by the Engineer.

4. The silt trap shall be cleaned when at 50% capacity by removal and disposal of the silt to maintain functionality. Sediment removed from the silt trap shall be deposited in an upland location.

5. The silt trap shall be removed when it is deemed of no further use by filling the area with soil and shaping to blend with the adjacent natural ground.

815.03 -- Method of Measurement

1. Silt trap construction will be measured based on equipment rental.
2. Silt removal will be measured based on equipment rental.
3. Silt trap removal will be measured based on equipment rental.

815.04 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|-----------------|
| Rental of Skid Loader,
Fully Operated | Hour |
| Rental of Loader,
Fully Operated | Hour |
| Rental of Crawler Mounted
Hydraulic Excavator, Fully Operated | Hour |
| Rental of Dump Truck,
Fully Operated | Hour |
| Rental of Backhoe,
Fully Operated | Hour |
2. Payment is full compensation for all work described in this Section.

SECTION 816 -- SILT FENCE

816.01 -- Description

1. This work consists of installing the silt fence at locations shown in the contract and at locations as approved or determined by the Engineer. The installation shall be in accordance with the contract.

816.02 -- Material Requirements

1. All silt fence material shall be selected from the Department's Approved Products List.

- a. Low Porosity Silt Fence is typically used for perimeter control.
- b. High Porosity Silt Fence is used for velocity control.
- c. Low Profile Silt Fence is used for perimeter control and inlet protection
- d. Coir Silt Fence is used for perimeter control of wetlands and locations specified to use a biodegradable silt fence.
- e. Temporary Silt Fence shall be any product from the silt fence category of the Department's Approved Products List with a use appropriate to the situation.

2. Silt Fence Posts

- a. The silt fence posts shall be Studded "T" Steel Posts with a minimum weight of 1.25 lbs/foot (37 Kg/m).
- b. Used Studded "T" Steel Posts are acceptable.
- c. Coir Silt Fence wooden posts shall be derived from hardwood tree species.

3. Zip ties shall be UV stabilized, black with a 50 lb (22 Kg) minimum tensile strength.

816.03 -- Construction Methods

1. The silt fence shall be installed and in good working condition prior any grading or excavation operations and as needed throughout the construction process. The silt fence installation shall not exceed the amount required for the current construction season.

2. Silt Fence may be installed in the ground by either of the two methods listed below.

a. Trenching Method

(1) The Contractor shall excavate a trench to the depth, width, and length shown in the contract.

(2) The Contractor shall place the silt fence in the trench and pin it as shown in the contract.

(3) Wire staples shall be used for anchoring the silt fence.

(4) The Contractor shall backfill the trench, compact the soil, and attach the fabric to the posts as shown in the contract. The posts shall be driven until firm.

b. Slicing Method

(1) The Contractor shall install silt fence by mechanically slicing the material into the soil.

(2) The Contractor shall compact the soil and attach the fabric to the posts as shown in the contract. The posts shall be driven until firm.

3. Silt Fence installed in below water conditions.

a. Trenching is not required.

b. Fold a 6 inch (150 mm) flap toward the sediment source and pin as shown in the contract. Install the stakes as for a dry installation. Attach the fabric to the posts with zip ties or other approved methods and secure from slipping down the post.

4. All silt fence splice joints shall be overlapped a minimum of 6 feet (1.8 m).

5. The Contractor shall remove sediment that accumulates near the silt fence during construction and dispose of it in an upland location.

a. Sediment removal shall be initiated when sediment depth has reached one-half the height of the above ground portion of the silt fence or as directed by the Engineer in conjunction with silt fence repairs.

b. Sediment shall be removed to approximately 6 inches (150 mm) from the face of the silt fence.

c. Each time sediment is removed, the silt fence shall be repaired to a good working condition. Good working condition includes fabric repair, retrenching, post repair, tie replacement, and any associated handwork.

6. The Contractor shall maintain the silt fence in good working condition throughout the life of the construction project. Upon completion of the project silt fence shall remain in place in good working condition, in locations specified in the contract or at locations specified by the Engineer.

a. Silt Fence may be removed from locations during construction or upon completion of the project as specified in the contract or as directed by the Engineer.

b. Silt Fence that has been determined to be unnecessary and is subject to removal shall be cut off at ground level and shall remain the property of the Contractor for disposal. Any accumulated sediment shall be removed to an upland location.

c. Silt Fence posts from removed fence shall remain the property of the Contractor and may be reused on other installations.

d. Temporary Silt Fence shall be removed at the completion of the project or when it is no longer functional.

816.04 -- Method of Measurement

1. Silt fence will be measured by the length of the silt fence in linear feet (meter).

2. Removal of sediment from the silt fence will be measured based on equipment rental.

816.05 -- Basis of Payment

1. Pay Item	Pay Unit
Fabric Silt Fence "Low Porosity"	Linear Foot (LF) [Meter (m)]
Fabric Silt Fence "High Porosity"	Linear Foot (LF) [Meter (m)]
Fabric Silt Fence "Low Profile"	Linear Foot (LF) [Meter (m)]
Fabric Silt Fence "Coir Fiber"	Linear Foot (LF) [Meter (m)]
Temporary Silt Fence	Linear Foot (LF) [Meter (m)]
Rental of Skid Loader, Fully Operated	Hour (h)
Rental of Loader, Fully Operated	Hour (h)
Rental of Dump Truck, Fully Operated	Hour (h)
Rental of Backhoe, Fully Operated	Hour (h)
Rental of Crawler Mounted Hydraulic Excavator, Fully Operated	Hour (h)

2. All silt fence repairs, such as fabric repair, tie replacement, retrenching, and splicing and associated handwork are subsidiary to the appropriate silt fence item.

3. Removal of silt fence and all of its components is subsidiary to the initial silt fence item.

4. Payment is full compensation for all work described in this Section.

SECTION 817 -- SLOPE TRACKING

817.01 -- Description

1. Slope tracking consists of placing cleat marks on a slope parallel to the contours to minimize erosion as shown in the contract or identified by the Engineer.

817.02 -- Construction Methods

1. Slope tracking shall be accomplished by the walking of tracked equipment perpendicular to the contour of a slope (not parallel to the contours of a slope) over an erodible area.

2. Slope tracking is performed using equipment propelled by tracks with parallel cleats at least 1-1/2 inch high.

817.03 -- Method of Measurement

1. Slope Tracking will be measured by the Square Yard (Square Meter) of roughened area.

817.04 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|----------------|---|
| Slope Tracking | Square Yard (SY)
{Square Meter (SM)} |
2. Payment is full compensation for all work described in this Section.

SECTION 818 -- SOIL ROUGHENING

818.01 -- Description

1. This work consists of roughening exposed soil as an erosion control measure. This work shall be performed along slope contours or across ditch bottoms as shown in the contract or as directed by the Engineer.

818.02 -- Construction Methods

1. This work shall consist of using a field cultivator or disk to produce parallel roughened strips on the contours of slopes or across ditch bottoms. The roughened strips shall be a minimum of 8 feet (2.5 m) wide and a minimum depth of 3 inches (75 mm) and placed as directed by the Engineer.

2. This work shall be initiated when the finish grade is established for any location designated in the contract for soil roughening.

3. Soil roughening may be used when work stops for a period of time after locations have been rough graded.

818.03 -- Method of Measurement

1. The work of soil roughening will be measured by the Linear Foot (Meter) for the length of each pass as described.

818.04 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|-----------------|------------------------------|
| Soil Roughening | Linear Foot (LF) {Meter (m)} |
2. Payment is full compensation for all work described in this Section.

SECTION 819 -- INLET PROTECTION

819.01 -- Description

1. This work shall consist of installing, maintaining, and removing manufactured or site constructed curb inlet and area inlet protection devices at locations shown in the contract, temporary erosion control plans, or as directed by the Engineer.

819.02 -- Material Requirements

1. Inlet protection devices shall be constructed as shown in the contract.

2. Manufactured inlet protection devices shall be selected from the Department's Approved Products List.

819.03 -- Construction Methods

1. Inlet protection shall be manufactured or site constructed devices.

a. Approved manufactured products shall be installed as per manufacturer's recommendations. The Engineer shall be given a copy of the instructions before installation.

b. Site constructed protection devices shall be approved by the Engineer.

c. Inlet protection devices shall be installed in a manner to protect the inlet and prevent ponding of stormwater on the roadway.

2. Inlet protection devices shall be maintained, repaired, and repositioned to provide effective protection. Good working condition includes sediment removal, fabric and post repair, broken fasteners, undermining and the repositioning of devices.

a. The Contractor shall remove and dispose of sediment that accumulates near the inlet protection device when it is at 50% capacity on closed roadways.

b. The Contractor shall remove and dispose of all sediment from the roadway within 24 hours of the end of a storm event on roadways open to traffic.

3. Inlet protection devices shall be removed at the completion of the project, or as directed by the Engineer.

819.04 -- Method of Measurement

1. Area Inlet Protection will be measured based on each location installed.

2. Silt removal will be measured based on equipment rental.

3. Removal of inlet protection devices shall be subsidiary to the installation of the item. Inlet protection devices shall remain the property of the Contractor.

819.05 -- Basis of Payment

1. Pay Item	Pay Unit
Area Inlet Protection	Each
Curb Inlet Protection	Linear Foot
Rental of Skid Loader, Fully Operated	Hour
Rental of Loader, Fully Operated	Hour
Rental of Crawler Mounted Hydraulic Excavator, Fully Operated	Hour
Rental of Dump Truck, Fully Operated	Hour
Rental of Backhoe, Full Operated	Hour

2. Payment will not be made for individual components of the device installed.

3. Maintenance, repair, repositioning and any handwork required in the maintenance operation of an inlet protection device to a good working condition will not be measured for payment, but will be considered subsidiary to the appropriate inlet protection item.

4. Payment is full compensation for all work described in this Section.

SECTION 820 -- TURBIDITY BARRIER

820.01 -- Description

1. Turbidity barriers consist of a heavy duty reinforced fabric attached on the upper side to floatation members and ballasted on the lower side with chains or weights to form a bottom-tensioned floating curtain boom.

820.02 -- Material Requirements

1. The products used for turbidity barriers shall be shown on the Department's Approved Products list.

2. Anchors shall be capable of holding the floating basin boom in place.

3. Prior to installation, the contractor shall provide an installation guide to the Engineer.

820.03 -- Construction Methods

1. Turbidity barriers shall be installed at the locations shown in the contract or as directed by the Engineer.

2. Installation shall be as recommended by the manufacturer for the intended application.

3. The Contractor shall maintain the turbidity barrier in good working condition at all times.

4. Prior to the completion of the project, the Contractor shall remove the turbidity barrier and it will become the property of the Contractor.

820.04 -- Method of Measurement

1. Turbidity barriers will be measured by the length in place.

2. The measurement will be taken along the top line of the boom.

3. Maintenance, repair and removal of the turbidity barrier will not be measured for payment, but considered subsidiary to the item of Turbidity Barrier.

820.05 -- Basis of Payment

Pay Item	Pay Unit
Turbidity Barrier	Linear Foot (LF)

2. Payment is full compensation for all work described in this section.

SECTION 821 -- TEMPORARY SLOPE DRAIN

821.01 -- Description

1. This work consists of constructing slope drains with any type of new or used, rigid or flexible pipe that will adequately carry the water from the top of the slope to the ditch to prevent erosion on the slope.

821.02 -- Construction Methods

1. Temporary slope drains shall be sized to carry the anticipated volumes of flow. The diameter of the pipe shall be as shown in the contract or as directed by the Engineer.

2. The length of pipe shall be approved by the Engineer.

3. Stormwater shall be channeled into the temporary slope drain inlet.

4. Temporary slope drains shall be placed without bedding requirements.

5. Temporary slope drains shall be securely anchored at the inlet, outlet and along the slope.

6. Velocity dissipation devices shall be placed at the temporary slope drain outlet to prevent erosion.

7. The Contractor shall maintain the temporary slope drain in good working condition at all times. Good working condition includes anchoring repair, and repositioning of the inlet or outlet at the original installation.

8. Upon completion of the final erosion control measures, the temporary slope drain shall be removed from the project.

821.03 -- Method of Measurement

1. The temporary slope drain will be measured in linear feet along the longitudinal axis of the pipe.

2. Maintenance and repair of the temporary slope drain will not be measured for payment, but will be considered subsidiary to the item of Temporary Slope Drain.

3. Removal of the temporary slope drain will not be measured for payment, but will be considered subsidiary to the item of Temporary Slope Drain. All material shall remain the property of the Contractor and removed from the site.

4. Velocity dissipation devices will not be measured for payment.

821.04 -- Basis of Payment

1. Pay Item	Pay Unit
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Temporary Slope Drain	Linear Foot (LF)
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2. Velocity dissipation devices shall be subsidiary to the temporary slope drain.

3. Payment is full compensation for all work described in this section.

SECTION 822 -- DUST CONTROL

822.01 -- Description

1. This work consists of the application of water for the alleviation or prevention of dust.

822.02 -- Material Requirements

1. The water shall be from a potable source or free of contaminants and odors.

822.03 -- Equipment

1. The distributor equipment shall provide accurate and uniform distribution of water. The control valves shall close fully to prevent leakage.

2. The Engineer may approve alternate water distributing equipment.

822.04 -- Construction Methods

1. The contractor shall be responsible for dust control on the project.

2. Water shall be applied uniformly to prevent concentrated flows and avoid erosion problems.

822.05 -- Method of Measurement

1. a. Water is measured by the volume applied. The volume unit is 1,000 gallons (MGAL) [kiloliter (kL)].

b. Each time a meter is used, the Contractor shall furnish the Engineer with a certified copy of the meter calibration. The meter calibration shall have been performed during the last 12 months.

c. The Engineer shall deduct water that is wasted, lost, or applied in excess.

822.06 -- Basis of Payment

1. Pay Item	Pay Unit
Water for Dust Control	MGAL

2. Water for Dust Control is paid for as an "established" contract unit price item, which is shown in the bid proposal "Schedule of Items". The unit price will be established by the Department.

3. Payment is full compensation for all work described in this Section.

SECTION 823 -- STABILIZED CONSTRUCTION EXIT

823.01 -- Description

1. This work consists of the construction, maintenance and removal of stabilized construction exits to minimize the tracking of sediment onto roadways.

823.02 -- Material Requirements

1. Rock or broken concrete shall have a diameter between 2 inches and 4 inches.

2. Filter fabric shall be a Class II Strength Non-Woven Geotextile from the Department's Approved Products List unless otherwise specified by the Engineer.

3. Pre-fabricated exits may be approved by the Engineer.

4. Tire Wash Systems may be approved by the Engineer.

823.03 -- Construction Methods

1. Stabilized construction exits shall be constructed at the locations shown in the contract or on the temporary erosion control plans. Changes in locations must be approved by the Engineer.

2. Runoff from stabilized construction exits shall pass through a sediment control device before discharging from the site.

3. The area of the stabilized construction exit shall be excavated a minimum of 3 inches and shall be cleared of unsuitable material that may tear the filter fabric.

a. The filter fabric shall be placed the full width and length of the stabilized construction exit.

b. Pre-fabricated exits shall be installed according to the manufacturer's recommendations.

c. Tire Wash Systems shall be installed according to the manufacturer's recommendations.

4. Place rock or broken concrete over filter fabric to at least 6 inches in depth and leave in a roughened condition to dislodge sediment from tires.

5. Stabilized construction exits shall accommodate the largest construction vehicle in length and width that will exit the site.

6. Stabilized construction exits shall be maintained in a condition which will prevent tracking or the flow of sediment onto roadways or into storm drains. Periodic top dressing with additional stone and/or the reworking of existing stone as conditions demand may be required. Any sediment tracked from vehicles onto roadways must be removed immediately. The use of water trucks to remove sediment from roadways will not be permitted.

7. The locations of all stabilized construction exits on a site will be documented on the temporary erosion control plan.

8. Prior to completion of the project, the stabilized construction exit shall be removed and the area shall be restored in accordance with the erosion control plans.

823.04 -- Method of Measurement

1. Only stabilized construction exits shown in the contract or approved by the Engineer will be measured by the each.
2. No payment will be made for unauthorized stabilized construction exits.
3. Top dressing with additional stone or the reworking of existing stone will be considered subsidiary to the pay item.
4. Removal of the stabilized construction exit is subsidiary to the pay item.

823.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|------------------------------|-----------------|
| Stabilized Construction Exit | Each |
2. Payment is full compensation for all authorized stabilized construction exits.

SECTION 824 -- CONCRETE WASHOUT

824.01 -- Description

1. This work consists of installing concrete washout facilities located on the right of way. Concrete Washouts shall contain concrete waste from cleaning concrete equipment. The washout facilities shall prevent runoff and leaching of liquids.

824.02 -- Material Requirements

1. Contractor shall use plastic lining material with at least 10-mil thickness and shall be free of holes, tears or other defects that compromise the impermeability of the material.

2. Prefabricated concrete washout devices must be approved by the Engineer.

824.03 -- Construction Methods

1. Concrete Washout

a. Concrete washout facilities shall be constructed of sufficient size to contain all liquid and concrete waste generated by washout operations.

b. The contractor shall line the pit with plastic sheeting that has no holes or tears to prevent leaching of liquids into the ground.

c. The soil base shall be prepared to prevent tears or holes in the plastic sheeting material.

d. Concrete washout facilities shall be maintained to provide adequate holding capacity.

e. Constructed washout facilities shall be evaluated during scheduled inspections to ensure that plastic sheeting is intact and sidewalls have not been damaged by construction activities.

2. Concrete washout facilities shall be located a minimum of 50 feet from waters of the state.

3. The Contractor shall furnish, install, maintain and remove at no cost to the Department, a "Concrete Washout" sign adjacent to each washout facility.

a. The sign shall be placed in a manner in which it is visible to equipment operators.

4. The location of all concrete washout facilities shall be identified on the Temporary Erosion Control Plan.

5. Existing facilities must be cleaned, or new facilities shall be constructed when the washout is 75% full.

6. When concrete washout facilities are no longer required for the work, the hardened concrete shall be disposed of in accordance with all environmental regulations.

7. Upon completion of the concrete work, all concrete washout facilities shall be removed and the locations restored to the final erosion control requirements.

824.04 -- Method of Measurement and Basis of Payment

1. Construction, maintenance and removal will not be measured, but shall be subsidiary to the applicable items.

SECTION 825 -- FURNISHING AND PLANTING OF PLANT MATERIALS

825.01 -- Description

1. This work shall consist of furnishing, collecting, packaging, delivering, and planting the "plant materials."

2. Plant material shall mean trees, shrubs, vines, ground covers, and plants of all descriptions.

3. *Hortus Third*, compiled and published by the staff of the L. H. Bailey Hortorium, Cornell University, shall be the Department's reference for species nomenclature.

825.02 -- Material Requirements

1. Planting Seasons

a. A minimum of 90 days before each planting season, the Contractor shall submit to the Department:

- (1) A copy of confirmed nursery purchase orders.
- (2) A list showing each plant and where it was grown.

b. All plant material shall have been grown within the boundaries shown on the plant hardiness zone map in the special provisions.

c. Plant material from unapproved sources will be rejected.

d. (1) Planting is restricted to the following:

- (i) Spring, Coniferous -- March 15 to May 1.
- (ii) Spring, Deciduous -- March 15 to May 15.
- (iii) Fall, Coniferous -- August 15 to September 30.

(iv) Fall, Balled and Burlapped or container grown Deciduous -- August 15 to December 1.

(2) Planting within these seasons is further restricted by weather, soil conditions, and accepted local practices.

2. All plant materials shall be grown in a State inspected nursery unless specified otherwise (i.e., collected plant materials).

3. The contract may allow or require the use of "Collected Plant Materials". Collected plant material is non-nursery-grown plant material, including coniferous plant material grown for Christmas trees, which has not received the normal transplanting and root pruning given nursery-grown plant material.

4. All Contractor provided plant materials shall conform to the appearance and physical properties standard described in the *American Standard for Nursery Stock* published by the American Association of Nurserymen, Inc.

5. a. All plants shall be labeled.

b. The information on each plant's label shall describe the plant's:

- (1) Botanical genus.
- (2) Species.
- (3) Common name.

(4) Size or age.

c. Legible labels shall be attached by the nursery grower to individual plants, boxes, bundles, bales, or other containers to insure that all species and varieties are identified.

d. Plant materials which are delivered and/or planted and are not the species shown on the plant label shall be removed and replaced at no additional cost to the Department.

6. a. All plant material shall be sound, healthy specimens of their species or variety and shall have well-formed tops and healthy root systems.

b. (1) Plant materials which lack proper proportions, have serious injuries to the bark or roots, broken branches, objectionable disfigurements, shriveled dry roots, broken root balls, insect pests, diseases, or which are not found to comply with these Specifications will be rejected.

(2) Rejected plant material shall be removed from the project as soon as practical. Diseased or insect infested plant material shall be removed within 24 hours of notification or identification.

c. Bud-break for the birch, redbud, hackberry, oaks, and hawthorns must occur before they are planted.

7. All plant materials are subject to an internal and/or an external examination at any time to ascertain the condition of the roots and the soil around the roots.

8. a. If a Contractor is unable to locate sufficient plant material in the specified sizes, the Department may elect to negotiate for a unit price reduction or increase.

b. Price negotiations shall be concluded before ordering plant materials.

9. Plant material held in storage will be rejected if excessive growth or other detrimental effects have occurred.

10. a. Unnecessary injury to or removal of fibrous roots from the plant material is cause for rejection of the plant material. The soil for balled, container-grown, or pot-grown material shall be in such condition so as to insure no crumbling or cracking. Balls shall be wrapped with burlap before removal from the ground. The burlap shall be held in place with cord and/or pinning nails. Handling of balled and burlapped material shall be done in such a manner as to keep the earth intact. Plant material on which earthen balls do not hold together or which crack in handling causing the plant to be loose in the ball will be rejected.

b. Plant material that is ordered "tree spaded" shall be delivered in burlap lined wire baskets, unless otherwise specified.

11. a. Planting fertilizer shall be pressure formed pellets and have a 20-10-5 (20% nitrogen, 10% phosphorous, and 5% potash) analysis with a mass of 21 g \pm 1 g per pellet; or the pellets may have a 14-3-3 (14% nitrogen, 3% phosphorous, and 3% potash) analysis with a mass of 16 g \pm 1 g per pellet. Either pellet shall contain a minimum of 11.5% water insoluble nitrogen.

b. Establishment period fertilizer shall be liquid urea with 28 to 32% nitrogen or an approved equal.

12. a. All mulch shall be approved by the Department.

b. The wood mulch shall be either chips, shreds, or shavings. The wood mulch shall not have been subjected to conditions that would cause it to lose its value as mulch. The mulch shall be reasonably free from sawdust and other foreign materials and shall be free of toxic substances.

13. Stakes shall be wood, approximately 1 1/2 inch x 1 1/2 inch x 6 feet (38 mm x 38 mm x 1.8 m) for all trees less than 2 inches (50 mm) in trunk caliper and coniferous trees less than 8 feet (2.4 m) in height.

14. a. The guying material shall be a combination of hose and wire, or commercial plant ties approved by the Engineer. The minimum size of wire used for guying shall be 14 gage (1.9 mm) soft drawn. The hose shall be nylon, rubber, or reinforced plastic and shall have an inside diameter of at least one-half inch (12.5 mm), and a minimum length of six inches (150 mm).

b. The Contractor shall send a sample to the Department for approval.

15. a. The absorbent polymer shall be an organic cross-linked copolymer in a powder form regularly manufactured for agricultural or horticultural uses.

b. When mixed with water, it shall produce a gel that will adhere to and coat plant roots when they are dipped in the solution.

c. The absorbent polymer shall be on the Department's Approved Products List.

16. a. The pre-emergent chemical shall be dimethyl-tetrachloroterephthalate (Dacthal) or an approved equal.

b. The post-emergent chemical shall be glyphosate (Roundup) or an approved equal.

17. Rocks, sods, clods, or other backfill materials that would tend to form air pockets and which will not compact uniformly shall not be used.

825.03 -- Construction Methods

1. Storing and Transporting Plant Materials:

a. All plant material shall be transported in a covered conveyance to and from the storage area and shall be packed to assure proper protection against injury.

b. Plants that cannot be planted immediately after delivery from the supplier shall be kept in storage.

c. Bare root plant material shall be stored in a building. Their roots shall be kept moist and protected with soil, sawdust, wood chips, shingle toe, moss, peat, straw, hay, or other acceptable moisture holding media.

d. Storage for the balled and burlapped or container-grown plant material shall be in a protected outside area.

e. All storage sites/facilities shall have a water source, good ventilation, protection from sun and drying wind, and be approved by the Engineer before delivery of the plants.

f. Plants in storage (stored plants) shall be watered daily.

2. Plant materials shall not be brought to the construction site until sufficient area has been prepared to allow proper and immediate planting.

3. a. The Contractor shall dip all bare-root stock in a slurry of fully hydrated absorbent polymer and water before transporting plants from storage to the planting site.

b. The mixing ratio for the polymer shall be as directed by the manufacturer and shall produce a gel that fully adheres to all roots and forms a coating around them.

4. The Contractor shall protect plant material, on site and not immediately planted, from freezing, drying, breaking, overheating, and other injuries.

5. a. The Contractor shall till existing vegetation at the planting site into the soil before excavating the planting hole. The dimensions of the area and the depth to be tilled shall be shown in the contract.

b. The Contractor shall cut and remove all volunteer trees or brush within the planting area that cannot be removed by tilling. Immediately after cutting, stumps shall be treated with 2-4-D amine or other approved chemicals.

c. The Contractor may accomplish this preparation work in the fall before the spring planting season with written permission from the Engineer.

d. All trees and brush shall be disposed of in a manner satisfactory to the Engineer.

6. a. For the balled and burlapped plants, the Contractor shall set the ball carefully into the hole on undisturbed soil at the proper planting depth as shown in the contract.

b. The Contractor shall plumb and partially backfill the ball enough to stabilize the plant in position.

c. All twine shall be cut away from the trunk and removed from balled and burlapped plants. Wire baskets shall be cut off half way down the side of the ball. The burlap shall be pulled back from the trunk and cut off.

d. The Contractor shall properly place the fertilizer tablets, complete the backfill, and then consolidate by watering.

e. Wire baskets, twine, and burlap shall be removed from the project site.

f. Balled and burlapped material which is dropped into the planting hole or so roughly handled as to cause the ball to crack and pull away from the roots shall be rejected.

7. a. The Contractor shall examine bare rooted plants, and any bruised or broken root shall be pruned to leave a clean cut.

b. The plant shall be set in the hole at the same depth as it was grown and then plumbed and partially backfilled.

c. The fertilizer shall be properly placed in the hole.

d. The backfilling shall then be completed and consolidated by watering.

8. a. The Contractor shall fertilize all plant material during the planting operation as indicated below or as shown in the contract.

b. Fertilizer shall never be placed in direct contact with plant roots.

c. Pressure-formed pelleted fertilizer shall be placed into the planting hole during planting after the plants are partially backfilled (approximately 50% of the backfill material in place) at the following rates:

(1) Three pellets per plant for all shrubs and vines.

(2) Six pellets per plant for all trees less than 2 inches (50 mm) in trunk caliper or less than 8 feet (2.4 m) in height.

(3) Ten pellets per plant for all trees larger than 2 inch (50 mm) in trunk caliper or taller than 8 feet (2.4 m) in height.

d. (1) Establishment period fertilizer shall be applied between May 15 and June 1 of the year following initial planting.

(2) All trees and shrubs shall be fertilized with a liquid solution.

(3) The solution shall be placed in the water basin and metered to insure the solution is applied as specified.

(4) The fertilizer shall be mixed at the rate of one part of liquid urea per 300 parts of water and applied at the following rates:

(i) Coniferous shrubs: 1 gallon of solution per foot (12L of solution per meter) of foliage spread.

(ii) Coniferous trees: 1 gallon of solution per foot (12L of solution per meter) of plant height.

(iii) Deciduous shrubs: 1 gallon of solution per foot (12L of solution per meter) of plant height.

(iv) Deciduous trees: 5 gallons of solution per inch (0.80L of solution per millimeter) of trunk caliper.

9. a. The Contractor shall thoroughly water all plant material following the backfilling operation the same day they are planted. This watering shall completely saturate the backfill. After the ground settles as a result of the watering, additional backfill shall be placed to match the level of the finished grade as shown in the contract.

b. The plant shall be adjusted to sit at the same elevation as it was growing.

c. (1) Plant material shall be watered on the same day it is planted.

(2) All planting shall cease until the watering is caught up to the specified time limit.

d. The plant material shall be kept in a moist condition as dictated by weather conditions, soil conditions, and as directed by the Engineer until final acceptance.

e. All plant material shall be watered, on average over the project life, every 10 days during the establishment period unless excused by the Engineer.

f. The recommended water application rates are shown in Table 802.01.

Table 825.01

Recommended Plant Establishment Watering Rates	
Plant Type	Water Application Rate
Trees	10 gallons (38L) per tree every 10 days
Shrubs	5 gallons (19L) per shrub every 10 days

10. a. The Contractor shall properly prune all deciduous plant material to remove dead or broken roots and branches, to improve plant structure, and to remove any branches that are rubbing each other.

b. All pruning cuts shall be made with a sharp tool.

c. All branches removed by pruning shall be disposed of in a manner satisfactory to the Engineer.

11. a. When the backfill is complete and watered, the Contractor shall stake and guy the trees as shown in the contract. The stakes shall be driven so they support the trees, but stakes shall not penetrate the ball or roots of the plants.

b. Guys shall be sufficiently tight to transfer support from the stake to the tree and yet allow some movement for proper trunk development.

12. The Contractor shall construct a watering basin for all plants as shown in the contract. A second watering shall be applied in the completed watering basin before placing the mulch.

13. a. The Contractor shall mulch all planted areas as specified and as shown in the contract.

b. The mulch shall be applied upon completion of the watering basin and after the pre-emergent has been applied.

c. Mulch shall cover all disturbed earth.

14. a. The Contractor shall furnish and apply pre-emergent chemicals to the areas indicated in the contract before mulching and again the next spring. The application rate shall be the midrange of the manufacturer's suggested rate.

b. The Contractor shall furnish and apply post-emergent chemicals to all mulched areas to control weeds as needed or directed by the Engineer during the establishment period. The application rate shall be the midrange of the manufacturer's suggested rate.

15. a. The establishment period will not begin until all of the following items of work, as required in the contract, have been performed on each and every plant: planting, backfilling, fertilizing, watering, pruning, staking, guying, water basin construction, application of chemical vegetation control, and mulching.

b. Each plant shall be in an acceptable growing condition to enter the establishment period and qualify for partial payment.

c. The establishment period shall be until June 1 of the year following the year in which the plant material was planted. The establishment

period may be extended for an additional 12 months for failure to maintain the plant material as specified or for providing incorrect varieties or species.

d. During the establishment period, the Contractor shall properly maintain all materials under the contract and shall replace all unacceptable plant material in the spring planting season. The establishment procedures shall include:

- (1) Additional pruning;
- (2) Protective measures against pests and diseases;
- (3) Watering an average of every 10 days, or as often as required by necessity or the direction of the Engineer;
- (4) Repairing damage to the watering basins;
- (5) Replacing mulch which becomes displaced;
- (6) Keeping the stakes firm and the guys adjusted;
- (7) Weed control with a pre-emergent and post-emergent chemical applications or other approved means;
- (8) Other establishment procedures as deemed necessary by the Engineer, including the removal of any dead plant material from the project site.

e. (1) Upon completion of the establishment period, the Contractor and the Engineer will make a joint inspection of the project for acceptability.

(2) The Engineer will determine acceptability of the plant material.

(3) The inspection will normally be made during the week that the establishment period terminates.

(4) The Contractor will be notified of the date of the inspection.

(5) All items of maintenance shall have been performed on the plant material before the inspection, and any item of maintenance that has not been performed may make a plant unacceptable.

(6) The Contractor will be given written notification by the Engineer when the establishment responsibilities on the acceptable plant materials are terminated.

f. The stakes and guys shall be removed from the plant material in the spring following the year in which the material was planted. The stakes shall be left on any replacement plant material. The Engineer may note exceptions. All stakes and guys furnished by the Contractor shall remain the property of the Contractor and shall be removed from the project.

825.04 -- Method of Measurement

1. The work of furnishing and planting of plant materials will be measured by the each as listed in the bid proposal Schedule of Items.

825.05 -- Basis of Payment

- | | |
|------------------------------|-----------------|
| 1. Pay Item | Pay Unit |
| _____ (Species) _____ (Size) | Each (ea) |

2. Partial Payment. The progress estimate payment schedule for planted materials is shown in Table 825.02.

3. The Engineer and Contractor will make an inspection on or about September 1 to determine the plants in an acceptable growing condition. The Engineer will determine acceptability of the plant material at the inspection.

4. If a plant is determined to be not acceptable, any 10% payment for establishment work after that determination will not be made.

Table 825.02

Maximum Payment Percentages of Contract Unit Price (Spring Planting Only)		
Percent Authorization	Time Payment is Authorized	Criterion for Payment
50% of the contract price of each applicable item.	After Planting Complete	1. Plant materials meet the Specifications, have been properly stored and transported to the work site.

Table 825.02 (continued)

Maximum Payment Percentages of Contract Unit Price (Spring Planting Only)		
Percent Authorization	Time Payment is Authorized	Criterion for Payment
An additional 10% of the contract price of each applicable item.	July 31	1. Plant materials have been properly maintained as specified during the establishment period. 2. The Engineer will determine at the "Time Payment is Authorized" date whether procedures have been properly performed for the time interval indicated. At the July 31 authorization date, all establishment procedures from time of planting until July 31 will be evaluated; at the August 31 date, all establishment procedures from August 1 to 31 will be evaluated; and on September 30, all establishment procedures from September 1 to 30 will be evaluated. 3. The Contractor will notify the Engineer when the establishment procedures are being accomplished in order to get paid for the work. If all establishment procedures are not performed, the Contractor will forfeit the 10% payment for establishment work for the interval(s) which were unacceptable and the Contractor cannot regain that payment. 4. An inspection will be conducted around September 1 to determine the number of plants that are acceptable. 5. If a plant is determined to be not acceptable, any 10% payment for establishment work after that determination will not be made. However, plants that are replaced before June 1 of the original planting year will be considered original plants.
An additional 10% of the contract price of each applicable item.	August 31	
An additional 10% of the contract price of each applicable item.	September 30	

Table 825.02 (continued)

Maximum Payment Percentages of Contract Unit Price (Spring Planting Only)		
Percent Authorization	Time Payment is Authorized	Criterion for Payment
An additional 20% of the contract price for all acceptable items.	At the end of the establishment period.	1. The establishment period is completed. 2. All establishment procedures are complete and verified by the Engineer on all replanted material. 3. The Engineer has inspected the project and determined the acceptability of each plant based on the normal growth habit for the species or variety.

5. a. If establishment procedures were properly performed, the Engineer notified, etc., for the indicated time intervals in Table 825.02, then on July 31, August 31, and September 30, a payment for each period equivalent to 10% of the contract price of each item will be made on all acceptable plants.

b. If establishment procedures are not performed in any of the time intervals in Table 825.02, then the "10% payment" for establishment work for the intervals that are unacceptable, are not authorized and those 10% payments will never be made.

6. a. The unacceptable plantings from the September inspection and any additional losses from the winter shall be replaced during the subsequent spring planting season. Payment for replacement plant establishment work is not authorized. Plant replacement shall be at no additional cost to the Department and shall be in accordance with the contract.

b. No additional planting fertilizer is required on replacement plant material.

c. The Contractor's responsibility for all replacement plants shall extend for 30 days after the last plant to be replaced is properly planted and accepted by the Engineer. No payments for replacement plants will be made until 30 days after the last plant is replaced. If plants are not replaced, the Engineer will deduct the 50% payment made at the original planting and will not make the 20% payment due at the end of the establishment period.

7. All payments and deductions will be made in terms of the number of plants at the contract unit price that equals the payment or deduction authorized.

8. Payment is full compensation for all work described in this Section. Payments and deductions are made from Department determinations of whether or not the work shown in Table 825.02 is properly completed.

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SECTION 901 – FIELD LABORATORIES, FIELD OFFICES, AND SCALE HOUSES

901.01 -- Description

1. The Contractor shall provide, furnish, and place the field office, laboratory, or scale house and then make the required utility connections for the buildings as described in the contract.

2. The field offices, laboratories, and scale houses are for the exclusive use of the Engineer.

901.02 -- Material Requirements

1. General Requirements:

a. (1) Buildings shall be completely insulated and weathertight.

(2) Buildings shall be constructed from wood or metal.

b. The outside doors and windows shall be provided with screens and locks.

c. The floors shall be vinyl tile or a similar surface material.

d. The Contractor shall provide cleaning and janitorial services for only those buildings with utility connections.

e. The Contractor shall furnish a safe, satisfactory, and dependable source of electricity for power and lights (120 volts AC) in all field laboratories and offices.

f. The Contractor shall furnish an adequate and constant supply of clean water to the pressure system or the supply tanks as required to perform the necessary testing for the type of field laboratories furnished.

g. The Contractor shall equip all field offices, laboratories, and scale houses with a suitable heating, ventilation, and air conditioning system which will maintain the temperature in the building at 70°F (21°).

h. The Contractor shall provide a phone outlet and a phone in field offices as required by the Engineer. The Department will pay for installation (which includes trenching to the trailer), disconnection, and the monthly service fees.

i. The Contractor shall provide and maintain a commercial Underwriters' Laboratory approved fire extinguisher capable of controlling Class A, B, and C fires.

j. Light fixtures shall provide illuminance of 93 foot-candles (1000 lx) on all working surfaces.

2. Field Laboratory, Type A:

a. In addition to the general requirements, the field laboratory, Type A shall meet the following requirements:

(1) The building's interior dimensions (approximate) shall be:

(i) Width - 9 feet (2.7 m).

(ii) Ceiling height - 7 feet (2.1 m).

(iii) Minimum floor area - 230 square feet (21.4 m²).

b. Two exterior doors and sufficient sliding or swinging type windows in each room to provide adequate light and ventilation.

c. The building shall have a transverse partition and door to provide a drying-sieving room with floor area of approximately 70 square feet (6.5 m²). The drying-sieving room shall be equipped with a suitable work bench, an exhaust fan(s) capable of changing the air in the room every minute, and at least 1 exterior door and 1 window.

d. (1) The field laboratory room shall be equipped with solid work benches, a writing table or desk, and 2 chairs.

(2) The work bench shall have a sink with a faucet and a hose bib connector. The Contractor shall install a sign above the sink prohibiting the disposal of hazardous material.

(3) Wash water shall be drained from the building so as to avoid health and safety problems. Wash water shall not be discharged directly to waters of the State.

e. The building shall be equipped with an adequate water supply system, either a pressure or a gravity feed system with a minimum storage capacity of 100 gallons (379 L).

f. A minimum of 8 conveniently located 120 VAC duplex wall outlets shall be furnished.

g. The building shall be air conditioned so it can maintain constant temperature of 75°F (24°C) in the working space at all times.

3. Field Laboratory, Type B:

a. In addition to the general requirements, the field laboratory, Type B shall have the following requirements:

(1) The building's interior dimensions (approximate) shall be:

(i) Width - 7 1/4 feet (2.2 m).

(ii) Ceiling height - 7 1/4 feet (2.2 m).

(iii) Minimum floor area - 150 square feet (13.9 m²).

b. An exterior door and sufficient sliding or swing type windows to provide adequate light and ventilation.

c. (1) Solid work benches, a writing table or desk, and a chair.

(2) The work bench shall have sink with a faucet and hose bib connector. The Contractor shall install a sign above the sink prohibiting the disposal of hazardous material.

(3) Wash water shall be drained from the building so as to avoid health and safety problems. Wash water shall not be discharged directly to waters of the State.

d. An adequate water supply with either a pressure or a gravity feed system with a minimum storage capacity of 100 gallons (379 L).

e. (1) The field laboratory, Type B, when required on projects with asphaltic concrete pay items, shall be equipped with a tabletop fume hood, balance table, and a microwave oven.

(2) The microwave oven shall be Underwriters' Laboratory approved, grounded, and have the capability of producing a power output of 1,000 watt minimum, 120 VAC at 60 Hz. The internal dimensions shall be

approximately 16 inches x 12 inches x 9 inches (height) [400 mm x 300 mm x 225 mm (height)].

(3) An isolated, grounded circuit protected from current overload by a 15 amp circuit breaker shall be provided specifically for the microwave.

(4) The microwave oven must be placed on a solid flat work surface with at least 3 inches (75 mm) of space on all sides and a 1 inch (25 mm) space above the oven for proper air flow.

f. The building shall be air conditioned so it can maintain constant temperature of 75°F (24°C) in the working space at all times.

g. The building shall have at least 6 duplex electrical outlets.

4. Field Laboratory, Type C:

a. In addition to the general requirements, the field laboratory, Type C shall have the following:

(1) The building's interior dimensions (approximate) shall be:

(i) Width - 7 feet (2.1 m).

(ii) Ceiling height - 7 feet (2.1 m).

(iii) Minimum floor area - 91.5 square feet (8.5 m²).

b. An exterior door and sufficient sliding or swinging type windows to provide adequate light and ventilation.

c. (1) Solid work benches, a writing table or desk, and a chair.

(2) The work bench shall have sink with a faucet and hose bib connector. The Contractor shall install a sign above the sink prohibiting the disposal of hazardous material.

(3) Wash water shall be drained from the building so as to avoid health and safety problems. Wash water shall not be discharged directly to waters of the State.

d. An adequate water supply for projects requiring water for testing.

e. Two 120 VAC duplex wall outlets.

5. Field Offices.

a. In addition to the general requirements, the field office shall have the following requirements:

(1) The building's interior dimensions (approximate) shall be:

(i) Width - 7 1/4 feet (2.2 m).

(ii) Ceiling Height - 7 1/4 feet (2.2 m).

(iii) Minimum floor area - 105 square feet (9.8 m²).

b. An exterior door and sufficient sliding or swing type windows to provide adequate light and ventilation.

c. The building shall be air conditioned so it can maintain a constant temperature of 75°F (24°C) at all times.

d. The field office shall be equipped with a 2 or 4-drawer filing cabinet, an office type desk having surface dimensions of approximately 30 inches x 60 inches (750 mm x 1.5 m), 2 chairs, and a work table or inclined surface suitable for supporting and examining a full size set of plans.

e. The field office shall be equipped with a minimum of 4 conveniently located duplex wall outlets.

6. Scales and Scale Houses

a. Material shall be weighed on approved scales.

b. The Contractor shall furnish a weather-proof scale house.

c. The scale house shall have or provide:

(1) Floor area of approximately 43 square feet (4 m²) and ceiling height of 7 feet (2.1 m) (approximate).

(2) A window facing the platform, capable of sliding open to allow transfer of documents.

(3) One desk and 2 chairs.

(4) Minimum light on working surfaces and dials of 93 foot-candles (1000 lx).

901.03 -- Construction Methods

1. The Contractor shall place the building (office, laboratory, and/or scale house) in locations as directed by the Engineer and relocate the building, as necessary, as the work progresses when directed by the Engineer.

2. The building shall be leveled and solidly supported to eliminate vibration.

3. The Contractor shall connect the required utilities to the office, laboratory, and scale house.

901.04 -- Method of Measurement

1. Field laboratories and offices are measured for payment by the each.

901.05 -- Basis of Payment

1. Pay Item	Pay Unit
Field Laboratory, Type _____	Each (ea)
Field Office	Each (ea)

2. The furnishing and operation of scales and scale houses by the Contractor will not be paid for directly but shall be considered to be subsidiary to items being measured.

3. Payment is full compensation for all work described in this Section.

SECTION 902 -- GUARDRAIL AND GUARD POSTS

902.01 -- Description

1. This work consists of furnishing and erecting guardrail and guard posts at locations shown in the contract.
2. Cable guardrail consists of wire cables supported by cable mounts that are attached to steel posts.
3. W-beam and thrie-beam guardrail consists of rigid beam elements bolted to the posts with offset blocks. If shown in the contract or approved by the Engineer, the offset blocks may be omitted.

902.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 902.01 or the contract.

Table 902.01

Material Requirements	
Applicable Materials	Section
Reinforcing Steel	1020
Steel Guardrail Posts, Special Posts, and Offset Blocks	1067
"W" and "Thrie"-Beam Guardrail	1066
Wood Guardrail Posts.....	1075
Concrete Aggregate	1033

2. The concrete for use in guardrail anchors and footings shall be a readily available, commercially designed concrete mixture or Contractor-produced concrete, which shall achieve a minimum compressive strength of 3000 psi (20 MPa) at 28 days. The cement shall be Type I, Type II, or Type III. The aggregate shall be from acceptable sources.

3. Cable Guard Rail and Fittings

- a. The cable shall be 3/4 inch in diameter and shall conform to the requirements of AASHTO M 30. The cable shall, unless otherwise specified, meet the requirements for "Type I" rope, with "Class A" galvanized coating.

- b. Fittings shall be as shown in the contract and as required in AASHTO M 30.

- c. All anchor rods, plates and fittings shall conform to the physical requirements of ASTM A 36. Turnbuckles and clevises shall be steel forgings conforming to the requirements of ASTM A 668, Class B. The forgings shall be annealed prior to being machined.

- d. Tension spring assemblies shall be as shown in the contract. Tension spring assemblies, when tested as installed in a normal cable guard rail installation, shall develop a minimum tensile strength of 25,000 pounds per 3/4 inch cable. The coil spring shall conform to the requirements of ASTM A 689.

- e. All fittings (rods, plates, turnbuckles, clevises, tension spring assemblies) shall have a uniform coating of zinc as required in AASHTO M 30.

4. The Contractor shall order guardrail items as shown in the contract unless the Engineer furnishes a field checked list of items, lengths, and locations.

902.03 -- Construction Methods

1. Guardrail Posts

a. The Contractor shall set posts plumb, firm, and spaced as shown in the contract and to lines and grades given.

(1) The Contractor may elect to drive, rather than set the posts in prebored holes.

(2) Posts damaged when driven into the ground will be rejected. The Contractor shall remove and replace the posts with acceptable materials.

(3) If the Engineer determines that damage is occurring to the surfaced shoulder during post placement due to the Contractor's driving operation, the Engineer will require that the posts be set in prebored holes.

b. W-Beam and Thrie-Beam Guardrail Posts: The Contractor shall construct a breakout in the surfacing around each post as shown in the contract documents.

c. Cable Guardrail Posts

(1) The 8 foot end posts shall be driven.

(2) The Contractor shall seal the joint around the posts and any cracking that may occur in the surfacing. The hot pour sealant shall comply with Section 519. This work will be considered subsidiary to the Cable Guardrail.

d. Any damage to galvanizing shall be repaired in accordance with Repair Method 2 as described in Section 1061.

e. All areas where the surface of treated timber is broken by cutting, boring, or other means shall be thoroughly coated with 3 applications of preservative. Each application shall be reasonably dry before the next coat is applied.

f. Backfill of Blockouts

(1) When blockouts are required in a surfaced area, the Contractor shall backfill all post holes with material approved by the Engineer. The material shall be compacted leaving a space around the post as defined in the contract. This remaining part of the hole shall be backfilled with granular material and approved bituminous material or flowable fill concrete placed to the elevation of the surrounding surfacing as shown in the contract. The material near the post shall be sloped to help any water run off away from the post.

(2) Posts placed in other than bituminous and concrete surfacing shall be backfilled with material approved by the Engineer and placed to the elevation of the existing surface.

2. W-Beam and Thrie-Beam Guardrail

a. The beam elements shall be straight and of uniform section.

b. Curved elements described in the contract shall be manufactured with the curve.

c. Warped or deformed elements will be rejected.

d. The edges of the beam elements shall be smooth after erection.

3. Bridge approach sections shall be mounted directly to the bridge with cast in place welded assemblies of threaded inserts or bolts through bridge rail as shown in the contract. Curb mountings, anchor bolts, and incidentals will be considered as part of the bridge approach sections.

4. The Contractor shall submit End Treatment plans.

902.04 -- Method of Measurement

1. Cable Guardrail

a. Cable guardrail is measured by the linear foot (meter). The Department will compute the cable guardrail length in linear feet (meters) from terminal section to terminal section, excluding intermediate anchorage sections.

b. Terminal anchorage sections and intermediate anchorage sections will be measured as single units complete and in place as shown in the contract.

2. "W"-Beam and "Thrie"-Beam Guardrail

a. "W" and "thrie"-beam guardrail is measured by the linear foot (meter). The Department will compute the "W" and "thrie"-beam guardrail length in linear feet (meters) from center to center of the end splices and shall not include the distance of the section of rail projecting beyond these points.

b. When "W" and "thrie"-beam guardrail is installed in conjunction with bridge approach sections, the pay length of these items shall be measured to the limits indicated in the contract.

c. When "W" and "thrie"-beam guardrail is installed in conjunction with terminal end sections, the pay length of these items shall be measured to the limits indicated in the contract.

d. Guardrail end treatment is measured by the each.

e. W-Thrie Beam Transition Section is measured by the each.

f. Special guardrail posts furnished and installed in conjunction with "W" and "thrie"-beam guardrail will be measured by the each.

902.05 -- Basis of Payment

1. Pay Item	Pay Unit
Cable Guardrail	Linear Feet (LF) [Meter (m)]
Intermediate Anchorage Sections	Each (ea)
Terminal Anchorage Sections	Each (ea)
Bridge Approach Sections	Each (ea)
Special Bridge Approach Section	Each (ea)
W-Beam Guardrail	Linear Feet (LF) [Meter (m)]
Thrie-Beam Guardrail	Linear Feet (LF) [Meter (m)]
W-Thrie Beam Transition Section	Each (ea)
Terminal Sections _____	Each (ea)
Special Guardrail Posts	Each (ea)
Special Guardrail Posts _____	Each (ea)
Guardrail Adapter _____	Each (ea)
	Each (ea)
Guardrail End Treatment _____	Each (ea)
End Anchorage Assembly	Each (ea)
Bullnose	Each (ea)

2. Terminal end shoes, when required in the contract, shall not be measured for payment but shall be considered subsidiary to the items for which direct payment is provided.

3. Guardrail post will be considered subsidiary to the guardrail item unless otherwise shown in the contract.

4. Payment is full compensation for all work described in this Section.

SECTION 903 -- REMOVE AND RESET GUARDRAIL

903.01 -- Description

1. Removing guardrail shall include the removal of all cable, approach sections, terminal sections, anchorage sections, and beam guardrail materials, fittings, and posts from locations shown in the contract or designated by the Engineer. Concrete anchors shall be removed in their entirety and disposed of by the Contractor.

2. Resetting guardrail shall include setting guardrail salvaged from the project or furnished and delivered to the project by others as indicated in the contract. New anchors shall be furnished by the Contractor. The Contractor shall furnish all new posts, offset blocks, hardware, and incidentals required to install the salvaged rail and cable elements.

903.02 -- Material Requirement

1. New materials, replacement materials, and concrete shall conform to the requirements of Section 902.

903.03 -- Construction Methods

1. "Remove and Salvage Guardrail"

a. The Contractor shall remove and salvage the guardrail as shown in the contract. The salvaged guardrail materials shall be stockpiled as indicated in the contract.

b. Cable shall be rolled on spools, and the length of cable on each spool shall not exceed 2,000 feet (610 m).

c. (1) Salvaged materials shall be stored on or near the right-of-way at locations designated by the Engineer.

(2) Hardware shall be placed in suitable containers.

(3) No more than 55 pounds (25 Kg) of salvaged material shall be placed in a single container.

d. The Contractor removing the existing guardrail shall replace all materials damaged during removal at no additional cost to the Department.

e. All materials that the Engineer determines are not salvageable or needed by the Department shall become the property of the Contractor. The Contractor shall remove all nonsalvagable materials from the project site and properly dispose these materials in accordance with all-applicable laws and regulations.

2. "Remove Guardrail"

a. The Contractor shall remove the guardrail and all materials belong to the Contractor and must be removed from the site.

3. "Reset Guardrail"

a. The Contractor shall reset the guardrail at the locations shown in the contract or as directed by the Engineer. The work shall be done in accordance with the requirements of Section 902.

903.04 -- Method of Measurement

1. "Reset Guardrail" is measured by the liner foot (meter). The Department will compute the length of guardrail reset by the linear foot

(meter) from center to center of guardrail element end connections, including approach and terminal sections, for each continuous length of guardrail.

2. "Remove Guardrail" or "Remove & Salvage Guardrail" is measured by the linear foot (meter). The Department will compute the length of guardrail removed by the linear foot (meter) from center to center of guardrail element end connections, including approach and terminal sections, for each continuous length of guardrail.

903.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|----------------------------|---------------------------------|
| Reset Guardrail | Linear Foot (LF)
[meter (m)] |
| Remove & Salvage Guardrail | Linear Foot (LF)
[meter (m)] |
| Remove Guardrail | Linear Foot (LF)
[meter (m)] |
2. Payment is full compensation for all work described in this Section.

SECTION 904 -- INERTIAL BARRIER MODULES

904.01 -- Description

1. The Contractor shall furnish and install sand filled inertial barrier modules (impact attenuators) at the locations shown in the contract.

904.02 -- Material Requirements

1. The inertial barrier modules shall be listed on the Department's Approved Products List.

2. Filler material for inertial barrier modules shall meet the requirements for concrete fine aggregate shown in Table 1033.02A. Salt shall be added to prevent freezing. The sand or filler material shall contain 5 to 15% (by volume) rock salt mixed with the filler material.

904.03 -- Construction Methods

1. The Contractor shall install the inertial barrier modules in accordance with the recommendations and instructions of the manufacturer and as directed by the Engineer.

904.04 -- Method of Measurement

1. The inertial barrier modules shall be measured by the each.
2. Filler material shall be measured by the cubic yard (cubic meter).

904.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|--|--|
| Inertial Barrier Modules, Type _____ | Each (ea) |
| Filler Material for Inertial Barrier Modules | Cubic Yard (CY)
[Cubic Meter (m ³)] |
2. Payment is full compensation for all work described in this Section.

SECTION 905 -- ROCK RIPRAP

905.01 -- Description

1. The Contractor shall prepare the slopes and furnish and place stone on the slopes at locations shown in the contract.

905.02 -- Material Requirements

1. a. The rock shall be sandstone, limestone, quartzite, or other hard stone. It shall be clean and free from earth, clay, or refuse.

b. The solid rock shall have a density of at least 140 lb/CF (2245 Kg/m³).

2. Each load of rock shall be graded as shown in Table 905.01. The rock shall be angular in shape to allow interlocking between the various rock sizes.

Table 905.01

Rock Riprap Gradation Requirements	
Size of Rock	Percent of Total Weight Smaller than the Given Size
Type A	
150 pounds (68 Kg)	100
35 pounds (16 Kg)	50
2 pounds (0.9 Kg)	Not to exceed 10
Type B	
300 pounds (136 Kg)	100
80 pounds (36 Kg)	50
5 pounds (2.2 Kg)	Not to exceed 10
Type C	
700 pounds (318 Kg)	100
150 pounds (68 Kg)	50
10 pounds (4.5 Kg)	Not to exceed 10

3. a. Gradation control shall be done by a visual inspection that verifies the rock is reasonably well graded and does conform to the gradation requirements in Table 905.01.

b. Each piece shall have no dimension greater than 3 times its least dimension.

4. Rock riprap shall not have a soundness loss greater than 14% by weight at the completion of 16 cycles of freezing and thawing when tested in accordance with NDOT T 103. The rock riprap shall be prepared for the freezing and thawing tests by crushing to comply with the gradation requirements of coarse aggregate, as specified in Section 1033, Table 1033.03A, Class "E" aggregate.

905.03 -- Construction Methods

1. a. The finished earth surface shall conform to the grades and slopes of the neat lines of the bottom surface of the riprap as shown in the contract.

b. The Contractor shall excavate for energy dissipation holes (scour holes) as described in the contract.

c. Depressions shall be filled with suitable dry material which shall be thoroughly tamped or otherwise compacted to insure stability.

d. Soft, unstable materials shall be removed and replaced with suitable material which shall be thoroughly tamped or otherwise compacted to insure stability. No raised places, bumps, or depressions will be allowed.

2. The approved rock shall be placed in such a manner as to produce a stable mass of rock within the limits shown in the contract or specified by the Engineer. All material shall be placed and distributed so that there will be no large accumulations of either the larger or smaller sizes of rock.

3. Any appreciable variation from the specified thickness of the riprap shall be corrected by redistributing the rock.

4. All riprap placed will be covered with native soil and seeded above the historical ordinary high water mark or approximately 3 feet above the existing channel flow line, whichever is greater.

905.04 -- Method of Measurement

1. Rock which is accepted and used in the construction will be measured by the ton (Megagram). The weight will be determined by measuring the volume [cubic yards (cubic meters)] of riprap placed and multiplying by 1.35 ton/cubic yard (1.6 Mg/m³).

2. a. Quarry weight determinations will be accepted by the Engineer. The attendant at the quarry will issue tickets to the driver for each load of rock riprap delivered to the project.

b. Each ticket shall include:

- (1) The name of the producer.
- (2) The date.
- (3) The location of the quarry.
- (4) The quantity delivered [in tons (Megagrams)].
- (5) The name of the Contractor.
- (6) The project number.

c. The ticket shall be given to the Engineer at the time of arrival at the placement site.

3. When any shipment's weight has not been documented, the Contractor shall measure the rock on approved scales in the presence of the Engineer.

4. When shipped by rail, the measured shipping weight of acceptable material, less material that is wasted, will be used as the basis for payment.

905.05 -- Basis of Payment

1. Pay Item	Pay Unit
--------------------	-----------------

Rock Riprap, Type _____	Ton (Tn) [Megagram (Mg)]
-------------------------	--------------------------

2. Energy dissipation hole excavation is subsidiary to the rock riprap bid item.

3. Placing and mixing of native soil in the riprap is subsidiary to the excavation or embankment item.

4. Payment is full compensation for all work described in this Section.

SECTION 906 -- BROKEN CONCRETE RIPRAP

906.01 -- Description

1. a. The Contractor shall prepare the slopes and place broken concrete on the earth slopes at the locations shown in the contract.
 - b. Any excavation or embankment necessary to place the riprap to the limits shown in the contract shall be part of this work.
2. The concrete riprap shall be obtained from the areas designated in the contract.
3. a. It shall be the responsibility of the Contractor to ensure that a sufficient quantity of concrete be broken to the requirements stated below and removed for use as riprap.
 - b. Any concrete intended but not used as riprap shall be disposed of as directed by the Engineer.

906.02 -- Material Requirements

1. a. The Contractor shall size the riprap by breaking the concrete rubble so that no individual piece will have a volume greater than 3.5 cubic (0.1 m³) feet.
 - b. No more than 10% of the riprap pieces shall have a volume of less than 30 cubic inches (0.0005 m³).
 - c. Fifty percent of the riprap shall be composed of pieces with a volume less than 1,220 cubic inches (0.02 m³).
 - d. Each piece shall have no dimension greater than 4 times its least dimension.
2. Control of the sizing shall be by visual inspection to verify that the concrete rubble is well graded and conforms to the maximum and minimum sizes specified.

906.03 -- Construction Methods

1. Grading
 - a. The finished earth surface shall conform to the grades and slopes of the neat lines of the bottom surface of the riprap as shown in the contract.
 - b. Depressions shall be filled with suitable dry material which shall be thoroughly tamped or otherwise compacted to insure stability.
 - c. Soft, unstable materials shall be removed and replaced with suitable material which shall be thoroughly tamped or otherwise compacted to insure stability. No raised places, bumps, or depressions will be allowed.
2. The Contractor shall place the broken concrete so each piece is touching the adjacent pieces in a configuration creating the highest possible density while producing a stable mass within the limits shown in the contract.
3. All material shall be placed so that the large and small sizes are well mixed.
4. Reinforcing steel bars projecting from the mass shall be cut off flush with the face from which it protrudes.

5. All riprap placed will be covered with native soil and seeded above the historical ordinary high water mark or approximately three (3) feet above the existing channel flow line, whichever is greater.

906.04 -- Method of Measurement

1. Broken concrete riprap shall be measured by the ton (megagram).
2. The weight will be determined by measuring the volume [cubic yards (cubic meters)] of broken concrete riprap placed and multiplying by 1.35 ton/cubic yard (1.6 Mg/m³).

906.05 -- Basis of Payment

- | | |
|------------------------|--------------------------|
| 1. Pay Item | Pay Unit |
| Broken Concrete Riprap | Ton (Tn) [Megagram (Mg)] |
2. Placing and mixing of native soil in the riprap is subsidiary to the excavation or embankment item.
 3. Payment is full compensation for all work described in this Section.

SECTION 907 -- GABIONS AND REVET MATTRESSES

907.01 -- Description

1. The Contractor shall furnish, assemble, tie, and fill with approved stones mesh wire baskets constructed and placed in conformity with the lines, grades, and dimensions shown in the contract.

907.02 -- Material Requirement

1. Materials shall conform to the requirements of Section 1074.

907.03 -- Construction Methods

1. The Contractor shall construct all gabion and revet mattress structures as shown in the contract.

2. All basket units shall be assembled by binding all adjacent vertical edges with basket connecting clips placed every 4 inches (100 mm).

3. Empty units shall be set to line and grade as shown in the contract.

4. Connecting clips shall be used to join the units together in the same manner as described above for assembling.

5. Internal connecting wires shall be uniformly spaced and securely fastened in each outside cell of the structure or where ordered by the Engineer.

6. A fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

7. a. The baskets shall be filled with stone, carefully placed so that air void volume is minimized.

b. Hand placing of the rock-fill shall be required on the exposed faces of the units so that the rock fill appears to be uniformly stacked.

c. The ledge rock shall be placed on its natural face surface rather than on the edge face.

d. After a basket has been filled, the lid shall be bent over until it meets the sides and edges.

8. Each basket shall be overfilled approximately 2 inches (50 mm) above the sides before closing the lids. The lid shall then be secured to the sides, ends, and partitions with the connecting wire in the manner described above for assembling. Special attention shall be given to see that all projections or wire ends are turned into the baskets.

9. The Contractor shall also comply with all manufacturer installation requirements. The Contractor shall submit the installation requirements to the Engineer two weeks prior to installation.

907.04 -- Method of Measurement

1. Gabions and revet mattresses shall be measured by the each.

907.05 -- Basis of Payment

1. Pay Item	Pay Unit
Gabion, Type _____	Each (ea)
Revet Mattress, Type _____	Each (ea)

2. Payment is full compensation for all work described in this Section.

SECTION 908 -- CONCRETE SLOPE PROTECTION, DITCH LINING, FLUMES AND DISCHARGE STRUCTURES

908.01 -- Description

1. The Contractor shall furnish all materials, prepare the subgrade, and construct the following as described in the contract:

- a. Concrete slope protection.
- b. Concrete ditch lining.
- c. Concrete flumes.
- d. Concrete discharge structures.

908.02 -- Material Requirements

- 1. Concrete shall be Class "47B-3000" (47B-20).
- 2. All materials shall conform to the requirements in Table 908.01.

Table 908.01

Material Requirements	
Applicable Materials	Section
Concrete	1002
Preformed Joint Filler	1015
Reinforcing Steel	1020, 1022, 1023

908.03 -- Construction Methods

1. a. The Contractor shall prepare the subgrade by trenching or filling to the required elevation.

b. The subgrade shall be thoroughly tamped.

c. In cuts, the excavation shall be made sufficiently wide to allow placing of forms and performing the required placing and finishing work.

d. In fills, the subgrade shall be made at least 1 foot (300 mm) wider on each side than required by the flumes or discharge structures. The subgrade shall be compacted to a minimum of Class I embankment or as shown in the contract.

e. The subgrade shall be excavated carefully in order that the finished grades conform to the neat lines of the bottom and slopes of the structure as shown in the contract.

f. No raised places or bumps will be allowed. Depressions left in the surface of the subgrade shall be filled with concrete.

g. If necessary, water shall be added by sprinkling to facilitate compaction.

h. At the time concrete is deposited, the subgrade shall be thoroughly moistened. Water ponding on the surface will not be allowed.

i. Sand-fill, when required, shall be uniformly compacted. The moisture content shall be sufficient to allow satisfactory compaction.

2. Tie bars shall be placed at the locations shown in the contract. Tie bars shall be used in all concrete discharge structures that are placed adjacent to the concrete pavement.

3. The forming requirements of Section 607 shall apply to this work.

Concrete Slope Protection, Ditch Lining, Flumes and Discharge Structures

908.03

4. The Contractor shall place joints and reinforcing steel as described in the contract.

5. The backfill shall be graded and compacted to the elevation of the top of the concrete structure as shown in the contract.

6. a. The concrete shall be placed the full thickness of the slab in one operation and shall be consolidated by tamping and the excess concrete screeded off flush with the forms.

b. The edges adjacent to all forms, expansion joints, curbs, or fixtures in the surface shall be thoroughly spaded for the full depth.

c. After consolidation, the surface shall be alternately tamped and struck off with a strike board until all voids are removed and the surface has the required grade and cross section.

7. The Contractor shall finish the edges with a suitable edging tool after the concrete has been floated.

8. The concrete shall be cured by one of the methods described in Section 603.

9. a. Concrete ditch liners shall have joints cut through them at least 25% of their slab thickness with an approved tool at intervals of not more than 8 feet (2.4 m).

b. The concrete shall be edged on both sides of the cuts.

c. Each cut shall be vertical and normal to the forms.

10. a. The concrete ditch lining footings and structure turndowns shown in the contract do not need to be formed if concrete is placed directly into excavated trenches that have smooth walls and level bases.

b. Footings and turndowns shall be placed monolithic with the ditch lining.

11. If the trenches are excavated larger than shown in the contract, the entire trench volume is still filled with concrete.

12. The Contractor shall dispose of all excess soil.

908.04 -- Method of Measurement

1. Concrete slope protection will be measured by the square yard (square meters) of finished surface area, including turndowns.

2. Concrete ditch lining will be measured by the Square Yard (SY) [Square Meter (m²)] or Linear Foot (LF) [Meter (meter)] along the center of the flow line and will be continuous through the end sections.

3. Concrete flumes and discharge structures shall be measured by the each.

908.05 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete Flume, Type _____	Each (ea)
Concrete Flume	Each (ea)
Concrete Discharge Structure	Each (ea)
Concrete Ditch Lining _____	Linear Foot (LF) [Meter (m)]
Concrete Ditch Lining _____	Square Yard (SY) [Square Meter (m ²)]
Concrete Slope Protection	Square Yard (SY) [Square Meter (m ²)]

2. In the event that more than one type of discharge structure is shown in the contract, an appropriate designation will be added to the pay item to differentiate as to the type or dimensions required.

3. a. The 28-day compressive strength of each day's production will be determined from cylinder strength tests.

b. Payment shall be reduced by the amount described in Table 603.03.

4. Payment is full compensation for all work described in this Section.

SECTION 909 -- INSTALLING TIE BARS

909.01 -- Description

1. The Contractor shall furnish and install transverse deformed steel tie bars in existing concrete slabs adjacent to new concrete pavement as described in the contract.

909.02 -- Material Requirements

1. Steel bars used shall be of the size and length specified in the contract and in conformance with Section 1020.

2. Grout shall be listed on the Department's Approved Products List.

909.03 -- Construction Methods

1. a. The Contractor shall drill tie bar holes to the depth shown in the contract. The diameter of the hole shall be at least 1/8-inch (3-mm) but not more than 3/8-inch (9-mm) larger than the bar diameter.

b. Wet or dry drilling operations may be employed.

c. Drilled holes shall be normal to the edge of the slab and level.

d. Dry-drilled holes shall be brushed with a stiff bristle brush and blown clean with oil-free, compressed air.

e. Wet-drilled holes shall be thoroughly washed after drilling to remove any residue.

2. Grout shall be placed in the holes so all of the embedded portion of the bar is bonded.

909.04 -- Method of Measurement

1. Tie bars are measured by the each.

909.05 -- Basis of Payment

1. Pay Item	Pay Unit
Tie Bars	Each (ea)

2. Payment is full compensation for all work described in this Section.

SECTION 910 -- RIGHT-OF-WAY AND BARBED WIRE FENCE

910.01 -- Description

1. The Contractor shall furnish materials and build the right-of-way fence or barbed wire fence, including gates, channel crossings, floodgates, private fence terminal installations, drainage structure terminal installations, concrete foundations, and other appurtenances as described in the contract.

910.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 910.01.

Table 910.01

Material Requirements	
Applicable Materials	Section
Fence	1064
Structural Timber and Lumber	1075

2. a. The concrete for use in fence post anchors and footings shall be a concrete mixture capable of achieving a minimum unit compressive strength of 1500 psi (10 MPa) at 28 days.

b. The aggregate shall be from acceptable sources.

c. The equipment used to mix, place, and finish concrete foundations for fences need not be calibrated.

910.03 -- Construction Methods

1. General.

a. The Engineer may designate certain portions or lengths of the right-of-way fence and barbed wire fence as essential to the beginning or continuation of other operations on the project. The Contractor shall conduct all operations so as to give priority to the erection of those portions or lengths of fence that are designated most essential by the Engineer.

b. (1) Where a fence is to be constructed parallel to the right-of-way lines, it shall be erected on the public right-of-way with the center of the posts 1 foot (300 mm) from the right-of-way line.

(2) Fencing materials shall be attached on the field side (private side) of the posts, except that on curves, the fencing materials shall be attached on the outside of the curves.

(3) The location of the fence shall be graded so that the fence will conform to the general contour of the ground.

2. a. Excavations shall be free of standing water or deleterious material before concrete is placed.

b. Where the concrete can be placed in dry excavation without the use of cribs or cofferdams and the nature of the soil is such that it will not slough or cave in, forms may be omitted at the discretion of the Engineer.

c. Care shall be exercised to prevent dirt, mud, or foreign material from becoming mixed with the concrete which is being placed.

d. Any excavation and backfilling work necessary in connection with the concrete footings shall be considered subsidiary to the posts, fence, or floodgates, as applicable.

3. a. All posts shall be set plumb.
- b. Concrete shall be allowed to cure for at least 24 hours before wire or fabric is placed.
- c. (1) Wood line posts may be driven or set in prebored holes and backfilled in layers not to exceed 6 inches (150 mm) and compacted with approved hand or mechanical tampers.
(2) Should the Contractor elect to drive posts, rather than set them in prebored holes, then all responsibilities and risks, including the posts splitting or breaking, are assumed by the Contractor.
(3) Posts damaged by driving shall be rejected, removed, and replaced with acceptable materials.
- d. Braces for wood posts shall be placed as indicated in the contract in 1 inch (25 mm) notches cut into the posts and nailed securely with at least 2 galvanized 20d [0.2 inch x 4 inch (5 mm x 100 mm)] common steel nails in each end.
- e. Cross ties shall be placed as indicated in the contract and shall consist of 4 strands of 0.146 inch (3.7 mm) diameter galvanized wire tightly wrapped at least twice around each post and the tie tightened by twisting the strands.
- f. The ties shall be fastened to the post with staples.
- g. Pull-posts shall be used at sharp breaks in vertical grades and approximately every 330 feet (100 m) on straight runs or as directed by the Engineer.
- h. Where the fence intersects or joins an existing fence, terminal installations shall be made in accordance with the details shown in the contract.
- i. Fence at stream crossings or drainage ways shall be installed in accordance with the details shown in the contract.
- j. (1) When indicated in the contract, terminal installations shall be made at drainage structures.
(2) The terminal installations shall consist of furnishing and erecting the end posts, complete with diagonal braces, and placing the 3 single strands of barbed wire as described in the contract.
(3) The eyebolts shall not be considered as a part of the drainage structure terminal installation.
(4) Each strand of barbed wire shall be tightly wrapped at least twice around the post and threaded at least once through the eyebolt.
(5) The loose ends, which shall be at least 4 inches (100 mm) in length, shall be tightly wrapped around the wire stretched between the eyebolt and the end post.
(6) The barbed wire shall be fastened to wood posts with staples.
- k. (1) The tension for stretching the fence material shall be applied by the use of mechanical fence stretchers designed for that purpose.

(2) Splices in the fabric and barbed wire shall be securely made with metal sleeves that have been approved by the Engineer before their installation.

(3) Fence fabric shall be fastened to all steel posts with wire ties at the top and bottom 2 wires and 3 other intermediate lateral wires, and to wood posts with staples on the same wires.

(4) Barbed wire shall be fastened to wood posts with staples and to steel posts with wire ties.

I. (1) When a power line runs parallel to and above the fence, the fence shall be grounded at 2,000 feet (610 m) intervals. When a power line crosses over the fence, the fence shall be grounded at the point where the power line crosses it.

(2) The ground shall include:

(i) A hard drawn, high conductivity, electrolytic copper or copper covered steel ground rod at least 8 feet (2.4 m) in length and having a minimum diameter of 0.56 inch (14 mm), driven vertically until the top is approximately 6 inches (150 mm) below the top of the ground.

(ii) A solid copper conductor securely fastened to the rod and to the fence with approved clamps so each element of the fence is grounded in accordance with *NEC* requirements.

4. a. Gates shall be constructed as described in the contract.

b. The wire fabric, barbed wire, and arrangement of the fence material shall be the same as used in the remainder of the fence.

c. The pipe shall be of the size shown in the contract.

d. The cinch fence stays shall be galvanized in accordance with Section 1063. The stays shall be twisted wire, 0.142 inch (3.6 mm) in diameter and 58 inches (1.5 m) in length.

e. The chains shall be galvanized common or proof coil chains with each link 1/4 inch (6 mm) in diameter and 12 links per foot (39 links per meter).

f. The top and bottom chains shall be furnished with a galvanized metal grab hook on one end.

g. Connections between the fabric and barbed wire and the posts and the installation of the cinch fence stays shall be securely made in accordance with the best industry practice and the fence manufacturer's recommendations.

5. The Contractor shall furnish padlocks as shown in the contract. They shall be 1 3/4 inch (44 mm) laminated type padlocks with one master key to open all padlocks. The Contractor shall deliver the keys and padlocks to the Engineer.

910.04 -- Method of Measurement

1. Private fence terminal installations, gates, floodgates, channel crossings, end posts, corner posts, pull posts, and drainage structure terminal installations will be measured by the each.

2. The quantity of "Right-of-Way Fence" is measured at the bottom of the fence fabric from center to center of posts in linear feet (meters). The lengths occupied by gates will not be included.

3. The quantity of "Barbed Wire Fence" is measured from center to center of posts in linear feet (meters). The lengths occupied by gates will not be included.

910.05 -- Basis of Payment

1. Pay Item	Pay Unit
Private Fence Terminals	Each (ea)
Floodgates, Type _____	Each (ea)
Channel Crossings, Type _____	Each (ea)
End Posts	Each (ea)
Pull Posts	Each (ea)
Corner Posts	Each (ea)
Gates	Each (ea)
Drainage Structure Terminals	Each (ea)
Right-of-Way Fence	Linear Foot (LF) [Meter (m)]
Barbed Wire Fence	Linear Foot (LF) [Meter (m)]

2. Padlocks are subsidiary to the gate.

3. Direct payment will not be made for concrete footings, excavation, and backfill. These items shall be considered subsidiary to the associated fence pay item.

4. Direct payment will not be made for electrical grounds, but they shall be considered subsidiary to the fence pay item attached to the electrical ground.

5. Payment is full compensation for all work described in this Section.

SECTION 911 -- CHAIN-LINK FENCE

911.01 -- Description

1. The Contractor shall furnish materials and build chain-link fence and gates, including takedown panels, channel crossings, access gates, floodgates, drainage structure terminal installations, private fence terminals, concrete foundations, and other appurtenances as described in the contract.

2. a. The Contractor shall furnish either zinc-coated steel fence fabric or aluminum-coated steel fence fabric.

b. All fence fabric furnished under the contract shall be of the same type.

c. The Contractor shall use tie wires that are the same material and coating as the fence fabric.

911.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 911.01.

Table 911.01

Material Requirements	
Applicable Materials	Section
Structural Timber and Lumber	1075
Fence	1064

2. a. The concrete used in fence post anchors and footings shall be any concrete mixture capable of achieving a minimum unit compressive strength of 1500 psi (10 MPa) at 28 days.

b. The aggregate shall be from acceptable sources.

c. Equipment used to mix, place, and finish concrete does not have to be calibrated.

911.03 -- Construction Methods

1. a. The Engineer may designate certain portions or lengths of chain-link fence as essential to the beginning or continuation of other operations on the project. The Contractor shall give priority to the erection of those portions or lengths of fence that are designated most essential by the Engineer.

b. (1) Where chain-link fence is to be constructed parallel to the right-of-way lines, it shall be erected on public right-of-way with the center of the posts 1 foot (300 mm) from the right-of-way line.

(2) Fencing materials shall be attached on the roadway side of the posts, except the fencing materials shall be attached on the outside of the posts on curves.

(3) The location of the fence shall be graded so that the fence will conform to the general contour of the ground.

2. The construction of concrete footings shall be performed in accordance with the requirements of Subsection 910.03, Paragraph 2.

3. a. (1) All posts shall be set in accordance with the requirements of Subsection 910.03.

(2) All posts shall be of the sizes and types shown in the contract.

(3) Tubular line posts shall have heavy malleable iron caps to hold the top rail and exclude moisture from inside the post.

(4) H-Section steel line posts shall be constructed or equipped with a suitable device to hold the top rail.

(5) All end, corner, and pull posts shall be furnished with braces, truss rods, turnbuckles, tension bands, and all fittings required to make a complete installation as shown in the contract.

b. Where the chain-link fence intersects or joins an existing fence, terminal installations shall be made in accordance with the details shown in the contract. Braces and cross ties shall be installed in accordance with the requirements of Subsection 910.03.

c. As indicated in the contract, variations in the requirements for fence construction will be required at stream crossings or drainage ways. The locations of these installations will be dictated by the topography and as directed by the Engineer.

d. When indicated in the contract, drainage structure terminal installations shall be made at structures. The terminal installation shall be made in accordance with the requirements of Subsection 910.03 except that chain-link fabric shall be used in place of barbed wire.

e. (1) The tension for stretching the fence material shall be applied by approved mechanical fence stretchers.

(2) Splices in the fabric shall be made according to the fence manufacturer's recommendations.

(3) The fabric shall be fastened to the top rail and posts with wire ties or clamps. Six fasteners, equally spaced, shall be used to fasten the fabric to each 10 feet (3 m) of rail; and 1 fastener shall be used for each foot (300 mm) of post height.

f. Where a power line crosses over the fence or parallels the fence, the fence shall be grounded in accordance with the provisions of Subsection 910.03.

g. Takedown panels shall be constructed in accordance with the details shown in the contract. All material used for the takedown panels shall be the same as those used for the remainder of the chain-link fence, including the tension bars and bands for the end, corner, and pull posts.

911.04 -- Method of Measurement

1. Private fence terminal installations, takedown panels, floodgates, access gates, channel crossings, end posts, corner posts, pull posts, and drainage structure terminal installations will be measured by the each.

2. The quantity of chain-link fence is measured at the bottom of the fence fabric from center to center of posts in linear feet (meters). The lengths occupied by takedown panels and gates will not be included.

911.05 -- Basis of Payment

1. Pay Item	Pay Unit
Private Fence Terminal for ____ Foot Chain-Link Fence	Each (ea)
Takedown Panel for ____ Foot Chain-Link Fence	Each (ea)
Floodgate, Type ____ for ____ Foot Chain-Link Fence	Each (ea)
Channel Crossing, Type ____ for ____ Foot Chain-Link Fence	Each (ea)
End Post for ____ Foot Chain-Link Fence	Each (ea)
Corner Post for ____ Foot Chain-Link Fence	Each (ea)
Pull Post for ____ Foot Chain-Link Fence	Each (ea)
Drainage Structure Terminal for ____ Foot Chain-Link Fence	Each (ea)
____ Foot Chain-Link Fence	Linear Foot (LF) [Meter (m)]
____ Gate ____ Foot Chain-Link Fence	Each (ea)

2. Direct payment will not be made for concrete footings, but they shall be considered subsidiary to the associated fence pay item.

3. Direct payment will not be made for electrical grounds, but they shall be considered subsidiary to the fence pay item attached to the electrical ground.

4. Payment is full compensation for all work described in this Section.

SECTION 912 -- SPECIAL SURFACE COURSE FOR MAILBOX TURNOUTS

912.01 -- Description

1. The Contractor shall furnish the materials, prepare the subgrade and/or shoulder, and construct a surface course for mailbox turnouts. This surface course shall be placed and compacted on the shoulder of the roadbed, adjacent to the surfacing, as described in the contract.

912.02 -- Material Requirements

1. The mailbox turnout surface course shall be constructed from asphaltic concrete material.

2. At the discretion of the Engineer, the following material may be used:

a. Coarse aggregate that complies with the gradation requirements for Class "E" aggregate in Section 1033, Table 1033.03A.

b. Bituminous aggregate salvaged from an existing bituminous mat or asphalt millings.

c. Fresh bituminous aggregate.

d. Any combination of the above approved in writing by the Engineer.

3. Salvaged material, at the time of placement, shall have been pulverized to comply with the following requirements:

	Min.	Max.
Total percent passing a 2 inch (50 mm) sieve	95	100
Total percent passing a 1 inch (25 mm) sieve	40	100

912.03 -- Construction Methods

1. The Contractor shall grade and shape the roadbed shoulder at the turnout location so the completed surface course will conform to the typical cross sections and dimensions shown in the contract.

2. a. The Contractor shall furnish and place any additional embankment necessary to complete the turnout to the typical cross section and dimensions shown in the contract.

b. Any additional embankment placed shall be compacted to conform to the requirements in Subsection 205.03, Paragraph 14.b.(2), Class "II" embankment.

3. This method of construction of the special surface course shall only apply to mailbox turnouts constructed with salvaged bituminous mat, asphalt millings, or coarse aggregate:

a. Aggregate, millings, and bituminous mat shall be placed in such quantities that the depth after compaction is equal to or greater than the minimum depth shown in the contract.

b. The materials shall be bladed to a uniform thickness over the described area.

c. The materials shall be compacted with a roller weighing at least 275 pounds per inch (4.9 Kg/mm) of tread of the rolling wheels. In lieu of using such a roller, the compaction may be accomplished by repeated coverage with the rear wheels of a motorgrader or heavily loaded truck.

d. If coarse aggregates are used, the Engineer may require the addition of moisture to facilitate the compaction of the surface course.

e. The compaction operations shall be continued until the finished surface course is dense and stable.

4. Asphaltic concrete mix areas shall be compacted with at least 2 passes of an approved roller.

912.04 -- Method of Measurement

- 1. Special surface course for mailbox turnouts is measured by the square yard (square meter).
- 2. Aggregates will not be measured and paid for separately.

912.05 -- Basis of Payment

- | | |
|---|--|
| 1. Pay Item | Pay Unit |
| Special Surface Course for Mailbox Turnouts | Square Yard (SY)
[Square Meter (m ²)] |
- 2. Asphaltic concrete, including PG Binder, is added to the quantities for those pay items.
 - 3. Payment is full compensation for all work described in this Section.

SECTION 913 -- RIGHT-OF-WAY MARKERS

913.01 -- Description

1. The Contractor shall furnish, install, and relocate right-of-way markers as described in the contract.

913.02 -- Material Requirements

1. Concrete shall be Class 47BD-3,000 (47BD-20).

2. Reinforcing steel shall meet the requirements of Section 1020.

3. One or more markers shall be broken to facilitate a visual inspection of the quality and dimensions of the concrete and reinforcing steel.

913.03 -- Construction Methods

1. The Contractor shall install and/or relocate the right-of-way markers as indicated in the contract.

2. The forms shall be designed so the finished marker will conform to the dimensions shown in the contract.

3. Reinforcement shall be placed and wired in position so that the reinforcing steel will not be displaced during concrete placement and consolidation.

4. The concrete shall be thoroughly consolidated by hand methods or mechanical vibration.

5. All surfaces shall be given an "Ordinary Surface Finish" in accordance with Subsection 704.03.

6. All markers cracked or broken in handling or delivery shall be rejected.

7. Markers removed during construction operations shall be stored near the site of removal and protected from all damage until they have been reset.

8. Excavation shall be made to the required depth and the markers set plumb and firm. The marker holes shall be at least 4 inches (100 mm) larger than each dimension of the marker's base. The area shall be backfilled with suitable material compacted with mechanical or hand tampers.

913.04 -- Method of Measurement

1. The quantity of "Right-of-Way Markers" is measured by the each.

2. The quantity of right-of-way markers that are reset is measured by the each.

913.05 -- Basis of Payment

1. Pay Item	Pay Unit
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Right-of-Way Markers	Each (ea)
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Reset Right-of-Way Markers	Each (ea)
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2. Removal of damaged markers shall be subsidiary to the marker pay item.

3. Payment is full compensation for all work described in this Section.

SECTION 914 -- PIPE UNDERDRAINS

914.01 -- Description

1. The Contractor shall furnish and install pipe underdrains, filter fabric, and underdrain headwalls as described in the contract.

914.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 914.01.

Table 914.01

Material Requirements	
Applicable Materials	Section
Corrugated Pipe Underdrains	1035
Plastic Pipe	1038

2. Gravel aggregate placed in the trench shall conform to the gradations shown in Table 914.02. The material shall have a Los Angeles Abrasion loss percentage (AASHTO, T-96) of not more than 40. The material shall also have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

Table 914.02

Granular Backfill Material		
Percent Passing		
English Sieve Size (Metric)	Target Value	Tolerance
1 inch (25 mm)	100	0
1/2 inch (12 mm)	94	±4
No. 4 (4.75 mm)	65	±25
No. 10 (2.00 mm)	20	±20
No. 50 (300 µm)	5	±5
No. 200 (75 µm)	3	±3

3. Granular backfill material shall be compacted to optimal stiffness as defined by a deflection target value established by the Engineer.

4. The trench should be lined with an approved filter fabric before filling with aggregate. The filter fabric shall be installed according to the contract details.

5. Filter fabric shall be on the Department's Approved Products List.

6. The filter fabric material will be chosen to accommodate the type of in-situ soils and within the manufacturer's requirements and limits.

914.03 -- Construction Methods

1. a. The trench for laying pipe underdrains shall be excavated beginning at the outlet end and proceeding toward the upper end, true to the required line and grade.

b. Trenches shall be of sufficient width to provide working space on each side of the pipe and in no case shall the width of the trench be less than 12 inches (300 mm).

c. Any material excavated below the proper grade shall be restored in kind to proper bearing capacity.

2. The perforated pipe shall be laid directly upon the floor of the trench. All loose material lying on the floor of the trench shall be removed prior to the placing of the perforated pipe. Grade and alignment shall not vary from the described grade by more than 0.03 foot (9 mm) at any point. The joints between sections of pipe shall be connected in a fashion acceptable to the Engineer.

3. Dead ends of pipe shall be tightly closed with satisfactory plugs. Discharge ends shall be protected with a suitable rodent screen.

4. If unsuitable foundation soils are present, other suitable material shall be placed under the pipe to prevent displacement.

5. a. Once the pipe is in place, it shall be covered immediately with Granular Backfill Material.

b. The Granular Backfill Material shall be of uniform depth on either side of the pipe.

6. Special inlets and special devices at the outlet end of the pipe shall be constructed as shown in the contract.

7. a. The underdrain headwalls shall be constructed as shown in the contract.

b. The concrete for the headwalls shall be Class 47B-3000 (47B-20 MPa) or BX-3000 (BX-20 MPa).

8. The Contractor shall place filter fabric as shown in the contract.

914.04 -- Method of Measurement

1. Each size of pipe underdrains shall be measured in linear feet (meters) along the centerline of the pipe.

2. Headwalls will be measured by the each.

914.05 -- Basis of Payment

1. Pay Item

Pay Unit

_____ Perforated Pipe Underdrain	Linear Foot (LF) [Meter (m)]
_____ Perforated _____ Pipe Underdrain	Linear Foot (LF) [Meter (m)]
_____ Nonperforated Pipe Underdrain	Linear Foot (LF) [Meter (m)]
_____ Nonperforated _____ Pipe Underdrain	Linear Foot (LF) [Meter (m)]
Underdrain Headwall	Each (ea)

2. Filter fabric is subsidiary to the appropriate underdrain pay item.

3. Granular backfill is subsidiary to the appropriate underdrain pipe pay item.

4. Payment is full compensation for all work described in this Section.

SECTION 915 -- GRANULAR SUBDRAINS

915.01 -- Description

1. The Contractor shall construct granular subdrains as described in the contract.

915.02 -- Material Requirements

1. Aggregate that is used in granular subdrains shall conform to the gradation requirements for Gravel Surfacing shown in Table 1033.07 of Subsection 1033.02.

915.03 -- Construction Methods

1. The Contractor shall excavate subdrain trenches to the dimensions and the elevations shown in the contract.

2. The Contractor shall provide and place aggregate in the trench as described in the contract.

3. After the aggregate has been placed, the trench shall be backfilled to the shoulder surface.

4. All backfill material shall be compacted to a density equal to the density of the adjacent shoulder.

5. Surplus material shall be disposed of on adjacent slopes.

915.04 -- Method of Measurement

1. The "Granular Subdrain" shall be measured by the each.

915.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|-------------------------------|-----------------|
| Granular Subdrain, Type _____ | Each (ea) |
| Granular Subdrain | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 916 -- CATCH BASINS, MANHOLES, INLETS, AND JUNCTION BOXES

916.01 -- Description

1. The Contractor shall construct catch basins, manholes, inlets, junction boxes, and similar concrete structures as described in the contract.

916.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 916.01.

Table 916.01

Material Requirements	
Applicable Materials	Section
Concrete Risers and Tops.....	1037
Portland Cement Concrete	1002
Reinforcing Steel	1020, 1022, 1023
Structural Steel.....	1045
Steel Castings	1050
Gray Iron Castings	1051
Paints and Paint Materials.....	1077

2. Concrete shall be Class 47B-3,000 (47B-20).

916.03 -- Construction Methods

1. The Contractor shall excavate to the dimensions shown in the contract.

2. The Contractor shall backfill as described in Section 702 for culverts.

3. Reinforcing steel shall be handled and placed in accordance with the requirements of Section 707.

4. Concrete construction shall be performed in accordance with the requirements of Section 704.

5. The foundation excavation shall be dewatered and stable before concrete is placed.

6. a. When footings can be placed on the dry excavation without the use of cribs or cofferdams, back forms may be omitted when the soil will provide a smooth, plumb surface.

b. Concrete placed outside the dimensions shown in the contract will be at no additional cost to the Department.

7. a. Structural steel and miscellaneous metals shall be fabricated and placed as provided in Section 708.

b. Castings shall be made in conformance with AWS Standard Specifications.

c. All castings shall be set on full mortar beds or otherwise secured as shown in the contract. They shall be set accurately to the correct elevation so that subsequent adjustments will not be necessary.

8. Structural steel shall be painted in accordance with the requirements of Section 709.

916.04 -- Method of Measurement

1. Manholes are measured by the each.
2. Concrete for catch basins, inlets, and junction boxes is measured as described in Section 704.
3. Reinforcement for catch basins, inlets, and junction boxes is measured as described in Section 707.
4. Structural steel and miscellaneous metals are measured by the pound (kilogram) and are included in the pay item "Structural Steel".
5. a. "Cast Iron _____" and "Castings" are measured by the pound (kilogram).
 - b. The weight of castings shall be computed by the Department from dimensions shown in the contract with an addition of 3% for fillets and overruns.

916.05 -- Basis of Payment

1. Pay Item	Pay Unit
Manhole _____	Each (ea)
Concrete for _____	Cubic Yard (CY) [Cubic Meter (m ³)]
Reinforcing Steel for _____	Pound (lb) [Kilogram (Kg)]
Epoxy Coated Reinforcing Steel _____	Pound (lb) [Kilogram (Kg)]
Structural Steel _____	Pound (lb) [Kilogram (Kg)]
Cast Iron _____	Pound (lb) [Kilogram (Kg)]
Castings	Pound (lb) [Kilogram (Kg)]

2. Excavation for catch basins, manholes, inlets, and junction boxes is subsidiary to the appropriate structure.
3. Concrete and reinforcing steel are subsidiary to "Manhole _____".
4. Concrete, except that used in the construction of manholes, shall be paid for in accordance with the provisions of Section 704.
5. Reinforcement, except that used in the construction of manholes, shall be paid for in accordance with the provisions of Section 707.
6. The depth of any manhole, except a precast manhole, may be increased or decreased from the depth indicated in the contract by not more than 1 foot (300 mm) without any adjustment in compensation. When the depth of a manhole is increased or decreased more than 1 foot (300 mm), the change in quantities and the adjustment in prices, when necessary to reflect the change in design, shall be recorded in a supplemental agreement.
7. Payment is full compensation for all work described in this Section.

SECTION 917 -- RECONSTRUCTION OF MANHOLES AND ADJUSTING MANHOLES TO GRADE

917.01 -- Description

1. The Contractor shall adjust the manhole elevations or reconstruct the manhole as described in the contract.
2. Adjusting a manhole elevation is defined as lowering the top 6 inches (150 mm) or less or raising the top not more than 1 foot (300 mm).
3. Reconstructing a manhole is defined as lowering the top more than 6 inches (150 mm) or raising the top by more than 1 foot (300 mm).

917.02 -- Material Requirements

Brick mortar shall be 1 part cement, 2 parts sand, and water as necessary to insure brick can be set at designed spacing.

917.03 -- Construction Methods

1. The Contractor shall:
 - a. Remove and replace the necessary surfacing to allow adjustment of the manhole.
 - b. Remove the castings and adjust the tops of the manholes by removing or adding concrete or brick, as the case may be.
 - c. Reset the frames and covers.
2. The work of reconstructing manholes or adjusting manholes to grade shall be performed in accordance with the requirements of Subsection 916.03 when concrete is used.
3. Bricks shall be approved by the Engineer. The bricks shall be bonded in mortar. All brick must be wetted before being placed. All joints shall be completely filled with mortar and shall be 3/8 inch (9 mm) thick.
4. The Contractor shall provide and set all cast iron covers, rings, frames, flanges, and other items as described in the contract.

917.04 -- Method of Measurement

1. Adjusting manholes to grade will be measured by the each.
2. Reconstructing manholes will be measured by the each.
3. Cast iron is measured by the pound (kilogram).

917.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---------------------------|-------------------------------|
| Reconstruct Manhole | Each (ea) |
| Adjust Manhole to Grade | Each (ea) |
| Reconstruct Manhole _____ | Each (ea) |
| Cast Iron _____ | Pound (lb)
[Kilogram (Kg)] |
2. Payment is full compensation for all work described in this Section.

SECTION 918 -- ABANDONING MANHOLES, INLETS, AND JUNCTION BOXES

918.01 -- Description

1. This work consists of demolishing manholes, inlets, and junction boxes and backfilling the area as described in the contract.

918.02 -- Material Requirements

1. Granular material in this Section is defined as material having 90% or more retained on the No. 200 (75 µm) sieve.

2. The backfill materials shall be compacted to the stiffness requirements for Class III embankment as described in Subsection 205.03, Paragraph 14.b.(3).

918.03 -- Construction Methods

1. The Contractor shall remove the manhole cover and the top cast iron flange.

2. The Contractor shall demolish the manhole, inlet, or junction box walls to at least 40 inches (1 m) below the finished grade elevation.

3. The Contractor shall plug all opening with concrete pipe plugs.

4. The Contractor shall demolish the floor of the structure. No piece shall be longer than 40 inches (1 m) in any dimension.

5. a. The Contractor shall fill the opening created by the demolition with granular material to within 40 inches (1 m) of the finished grade elevation.

b. The Contractor shall fill the remaining hole with soil and compact to the same stiffness as surrounding soils.

6. Materials which are removed and not salvaged shall be disposed of in accordance with requirements in Section 203.

918.04 -- Method of Measurement

1. "Abandon Manhole", "Abandon Inlet", and "Abandon Junction Box" are measured by the each.

918.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|----------------------|-----------------|
| Abandon Manhole | Each (ea) |
| Abandon Inlet | Each (ea) |
| Abandon Junction Box | Each (ea) |
2. Payment is full compensation for all work described in this Section.

SECTION 919 -- EQUIPMENT RENTAL

919.01 -- Description

1. The Contractor shall furnish, maintain, provide fuel, and operate equipment when the contract requires work on an "equipment rental" basis.

919.02 -- Equipment Requirements

1. Motorgraders shall be the self-propelled type, either tandem or all-wheel drive, equipped with pneumatic tires. They shall be equipped with a moldboard at least 12 feet (3.65 m) long with a suitable cutting edge, a scarifier with 9 or more teeth having minimum dimensions of 3 inches x 1 inch x 16 inches (75 mm x 25 mm x 400 mm), and power-operated controls. They shall be propelled by engines having a manufacturer's rating of at least 115 brake horsepower (85,755 brake watts).

2. Multiple-wheel, pneumatic-tired rollers shall be constructed so that they can be loaded to a gross weight of 200 pounds/inch (3.6 Kg/mm) of tire width. The internal pressure in the tires shall be at least 25 psi (172 kPa), and the tires on the front and rear axles shall be staggered so that they will cover the entire area over which the roller travels.

3. Tamping or sheepsfoot rollers shall consist of a cylindrical metal roller, drum, or shell studded with tamping feet projecting not less than 7 inches (175 mm) from the surface of the roller, drum, or shell. The tamping feet shall be spaced not less than 6 inches (150 mm) or more than 10 inches (250 mm) measured diagonally center to center in any direction, and the face area of each shall be not less than 4 square inches (2,580 mm²) nor more than 12 square inches (7,740 mm²).

4. Wheel tractors shall be a farm or industrial type tractor equipped with pneumatic tires and capable of pulling the rollers and trailer type rotary tillers described herein. The tractors shall be propelled by engines having a manufacturer's rating of at least 46 belt horsepower (34,300 belt watts).

5. Crawler tractors and scrapers shall be crawler-type tractors and scrapers that are designed to operate as a unit. The crawler tractors shall be propelled by engines having a manufacturer's rating of at least 100 drawbar horsepower (74,570 drawbar watts). The scrapers shall be equipped with pneumatic tires and shall have a minimum struck capacity of 13.5 cubic yards (10.3 m³).

6. Tractors and scrapers shall be pneumatic-tired tractors and pneumatic-tired scrapers that are designed to operate as a unit. The tractors shall be propelled with engines having a manufacturer's rating of at least 101 brake horsepower (75,300 drawbar watts). The scrapers shall have a minimum struck capacity of 6.5 (5 m³) cubic yards (10.3 m³).

7. Loading equipment shall be a unit or units capable of excavating soil in its original position and loading the excavated material into dump trucks. The equipment shall be of such size and capacity that it can excavate and load at least 52 cubic yards (40 m³) of soil each hour.

8. Draglines shall be the full-revolving type with booms not less than 32 feet (9.8 m) long, a manufacturer's rated capacity of at least 3/4 cubic yard (0.6 m³), and a Power Crane Shovel Association rating of at least 15 tons (13.6 Mg). The bucket shall in no case be larger or smaller than that for which the machine is designed.

9. Crawler tractors and bulldozers shall consist of crawler-type tractors and bulldozers, or angle-dozers that are designed to operate as a unit. The crawler tractors shall be propelled by engines having a manufacturer's rating of at least 100 drawbar horsepower (74,570 drawbar watts).

10. Dump Trucks:

a. Dump trucks shall be standard make trucks having a manufacturer's rating of at least 2 tons (1.8 Mg). They shall be equipped with power-operated hoists and dump boxes of the end dump type having a volumetric struck capacity of at least 5 cubic yards (3.8 m³).

b. Dump trucks shall be properly licensed and shall not exceed the statutory limitations in dimensions or wheel and axle loads.

c. Dump trucks shall have all applicable insurance coverage.

11. Side/End Dump Tractor Trailers:

a. Truck Tractors and Dump Trailers shall be standard make trucks and trailers having a manufacturer's rating of at least 20 tons (18 Mg). They shall be equipped with power-operated hoists and dump boxes having a volumetric struck capacity of at least 25 cubic yards (19 m³).

b. Dump Tractor/Trailers shall be properly licensed and shall not exceed the statutory limitations in dimensions or wheel and axle loads.

12. Rotary tillers shall be pulverizing and mixing units consisting essentially of a power-driven rotor fitted with tines or teeth. The rotor unit may be mounted on either a pneumatic-tired tractor or a trailer. Each unit shall include 2 rotor assemblies fitted with tines made of spring steel. One rotor shall be designed for pulverizing and the other for mixing. Each rotor shall have a minimum effective width of 6 feet (1.8 m). Sufficient power shall be provided to drive the rotor at efficient speeds for both pulverizing and mixing operations. Suitable devices shall be provided to allow easy and positive adjustment of the depth of cut and the lowering and raising of the rotor to and from the cutting position.

13. Disc harrows shall be of the construction type with off-set discs having a diameter of not less than 22 inches (560 mm).

14. Skid loaders shall be loaders or tractors with a minimum operating lifting capacity of 1,100 pounds (500 Kg).

15. Crawler Mounted Hydraulic Excavators shall be crawler-type units capable of excavating soil in its original position and loading the excavated material into dump trucks. The minimum operating weight shall be 13.2 tons (12 Mg).

919.03 -- Construction Methods

1. Equipment shall be operated within all manufacturer's operating parameters.

919.04 -- Method of Measurement

1. a. The hours of equipment rental shall be measured as the time the equipment is required by the Engineer at the site, even though the actual operation of the equipment, at times, may be intermittent.

b. The Engineer shall exclude from the measured time:

(1) Time expended in moving to and from the work, other than necessary travel time within the project limits.

(2) Time when no crew is available to operate the equipment.

(3) Time expended in repairing and servicing the equipment.

2. Delivery of the equipment is measured by the each for each equipment item rented.

919.05 -- Basis of Payment

1. Pay Item	Pay Unit
Rental of _____	Hour (h)
Deliver _____	Each (ea)

2. The cost of all repairs, depreciation, insurance, taxes, and other incidental costs, including all wage expense incurred for operators, forepersons, supervisors, and timekeepers, is subsidiary to equipment rentals.

3. Payment will be made to the Contractor for delivery of equipment that is ordered as equipment rental in accordance with these Specifications when such equipment is not normally required in the performance of the other major items of work in the contract.

4. When the contract includes items of equipment rental and does not include a corresponding item for delivery of the equipment, the furnishing, delivery, and operation of the equipment is subsidiary to the contract unit price for rental of that equipment.

5. Payment is full compensation for all work described in this Section.

SECTION 920 – DAMPPROOFING

920.01 -- Description

1. The Contractor shall furnish materials and dampproof surfaces as shown in the contract.

920.02 -- Material Requirements

1. Priming coat:

a. When coal-tar pitch is used in dampproofing, the creosote primer shall conform to the requirements of ASTM D 43.

b. When asphalt is used in dampproofing, the asphaltic primer shall conform to the requirements of ASTM D 41.

2. Mopping coat:

a. Coal-tar pitch, when used as a mopping coat in dampproofing, shall conform to the requirements of ASTM D 450.

b. Asphalt, when used as a mopping coat in dampproofing, shall conform to the requirements of ASTM D 449, Type II.

3. Materials for dampproofing shall be approved based on a certificate of compliance from the supplier stating that they conform to the above requirements.

920.03 -- Construction Methods

1. All surfaces to be dampproofed shall be free from dust, sand, mud, mortar, and other deleterious particles. All grease spots or marks of oil shall be removed by washing with a rag dipped in solvent. All surfaces shall be allowed to dry thoroughly before applying dampproofing. Work may be started as soon as the forms are removed.

2. After the surfaces have been thoroughly cleaned and dried, they shall be uniformly coated with 1 coat of primer and 2 coats of hot asphalt or coal-tar pitch. The primer may be applied cold, but the asphalt or coal-tar pitch shall be applied with a mop at a temperature of at least 250°F (121°C). Dampproofing shall be performed only in dry weather and when the temperature is above 41°F (5°C). Each coating shall be allowed to dry before the next coating is applied.

3. The primer shall be applied in quantities sufficient to thoroughly cover the surfaces to be treated. The total dampproofing application shall be not less than 6 gallons per 100 square feet (2.5 L/m²) of horizontal surface and 5 gallons per 100 square feet (2.25 L/m²) on vertical surfaces.

4. Care shall be exercised to confine all dampproofing materials to the areas being treated and to prevent disfigurement of any part of the structure by dripping or spreading of asphalt.

920.04 -- Method of Measurement

1. The dampproofing will be measured in square yards (square meters).

920.05 -- Basis of Payment

- | 1. Pay Item | Pay Unit |
|---|---|
| Dampproofing | Square Yard (SY)
[Square Meters (m ²)] |
| 2. Payment is full compensation for all work described in this Section. | |

SECTION 921 -- MAILBOX POSTS

921.01 -- Description

1. The Contractor shall install and assemble mailbox posts and brackets. The Contractor will not be required to install the mailbox.

921.02 -- Material Requirements

1. The Department will furnish the posts, brackets, and fasteners. The Contractor will be required to pick up the post assembly at one of the permanent maintenance headquarters. (See Subsection 422.02).

921.03 -- Construction Methods

1. The post assembly shall be installed as shown in the contract. The Contractor will be required to use a follower block to protect the post during driving.

921.04 -- Method of Measurement

1. Mailbox posts are measured by the each.

921.05 -- Basis of Payment

- | 1. Pay Unit | Pay Unit |
|--------------------------|-----------------|
| Mailbox Post | Each (ea) |
| Remove and Reset Mailbox | Each (ea) |
2. Payment is full compensation for all work described in this Section.

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SECTION 1001 -- GENERAL MATERIALS DEFINITIONS AND REQUIREMENTS

1001.01 -- General

1. Materials used in Department contracts shall meet the requirements described in Division 1000.

2. The Department has five methods of accepting material characteristics that are incorporated into the project. The methods of acceptance are listed below:

- a. Sample/Test
- b. Certification of Test (COT)
- c. Certification of Compliance (COC)
- d. Department's Approved Products List
- e. Visual

3. Descriptions of the methods of acceptance listed above are described in the following sections.

4. Material characteristics may be accepted using one or more methods of acceptance, with the exception of the Department's Approved Products List.

1001.02 -- Certified Tests

1. Most certified tests, sampling frequencies, and material certifications are identified and their procedures outlined in the Department's *Materials Sampling Guide* and the *Standard Method of Tests*.

2. The contract shall identify other certification tests which are required and the number of copies of certification reports to provide.

3. Sample and Tests: This method of acceptance is when a material is accepted based on physical tests characteristics, conducted by a qualified laboratory, as described in the associated material specifications.

4. Certificate of Compliance (COC): Certificate of Compliance shall state that the material or item meets all requirements defined for the project. Each COC will include all pertinent data for the materials represented by the certificate.

a. COC shall be signed by the manufacturer's authorized representative and indicate the representative's job title.

5. Certificate of Tests (COT): Manufacturer's Certificate of Tests shall show the required test results and certify that they are correct. In some instances, such as steel for reinforcement, the process of manufacture must also be shown.

a. COT shall be signed by the manufacturer's authorized representative and indicate the representative's job title.

6. Manufacturer's certified tests, reports, and certificates of compliance shall show:

- a. The project number.
- b. The name of the Contractor.
- c. Data analyzed (reports only).

- d. Tests performed.
- e. The quantity of material covered. (Indicate lot numbers.)
- f. The Department's specifications that the product is in compliance with.
- g. Signature and title of an authorized representative.

7. Materials which must be documented by a certificate of compliance, certified tests, or test reports, shall not be incorporated into the work until such documents have been delivered to the Engineer and verified for compliance.

a. The Contractor will be notified by the Engineer if the material is not acceptable for use in the project.

8. The cost of providing the COC, the COT and all expenses incurred regarding testing and sampling will not be paid for directly. This will be considered subsidiary to items for which the contract provides direct payment.

1001.03 -- Department's Approved Products List

1. Materials identified on the Department's Approved Products List may be incorporated into the work by notifying the Engineer of the specific brand name that is to be used.

2. Materials identified on the Department's Approved Products List do not require additional methods of acceptance for the approved application.

3. Materials added to the Department's Approved Products List after the letting date of a project may be incorporated into the work even though they were not listed on the letting date.

4. Materials not identified on the Department's Approved Products List may be used, provided the following criteria are met and approved by the Engineer:

a. The specifications or special provisions specify that the material must meet appropriate ASTM, AASHTO, Federal, other specifications, and;

b. There are no other Department specification requirements such as required testing by the Department prior to use, and;

c. A certificate of compliance and/or certified test report is submitted to the Engineer by the Contractor prior to incorporating the material into the work.

5. a. Suppliers and vendors with materials that may qualify for addition to the Department's Approved Products List may use the New Products Evaluation Request Form found on the Department website.

b. Products may also be submitted on-line, through the Department's website.

1001.04 -- Visual Acceptance

1. Materials, as determined by the department, may be accepted by visual inspection by the Engineer.

SECTION 1002 -- PORTLAND CEMENT CONCRETE

1002.01 -- Description

1. Concrete shall consist of aggregate, Portland cement, water, approved air-entraining and other admixtures, and pozzolans as required or allowed by these Specifications.

2. All pay items that include the class of concrete will have the appropriate designation added to the pay item to show the 28-day compressive strength. For example: 47B concrete with a 28-day compressive strength requirement of 3500 psi (25 Mpa) shall be identified as Class 47B-3500 (47B-25). The 7-day compressive strength should be 70% of the 28-day compressive strength.

1002.02 -- Material Characteristics

1. All materials shall conform to the requirements in Table 1002.01.

Table 1002.01

Material Requirements	
Applicable Materials	Section
Portland Cement.....	1004
Water for Concrete	1005
Concrete Aggregate.....	1033
Fly Ash.....	1008
Admixtures.....	1007
Silica Fume.....	1009

- a. Concrete mixes will be in accordance of Table 1002.02
2. The Contractor may elect to substitute an acceptable class of concrete shown in Table 1002.03 at no additional cost to the Department. The Engineer shall be notified of any substitutions before batching the concrete.
3. Type IP, IS and IT Interground/Blended cement shall be used for all classes of concrete except for pavement repair. Type IP, IS and IT Interground/Blended cement shall meet all requirements of ASTM C 595. Pavement repair shall include Type I/II Portland cement for Class PR1 concrete and Type III Portland cement shall be used in Class PR3 concrete.
4. Temperature Requirements:
 - a. The temperature of the mixed concrete shall be not less than 50°F (10°C) immediately after being placed.
 - b. When the air temperature in the shade and away from artificial heat is less than 35°F (2°C), the Engineer may require the water and/or aggregates to be heated to not less than 70°F (21°C) nor more than 150°F (65°C), such that the temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement.
 - c. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. Aggregates may be heated in bins with a steam-coil or water-coil system or by other methods which are not detrimental to the aggregates.

d. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The apparatus used shall heat the aggregate uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might damage the aggregates.

e. Steam may be used to heat aggregates. When live steam is used in stockpiles, it shall be used in such a manner as to preclude excessive moisture variations within the material. Material containing frost or frozen material shall not be used in the mix.

ENGLISH

Table 1002.02

Class of Concrete (1)	Base Cement Type	Total Cementitious Materials Min. lb/cy	Total Aggregate	
			Min. lb/cy	Max. lb/cy
47B**	IP/IT*	564	2850	3150
47B***		564	2850	3150
47BD		658	2500	3000
47B-HE		752	2500	3000
BX ₍₄₎		564	2850	3150
47B-OL****		564	2850	3200
PR1	I/II	752	2500	2950
PR3	III	799	2500	2950
SF ₍₅₎	I/II	589	2850	3200

Table 1002.02 (Continued)

Class of Concrete (1)	Air Content % Min.-Max. (2)	Ledge Rock (%)	Water/Cement Ratio Max. (3)	Required Strength Min. psi
47B**	6.5 -9.0	-	0.45	3500
47B***	6.0 - 8.5	-	0.45	3500
47BD	6.0 - 8.5	30+3	0.42	4000
47B-HE	6.0 - 8.5	30±3	0.40	3500
BX ₍₄₎	6.0 - 8.5	-	0.45	3500
47B-OL****	5.0-7.0	30±3	0.36	4000
PR1	6.0 - 8.5	30±3	0.36	3500
PR3	6.0 - 8.5	30±3	0.45	3500
SF ₍₅₎	6.0 - 8.5	50±3	0.36	4000

(1) Each class of concrete shall identify the minimum strength requirement, per the contract. For example, where the last four digits indicate the psi. In the table above, strength of 3,500 psi is indicated for 47B-3500; however, other strengths may be authorized elsewhere in the contract. The classes shown in the chart are typical examples.

All classes of concrete shall be air-entrained and a water-reducing admixture shall be used per manufacture’s recommendations.

- Class R Combined Aggregate shall use a mid-range water reducer admixture. The dosage shall be at the manufacture’s recommendation and the Engineer may approve a low-range water reducer admixture.

(2) As determined by ASTM C 138 or ASTM C 231.

FOR INFORMATION ONLY. The Contractor may develop a Quality Control Program to check the quantity of air content on any given project; such as, checking the air content behind the paver.

(3) The Contractor is responsible to adjust the water/cement ratio so that the concrete supplied achieves the required compressive strength without exceeding the maximum water/cement ratio. The minimum water/cement ratio for any slip form concrete pavement is 0.38, unless the Contractor requests approval from the Engineer in writing to change the minimum water/cement ratio to 0.36.

(4) For temporary surfacing, Type I/II cement is allowed.

(5) Minimum Portland Cement shall be 564 lbs/cyds and the total Silica Fume added shall be 25 lbs/cyds.

(*) Refer to Subsection 1004.02 for material characteristics.

Lithium Nitrate may be used in place of Supplemental Cementitious Materials (SCMs), see Section 1007 of the Standard Specifications.

(**) For slip form applications.

(***) For hand-pours and substructures applications.

(****) When IP using Class N pozzolan, the maximum water/cement ratio is 0.41.

Table 1002.03

Table of Acceptable Concrete Class Substitutions	
Class Specified	Acceptable Class for Substitution
BX	47B, 47BD or 47B-HE
47B	47BD, or 47B-HE

5. Class PR1 and PR3 Concrete:

a. The calcium chloride for use in PR concrete shall be either:

(1) A commercially prepared solution with a concentration of approximately 32% by weight.

(2) A Contractor prepared solution made by dissolving 4.5 pounds (0.54 Kg) of Grade 2 or 6.2 pounds (0.74 Kg) of Grade 1 calcium chloride per gallon (liter) of water to provide a solution of approximately 32% by weight.

b. The 7.4 pounds (10.89 Kg) of water in each gallon (liter) of solution shall be considered part of the total water per batch of concrete.

c. The calcium chloride solution shall be added, just prior to placement, at a rate of 0.375 gallons/100 pounds of cement (1.4 lb. calcium chloride per 100 lb. cement) [3.13 L/100 Kg of cement (1.4 Kg calcium chloride per 100 Kg cement)].

d. Class A, Flaked or Pellet Calcium Chloride shall be added at a rate not to exceed 2.0% of the weight of the cement for Grade 1, or 1.6% of the weight of the cement for Grade 2. Grade 1 Calcium Chloride purity is between 70 and 90% and Grade 2 Calcium Chloride is between 91 and 100%.

e. Where mixing trucks are used:

(1) For Class PR3 concrete, calcium chloride shall be thoroughly mixed into the concrete before placement. The minimum mixing time is 2 minutes.

(2) For Class PR1 concrete, calcium chloride shall be added first and then the concrete mixed at least 2 minutes or as required by manufacture. Next, the Type F high range water-reducer admixture is added and the concrete is mixed an additional 5 minutes.

6. Class High Early (HE) Concrete

a. High Early (HE) strength concrete shall be cured as described in Subsection 603.03, Paragraph 7. The contractor shall take necessary curing measures so the required strength is achieved.

b. High early concrete shall achieve a compressive strength of 3,500 psi (25 MPa) at 48 hours after placement.

c. The 48-hour compressive strengths shall be used to determine pay factor deductions for high early concrete in accordance with Table 603.03.

d. A non-calcium chloride accelerator shall be used when the ambient temperature at the time of the placement of concrete is 70°F or less.

e. When requested by the Contractor, the maturity method, as provided in NDOT C 1074, may be used in lieu of the requirements of Subsection 603.03, Paragraph 11.c. and d. to determine the strength of concrete pavement for the purpose of early opening to traffic and acceptance. Requests by the Contractor for use of the maturity method shall be on a project basis and shall be made in writing to the Engineer.

7. The yield of the concrete proportions shall be determined by the Producer.

8. All Classes of Concrete with the exception of PR1 and PR3 shall have a Durability Factor not less than 70 and a mass loss not greater than 5% after 300 freeze/thaw cycles when tested in accordance with ASTM C 666. The freeze/thaw testing shall be conducted according to Procedure A.

1002.03 -- Procedures

1. The Contractor shall identify the plant that will supply the concrete 14 days before use and be entirely responsible for its calibration, batching of

concrete, aggregate and sampling of cement per Department's Sampling Guide.

a. The Contractor shall be responsible for the following:

(1) Batching concrete.

(2) Contractor shall sample aggregate from the conveyor belt or stockpile. Gradations from a split sample shall be tested in accordance to Section 1033 and reported to the Engineer at the frequency required by the Department's Materials Sampling Guide.

(i) Contractor shall retain possession of the split samples on-site at the Contractor's facility until such a time disposal is approved by the Engineer.

(a) At the pre-construction meeting:

i. Contractor shall determine the location of testing and report the names of the technician performing the sampling and testing.

ii. Engineer will notify the Contractor of the retrieval of the split samples.

(ii) The Contractor shall split the sample, place the Department's split sample into a cloth bag and immediately seal the split sample with the provided security seal. The cloth sample bag shall be supplied by the Department.

(iii) The sampling splitting and placement of the security seal of aggregate samples shall be witnessed by certified Department personnel.

(iv) Contractor shall secure the split sample using a consecutively numbered security seal of 75 pounds breaking strength provided by the Department. The Contractor shall use the consecutively numbered security seals to identify and track each Aggregate Class. Samples that are not consecutively numbered will be investigated for custody of the sample and the Engineer may cease production until it is determined what action will be required.

(a) The Contractor shall report the security seal tracking number with the split sample gradation.

(b) The following training shall be required for personnel who oversee the batching of the concrete:

i. Concrete Technician Personnel

[1] Concrete Plant Technician

ii. Portland Cement Sampler

[1] NDOT Portland Cement Sampler

2. Portland cement concrete shall be supplied by certified Ready Mix Plants that are in compliance with the requirements in the *Quality Control Manual*, Section 3, -- Certification of Ready Mixed Concrete Production Facilities published by the National Ready Mixed Concrete Association. Refer to the Department's Material Sampling Guide for the policy on stationary and portable plants.

Table 1002.04

Specific Gravity Correlation Factors			
Specific Gravity	Correction Factor	Specific Gravity	Correction Factor
2.75	1.050	2.62	1.000
2.70	1.030	2.61	0.997
2.69	1.026	2.60	0.993
2.68	1.022	2.59	0.989
2.67	1.019	2.58	0.985
2.66	1.015	2.57	0.981
2.65	1.012	2.56	0.977
2.64	1.008	2.55	0.974
2.63	1.004	2.50	0.955

3. When the pavement is constructed under a Quality Control/Quality Assurance specification, the Contractor shall have a furnished testing laboratory on the project site. In the event the concrete is obtained from a commercial supplier, the supplier shall have a furnished testing laboratory at the site where the concrete is produced.

4. a. Mix times shall meet the requirements of ASTM C 94. Mixing time tests shall be repeated whenever the concrete appearance indicates that mixing was inadequate.

b. Batch plants that are transporting the concrete in non-agitating trucks, the mixing time will not be less than 60 seconds, and for agitating trucks, the mixing time will not be less than 45 seconds.

c. The Certification of stationary and portable ready mix plants will conform to the tests that are required in the Department's Materials Sampling Guide.

5. The Contractor shall furnish the Engineer a weekly concrete placement schedule that is updated as necessary. The Engineer may observe any or all of the procedures and shall have access to all reported data during production and placement. Any inconsistencies shall be reported to the job superintendent and noted in the Engineer's diary.

6. Batch tickets shall be prepared as described in the National Ready Mixed Concrete Association's *Quality Control Manual*. The Contractor shall keep all gradations and batch tickets until final acceptance by the Department. Projects that have less than 200 cubic yards of concrete placed will be allowed to have hand written tickets. For projects greater than 200 cubic yards, hand written tickets will be at the Engineer's discretion. The concrete batch tickets shall show batch weights, aggregate moisture (shall be tested daily and moisture probes are allowed), admixtures used, water, and mix design calculations. A copy of the batch ticket shall be given to the Engineer upon delivery of concrete.

7. Aggregates from different sources shall be stockpiled separately. Aggregates produced by pumping from different pits in the Platte River Valley shall be considered to be from the same source. Aggregate production and quality of concrete are subject to the approval of the Department.

8. Coarse aggregate and aggregate from a dry pit shall be uniformly saturated with water before it is used. The wetting shall begin 24 hours before concrete mixing to allow complete saturation.

9. Cementitious Materials:

a. Cementitious materials shall be stored separately according to material type, class, and source. Similar materials from different sources shall not be mixed or stored together or used alternately in the same concrete placement without permission of the Engineer.

b. When the same scale is used to weigh more than one cementitious material, the weight of the Portland cement shall be determined first.

c. Cementitious materials shall be stored in watertight bins.

10. Concrete mixers shall have a 1/4 inch (6 mm) diameter drilled hole at the midpoint of each blade located at the point(s) recommended by the manufacturer.

11. Concrete transported in truck mixers or agitators shall be discharged within 90 minutes after the introduction of the cement to the aggregate. In hot weather, or under other conditions contributing to stiffening of the concrete, a shorter time may be specified by the Engineer.

12. Concrete transported in non-agitating trucks (i.e., dump trucks) shall be discharged within 30 minutes after the introduction of the cement to the aggregate. In hot weather, or under other conditions contributing to stiffening of the concrete, a shorter time may be specified by the Engineer.

13. Water:

a. The quantity of water shall be determined by the Contractor. The minimum quantity of water should be used which will produce the required workability. Any additional water used to rinse the charging hopper and fins after the batching of concrete is allowed. This water must be estimated and recorded on the batch ticket.

b. If the water/cement ratio is varied by more than 1%, an air test shall be performed and cylinders made to determine if the concrete is acceptable.

c. Water added to any mix must pass through an approved and adjustable water-measuring device.

14. Additional Water:

a. If additional mixing water is added, a minimum of 20 revolutions of the truck mixer drum at mixing speed shall be required.

b. In no case shall the total amount of water in the batch exceed that allowed in Table 1002.02.

c. No water may be added after discharge has begun.

15. Mobile mixers:

a. Mobile mixers shall be self-contained and continuously mix the concrete.

b. The mixer shall be self-propelled and shall be capable of carrying unmixed, dry bulk cement, aggregate, and water.

c. The mixer shall measure the volume of cement added to the mix. A recording meter visible at all times and equipped with a ticket printout shall indicate this quantity.

d. Water flow into the mixing chamber shall be automatically controlled. Water flow shall be indicated by flow meter and shall be readily adjustable to provide for minor variations in aggregate moisture.

e. The Contractor shall calibrate the aggregate gates once each year. However, the cement meter must be calibrated at each project site. The Engineer shall be given advance notice of the calibration tests so they can be observed.

16. Hand mixing will be allowed only on small jobs or in the case of an emergency. When hand mixing is allowed, it shall be done on a watertight platform.

1002.04 -- Acceptance Requirements

1. Class 47B Concrete Mix Design Submittal:

a. The Contractor shall submit the Concrete Mix Design Worksheet consisting of design mix proportions, testing of mix design from a minimum of 4 cubic yards and aggregate data for 47B class of concrete being placed on the project.

(1) All testing must be performed by a qualified laboratory found on the Department's Material and Research website, under the Nebraska Qualified Consultant & LPA Laboratories and submitted to the Engineer.

(2) The Concrete Mix Design shall be submitted to the Engineer 4 weeks prior to any concrete being placed on the project.

(3) The Concrete Mix Design shall not be paid for directly by the Department and shall be subsidiary to items which direct payment is made.

(4) Concrete shall not be placed on the project before the Concrete Mix Design Worksheet has been reviewed and approved by the Engineer.

b. The Contractor shall submit the Concrete Mix Design Worksheet to the Engineer. Email submissions are preferred but will be accepted by fax or postal mail.

(1) Contractor's Mix Design Worksheet can be found on the Materials and Research website. The submitted Mix Design Worksheet shall include the following:

- Contractor Name
- Project Number
- Date
- Location of ready mix or central mix plant
- Date submitted
- Signature of Contractor representative

(2) Material Source Information.

- Cement Manufacturer
- Type of Interground/Blended Cement
- Type of Admixtures
- Aggregate Pit and Quarry location

(3) Specific Gravity of each individual aggregate source.

(4) Sand Equivalent for dry pit sand-gravel aggregate.

(5) Combined Aggregate percent passing as described on Table 1033.03C.

(6) Contractor's Target combined aggregate gradation percent passing.

(i) The Contractor's required worksheet can be found on the Materials and Research website.

(7) Testing of Mix Design:

(i) The mix design shall show the weights of all ingredients including Interground/Blended cements, aggregates, water, admixtures types and water cement ratio.

• Temperature of concrete at time of sampling, ASTM C 1064.

• The air content of plastic concrete, ASTM C 231.

• Weight per cubic foot, Yield, ASTM C 138. The relative Yield shall be a minimum of 97%.

• Compressive strength shall be performed with a minimum of three averaged specimens at 7-day and 28-day, ASTM C 39. The minimum 28-day compressive strength shall be 3500 psi.

(8) Traditional 47B Mix Design is defined as an IP(25) cement, 70% Class B Aggregate and 30% Class E Aggregate may be exempt from the concrete testing described in Paragraph 1.(b)(7). All other requirements shall be included in the Concrete Mix Design Report.

c. The PCC Engineer will notify the Contractor of the mix design approval for Class 47B Concrete. Approval of the mix design does not alleviate the Contractor of the responsibility of the in-place concrete. The Contractor may adjust admixtures, water cement ratio, vibrator frequency, etc., as needed in accordance to the specifications.

d. The Contractor shall submit a new concrete mix design worksheet meeting the above requirements when a change occurs in the source, type, or proportions of cements or aggregates; unless otherwise approved by the Engineer.

2. The quantity of water to be used shall be determined by the Contractor. It shall not be varied without the Engineer's consent.

3. If the concrete mixture is excessively wet causing segregation, excessive bleeding, excessively dry or any other undesirable condition, the concrete shall be rejected. At the option of the Engineer, slump tests may be performed to determine the consistency.

4. Concrete which has developed initial set before it is consolidated and finished shall be rejected.

5. a. If false set is encountered, the batching operation shall be stopped until the problem is resolved.

b. Each batch must be mixed or agitated for at least 3 additional minutes after observing the false set and the concrete must be of satisfactory consistency.

6. Compressive strength tests shall be made in accordance with ASTM C 39.

7. Concrete shall be sampled as described in the Department's Materials Sampling Guide. Samples shall be taken at the point of placement, never before the discharge from the last conveyance.

8. Aggregate Acceptance, Verification, Sampling and Testing:

a. The aggregate will be accepted based on the Contractor's testing results except as noted below.

b. The aggregate verification sampling and testing by the Department will be randomly selected and tested according to subplot sizes in Table 1002.05.

Table 1002.05

Aggregate Class	Lot	Sublot
E and F	3000 tons	1000 tons
A, B and C	6000 tons	2000 tons
R	6000 tons	2000 tons

c. The results of Contractor split sample will be verified by the Department's verification tests. Any samples outside of the tolerances as specified according to the Materials Sampling Guide, Section 28 under the Acceptable Tolerance Limits for Independent Assurance will result in an Independent Assurance (IA) review of testing and may result in the Department test results being applied.

d. On any given Lot, if the results of the gradation from the verification test are within Department's specification, the Contractor's results will be used for the entire lot. On any given Lot, if the gradations results from the verification test are outside Department's specification, further investigation will be initiated by the Engineer for that subplot. Any or all of the remaining Department subplot samples may be tested and the Department subplot test results may be applied to the respective subplot and the acceptance will apply.

e. When verification tests are within testing tolerance but results show a consistent pattern of deviation from the split sample results, the Engineer will exercise one or more of the following:

- Cease production.
- Request additional verification testing.
- Initiate a complete IA review.

f. Independent Assurance (IA) Review of Testing:

(1) The Contractor shall allow the Department personnel access to the Contractors' laboratory to conduct IA review of the technician testing procedures and apparatus. Any deficiencies discovered in the Contractor's testing procedures will be reported to the Contractor and corrected by the Contractor.

(2) During the IA review, the Department personnel and the Contractor shall split a sample for the purpose of IA testing. The samples selected will be tested in the Department's Branch Laboratory. Any IA test results found to be outside of defined testing tolerances as stated in Paragraph 8.c. of Subsection 1002.04 will be reported to the Contractor. The Contractor shall immediately correct any deficiencies found during the IA review.

(3) If the project personnel and the Contractor cannot reach agreement on the accuracy of the test results, the Department Central Laboratory will be asked to resolve the dispute, which will be final. All dispute resolutions will be in accordance with the Quality Assurance Program requirements in the Department's Materials Sampling Guide.

SECTION 1003 -- FLOWABLE FILL

1003.01 -- Description

1. Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head.

1003.02 -- Material Characteristics

1. The approximate quantities of each material per cubic yard (cubic meter) of mixed material shall be as shown in Table 1003.01.

Table 1003.01

Flowable Fill Composition	
Cement (Type I or II)	50 pounds/cu. yd. (30 kg/m ³)
Fly ash	200 pounds/cu. yd. (120 kg/m ³)
Fine sand	2,700 pounds/cu. yd. (1600 kg/m ³)
Water (approx.)	420 pounds/cu. yd. (250 kg/m ³)
Air content (approx.)	10%

2. Actual quantities shall be adjusted to provide a yield of 1 cubic yard (cubic meter) with the materials used.

3. Approximate compressive strength should be 85 to 175 psi (0.6 to 1.2 MPa).

4. Fine sand shall be an evenly graded material having not less than 95% passing the No. 4 sieve (4.75 mm) and not more than 5% passing the No. 200 (75 μ m) sieve.

5. Mixing and handling of the material shall be in accordance with Section 1002.

1003.03 -- Acceptance Requirements

1. Flowable fill is accepted based on it meeting the requirements in this Section.

2. Cement must be on the Department's Approved Products List.

3. Fly ash meeting requirements in Section 1008 can be either Class "C" or Class "F".

SECTION 1004 -- PORTLAND CEMENT

1004.01 -- Description

1. Portland cement is the binder in concrete, locking the aggregate into a solid structure. It is manufactured from lime, silica, and alumina (with a small amount of plaster or Gypsum).

2. Equivalent alkali is defined as the sum of the Sodium Oxide (Na_2O) and the Potassium Oxide (K_2O) calculated as Equivalent Alkali $\text{Na}_2\text{O}_e = \text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$.

3. Interground and Blended cements consist of uniform intergrinding and/or blending of Portland cement clinker, Slag cement, Pozzolan and/or Limestone.

1004.02 -- Material Characteristics

1. Type I, Type II and Type III Portland cement shall conform to the requirements in ASTM C 150 with the following additional requirements:

a. Portland cement shall not contain more than 0.60% equivalent alkali.

2. Interground and Blended Cement shall conform to the requirements in ASTM C 595 with the following additional requirements:

a. Interground/Blended cement (Type IP)

(1) For Type IP(25) shall be composed of Class F fly ash or Class N pozzolan replacement at 25% - 2%.

(2) For Type IP(20) shall be composed of Class F fly ash or Class N pozzolan replacement at 20% + 2%.

b. Interground/Blended cement (Type IS)

(1) For Slag Cement, the maximum replacement shall be 35% +5 when incorporated into the final Interground/Blended cement.

c. Interground/Blended cement (Type IT)

(1) For Supplemental Cementitious Materials (SCMs), Slag cement and Limestone, the maximum replacement by weight shall be 40%. The manufacturer has a production tolerance of + 2% from the proposed replacement.

(2) For Limestone cement, the replacement range shall be from 5.1% to 10.0% when incorporated into the final Interground/Blended cement.

d. No additional SCMs, Slag cement and Limestone will be added at the batch plant.

1004.03 -- Procedures

1. The Contractor shall provide adequate protection for the Portland and Interground/Blended cement against dampness.

a. Portland and Interground/Blended cement shall be hauled or stored in railroad cars, dry bulk trailers or in suitable moisture-proof buildings.

b. The use of tarpaulins for the protection of the Portland and Interground/Blended cement will not be allowed.

2. No Portland and Interground/Blended cement which has become caked or lumpy shall be used.
3. Portland and Interground/Blended cement which has been spilled shall not be used.
4. Accepted Portland and Interground/Blended cement which has been held in storage at the concrete mix plant more than 90 days shall be retested.
5. Portland and Interground/Blended cement coming directly from the manufacturer shall not be used until its temperature is 150°F or less.
6. Portland cement having false set when tested in accordance with ASTM C 150 will not be used.

1004.04 -- Acceptance Requirements

1. Portland and Interground/Blended cements shall be on the Department's Approved Products List (APL).

2. The Contractor shall submit any new Portland and Interground/Blended cements to the Engineer to be approved for the APL with the following:

a. Material source information:

- (1) Mill Location
- (2) Type of Portland and Interground/Blended cements
- (3) Grinding Period
- (4) Associated Manufacture Product Name
- (5) Provide source and type of each SCMs and/or Slag Cement used for final product.

(i) The Department will allow the use of ASTM C 1697.

(a) When two or more SCMs and/or Slag Cement are pre-blended, the Contractor shall report chemical composition analysis of the final blend.

(b) The final blend shall be reported as per ASTM C 1697, Paragraph 4.

(6) Portland cement shall conform to ASTM C 150.

(7) Interground/blended cements shall conform to ASTM C 595.

(8) Provide total cementitious materials replacement per ASTM C 595.

(9) Report test results per ASTM C 1567 at 28-days.

3. Alkali Silica Reaction Requirements and Testing:

a. Interground/Blended cement shall be tested according to the provisions of ASTM C 1567.

(1) The mortar bars shall be composed of Type IP, IS or IT Interground/blended cement and sand and gravel from an approved Platte River Valley-Saunders County source.

(i) When Elkhorn River-Madison County source or an out of state aggregate source is being used on a project, the Elkhorn River or an out of state aggregate source shall be used in lieu of the Platte River Valley-Saunders County source.

(ii) When Contractor proposes a change of aggregate source, then the new aggregate source shall be tested by ASTM C 1567.

(2) The mortar bars for the ASTM C 1567 shall not exceed 0.10% expansion at 28 days.

4. Portland and Interground/Blended cements will be placed on the Department's Approved Products List based on the conformance with the Department's Acceptance Policy for Portland and Interground/Blended Cements.

1004.05 -- Sampling and Testing Requirements

1. All Portland and Interground/Blended cements shall be sampled and tested at the rate described in the Department's Materials Sampling Guide.

a. The Department will inform the Contractor when a sample is required.

b. A sample shall be taken by a Contractor's Certified Portland Cement Sampler and must be under the supervision of Department certified personnel.

c. The sample shall be taken at the plant from a bulk shipment of a rail car, dry bulk trailer, batch plant silo or from the line between the bulk truck and the silo. Upon sampling, the Department will take immediate custody of the sample.

2. Noncompliant material shall be tested in accordance with ASTM C 1567 and in accordance with Section 1004.04, Paragraph 3.a. (1).

a. The mortar bars for the ASTM C 1567 shall not exceed 0.10% expansion at 28 days.

b. If the expansion is greater than 0.10% at 28 days, then the Interground/Blended cement shall be subject to removal, 40% pay and/or removal from the Department's APL in accordance with Department's Acceptance Policy on Portland and Interground/Blended Cements.

3. Noncompliant material from the mill, terminal or project will be temporarily removed from the Approved Products List pending further investigation.

4. If the noncompliant Portland or Interground/Blended cement is removed from the Department's Approved Products List, all shipments from the supplier will be held until the investigation of the failing samples have been completed by the Department's Materials and Research Division.

SECTION 1005 -- WATER FOR CONCRETE

1005.01 -- Description

1. Water shall be free from objectionable quantities of oil, acid, alkali, salt, organic matter, or other deleterious materials and shall not be used until the source of supply has been approved.

2. Wash water from the mixer washout may be used only with the Engineer's approval. Use of wash water will be discontinued if undesirable reaction with admixtures or aggregates occurs.

1005.02 -- Material Characteristics

1. Water which contains more than 0.25% total solids by weight shall not be used.

2. When required by the Engineer, the quality of mixing water shall be determined by NDOT C 114, NDOT T 290, NDOT D 512, NDOT C 1602, ASTM C 31, ASTM C 109, ASTM C 191, and ASTM C 1603.

3. Upon written request by the concrete producer and approval by Engineer, the concrete producer may utilize up to 10% wash water for batching all classes of concrete with the following conditions:

a. Wash water conforms to requirements in Paragraph 2 of Subsection 1005.02.

b. Wash water must be clarified wash water that has been passed through a settling pond system.

c. Wash water must be scalped off of a settling basin that has been undisturbed for a minimum of 12 hours.

d. Wash water must be metered into each load.

e. Wash water quantities shall be shown on the batch ticket.

SECTION 1006 -- CALCIUM CHLORIDE

1006.01 -- Description

1. Calcium Chloride shall be Type S (Solid) or Type L (Liquid). Calcium Chloride can be used for, but not limited to, dust control and acceleration of the set of concrete.

1006.02 -- Material Characteristics

1. The requirements for calcium chloride shall be as shown in ASTM D 98.

1006.03 -- Acceptance Requirements

1. Acceptance shall be based on requirements contained in the Department's Materials Sampling Guide.

SECTION 1007 -- CHEMICAL ADMIXTURES

1007.01 -- Description

1. Admixtures are materials added to Portland cement concrete to change characteristics such as workability, set time, strength, permeability, freezing point, and curing.

2. The Department's concrete admixture types are:

a. Type A - Water-Reducing Admixture - An admixture that reduces the quantity of mixing water required to produce concrete of a given slump.

b. Type B - Retarding Admixture - An admixture that slows down the setting of concrete.

c. Type C - Accelerating Admixture - An admixture that speeds up the setting and early strength development of concrete.

d. Type D - Water-Reducing and Retarding Admixture - An admixture that reduces the quantity of mixing water required to produce concrete of a given slump and slows down the setting of concrete.

e. Type E - Water-Reducing and Accelerating Admixture - An admixture that reduces the quantity of mixing water required to produce concrete of a given slump and speeds up the setting and early strength development of concrete.

f. Type F - Water-Reducing, High Range Admixture - An admixture that reduces the quantity of mixing water required to produce concrete of a given slump by 12% or greater.

g. Type G - Water-Reducing, High Range and Retarding Admixture - An admixture that reduces the quantity of mixing water required to produce concrete of a given slump by 12% or greater and slows down the setting of concrete.

h. Air-Entraining - An admixture that encapsulates air in the concrete.

i. Lithium Nitrate - An admixture used to control the Alkali-Silica-Reaction (ASR) in concrete.

1007.02 -- Material Characteristics

1. Type A through G admixtures shall meet the requirements in ASTM C 494.

2. Air-entraining admixtures shall meet the requirements in ASTM C 260.

3. Use of admixtures other than those cited may be requested by the Contractor.

4. Admixtures shall not contain more than 1% of chlorides calculated as calcium chloride.

5. Admixtures shall be used at the manufacturer's recommended dosage rates.

6. The air-entraining admixture characteristics shall produce concrete with satisfactory workability and a total air content as described in Table 1002.02.

7. a. When using the Lithium Nitrate admixture, the Contractor shall submit to the Engineer:

(1) A five pound sample of Portland cement that will be used on the project.

(2) The Manufacturer's method for determining the recommendation for the required dose rate based on the equivalent alkali content.

(3) Water content of the Lithium Nitrate admixture solution.

b. The Engineer will report the equivalent alkali content to the Contractor. The Contractor shall use the reported equivalent alkali content to determine the required dose rate based on the manufacturer's recommendation.

1007.03 -- Procedures

1. Field Addition of Admixtures:

a. The process for adding admixtures to a ready mix truck on the project site involves positioning the load of concrete up to the truck chute, stopping short of discharge.

b. The admixture is then poured over the surface of the concrete and mixed for at least 5 minutes.

c. No more than 1.3 gallons (5L) of water shall be used to rinse the admixture from the fins and top chute. This water must be shown on the proportioning report and shall not cause the water cement ratio of the mix to be exceeded.

d. When Lithium Nitrate is used, the portion of the admixture that is water will be shown on the proportioning report and shall not cause the water cement ratio of the mix to be exceeded.

e. The Contractor is responsible for the addition of the admixture.

2. Field adjustment of Air Content:

a. If the air content is less than the minimum specified, addition of air-entraining admixtures is allowed.

b. The Contractor shall take measures based on manufacturer's recommendations that are within compliance of Department Specifications, to bring the load of concrete into the Department described limits according to Table 1002.02.

c. If the air content is then outside the limits in Table 1002.02, the load of concrete shall be rejected.

SECTION 1008 -- FLY ASH

1008.01 -- Description

1. Fly ash shall be Class C or F meeting the requirements of ASTM C 618.

1008.02 -- Material Characteristics

1. All fly ash will be acceptance tested by the Department. This includes production plant samples and field samples.

2. Fly ash shall conform to the requirements of Class C or Class F pozzolan as defined in ASTM C 618 except that the maximum loss on ignition for Class F pozzolan shall be 3.0%. Either class of fly ash shall not contain more than 1.5% of available alkalis as Na_2O .

3. Fly ash produced in furnace operations utilizing liming materials or soda ash (sodium carbonate) as an additive will not be acceptable.

1008.03 -- Procedures

1. Fly ash shall be protected, stored, handled, and sampled in the same manner as specified for Portland cement in Sections 1002 and 1004 and the Department's *Materials Sampling Guide*.

2. Each shipment of fly ash sent to the project or ready mix plant shall be accompanied with a certificate of compliance from the supplier. The certificate must include the following information:

- a. Name of the supplier.
- b. Source of the fly ash.
- c. Consignee and destination of the shipment.
- d. Project number to be used on, if available, and date shipped.
- e. Railroad car number or truck identification number.
- f. Weight of the shipment.
- g. Certified test number representing the material being shipped.
- h. An unrepeatable order number or other identification number so that each shipment is separately identified.
- i. The Department's specifications that the product is in compliance with.

3. The following signed certification statement, or similar wording, must also be included on the form:

"This is to certify that this shipment of fly ash meets the specification requirements of the Nebraska Department of transportation for Class _____ fly ash."

Signed _____

For _____

(Supplier)

4. Two copies of the certificate of compliance shall be sent with the shipment for the Engineer. The Engineer will retain one copy for his/her file and send the other copy to the Department's Materials and Research Division to serve as notification of receipt and identification of the fly ash.

5. Fly ash may be used as soon as it is received, provided it is accompanied by the proper certificate of compliance and the results of previous tests indicate a satisfactory product.

1008.04 -- Acceptance Requirements

1. Approved fly ash will be on the Department's Approved Products List.

Fly ash may be added to the Department's Approved Products List if it is in conformance with the Department's Acceptance Policy for Fly Ash. This information is available upon request from the Department's Concrete Materials Section.

2. Should any sample indicate noncompliance with the specifications, use of material from that source based on certification only may be withheld. It will be necessary that the fly ash be held in special silos or bins at the generating plant or some facility under control of the company furnishing the fly ash until such time that test results show compliance.

When it can be shown that continuing production from that generating plant has a high assurance of meeting specifications, material acceptance may once again be based on certification only.

3. If tests made on field samples taken by the Department fail to meet any of the specification requirements, all shipments from the supplier will be held until tests have been completed by the Department's Materials and Research Division and approval for use is issued.

This procedure will be continued until it can reasonably be assured that the fly ash from the supplier will again continue to meet contract requirements.

SECTION 1009 -- SILICA FUME

1009.01 -- Description

1. Silica fume is very fine pozzolanic material composed mostly of amorphous silica produced by electric arc furnaces as a by-product of the production of elemental silicon or ferro-silicon alloys.

1009.02 -- Material Characteristics

1. Silica fume shall conform to the requirements of ASTM C 1240, including the optional chemical and physical requirements, except that the minimum SiO₂ shall be 90% by weight.

2. Silica fume in slurry form shall not be allowed.

1009.03 -- Procedures

1. The Contractor shall provide adequate protection for the silica fume against dampness.

2. Silica fume shall be protected from temperatures in excess of 90°F (32°C).

3. Silica fume shall be protected from exposure to direct sunlight.

4. Each shipment of silica fume sent to a project or ready mix plant shall be accompanied with a certificate of compliance executed by the manufacturer. The certificate must include the following information:

a. The name of the manufacturer.

b. The location of the manufacturer.

c. The batch or lot number.

d. The date of manufacture.

e. The weight of the shipment.

f. The Department's specifications that the product is in compliance with.

5. No silica fume which has become caked or lumpy shall be used.

6. Silica fume which has been spilled shall not be used.

1009.04 -- Acceptance Requirements

1. Silica fume approved for use is on the Department's Approved Products List. The suppliers, in addition to providing a manufacturer's certification of compliance for each shipment, must submit certification annually to the Department's Materials and Research Division stating that their product meets Department's specifications.

2. Silica fume that arrives without proper certification shall be sampled, tested, and approved by the Department's Materials and Research Division before use.

SECTION 1010 -- WHITE OPAQUE POLYETHYLENE FILM AND WHITE BURLAP-POLYETHYLENE SHEET FOR CURING CONCRETE

1010.01 -- Description

1. White opaque polyethylene film and white burlap-polyethylene sheet shall conform to requirements in this Section.

1010.02 -- Material Characteristics

1. White opaque polyethylene film for curing concrete shall conform to the requirements of AASHTO M 171 except that:

- a. The reflectance, minimum percent, shall be 60.
- b. The requirement for moisture loss shall not apply.
- c. The AASHTO requirement for tensile strength and elongation, in both the longitudinal and transverse direction, shall not apply.

2. Reinforced white opaque polyethylene film for curing concrete shall conform to the requirements of white opaque polyethylene film in AASHTO M 171 except that:

- a. The minimum percent elongation in both the longitudinal and transverse directions shall not apply.
- b. The requirement that the polyethylene film shall consist of a single sheet shall not apply.
- c. The reflectance, minimum percent, shall be 60.

3. White burlap-polyethylene sheet for curing concrete shall conform to the requirements of AASHTO M 171 except that:

- a. The burlap portion weight shall not be less than 0.05 lb/ft² (0.25 kg/m²).
- b. The reflectance, minimum percent, shall be 60.

1010.03 -- Acceptance Requirements

1. Acceptance shall be based on sampling and testing in accordance with requirements in the Department's *Materials Sampling Guide*.

SECTION 1011 -- BURLAP FOR CURING CONCRETE

1011.01 -- Description

1. Burlap for curing concrete shall conform to the requirements of this Section.

1011.02 -- Material Characteristics

1. Burlap shall be clean, evenly woven, free of encrusted concrete or other contaminating materials, and shall be reasonably free from cuts, tears, broken or missing yarns, and thin, open, or weak places.

1011.03 -- Acceptance Requirements

1. Acceptance shall be based upon visual examination of the material by the Engineer.

SECTION 1012 -- LIQUID MEMBRANE-FORMING COMPOUNDS FOR CURING CONCRETE

1012.01 -- Description

1. Liquid membrane-forming compounds are intended for application to concrete surfaces to reduce the loss of water during the early-hardening period. White-pigmented compounds serve the additional purpose of reducing the temperature rise in concrete exposed to radiation from the sun.

1012.02 -- Material Characteristics

1. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M 148, Type 2.

1012.03 -- Acceptance Requirements

1. All curing compounds to be approved must be manufactured during the current calendar year with no carry-over from the previous years.

2. Approved compounds are on the Department's Approved Products List.

3. Products not on the Department's Approved Products List shall be sampled and tested in accordance with requirements of the Department's Materials Sampling Guide prior to their use.

SECTION 1013 -- BITUMINOUS LIQUID COMPOUNDS FOR CURING CONCRETE

1013.01 -- Description

1. The compound shall consist of an asphaltic base and shall be of a consistency suitable for spraying at temperatures existing at the time of construction operations. It shall be applied to form a continuous, uniform film. It shall be free of precipitated matter caused by conditions of storage or temperature. The compound shall be relatively nontoxic.

1013.02 -- Material Characteristics

1. When tested in accordance with AASHTO T 155, the loss of water shall not be more than 0.11 lb/ft² (0.55 kg/m²) of surface area at 3 days, unless otherwise specified by the Engineer.

1013.03 -- Acceptance Requirements

1. The base material shall conform to Sections 1030, 1031 and 1032.

SECTION 1014 -- JOINT AND CRACK SEALING FILLER

1014.01 -- Description

1. Joint sealing filler shall be either a cold applied silicone product or an asphalt product (hot pour) conforming to the requirements of the contract. The type of joint filler to be used shall be as specified in the contract. If not specified, any of the joint sealing fillers in this Section may be used.

2. Crack sealing filler shall be a hot pour sealer conforming to the requirements of the contract.

1014.02 -- Material Characteristics

1. NE – 3405 and NE-3405LM (hot pour)

a. NE-3405 joint and crack sealer shall conform to the requirements of ASTM D 6690, Type II. The material shall conform to the requirements of Table 1 with the following exceptions:

(1) The test of Bond, non-immersed, ASTM D5329, 3 specimens through 3 cycles shall be run at 0°F (-18°C), 100% extension.

b. NE-3405LM (Low Modulus) joint and crack sealer shall conform to the requirements of ASTM D6690, Type IV. The material shall conform to the requirements of Table 1.

c. The test of Bond, non-immersed, ASTM D5329, will be tested on concrete blocks which are constructed by the Department's Concrete Laboratory. The materials used are a common design in Nebraska concrete paving specifications. The design is a 47B concrete mixture as specified in Section 1002 of the Department's Standard Specifications. The design is amended to not include flyash, but all other specifications for Portland Cement Concrete apply.

d. Sample conditioning, preparation and heating shall be in accordance with ASTM D5167 with the following exceptions:

(1) The following sentence of 8.1.2, "Also, if present, remove container liner by cutting it away", is void and superseded by the following:

"Also, if present, as much of the polyethylene bag as possible, shall be removed by cutting it away. Wholly-meltable type container in adhered contact with the sample section is left in place. For wholly-meltable type containers that do not adhere to the sealant material, a pro-rated amount of the meltable type container shall be added to the sample."

(2) The last sentence of section 8.1.2 "Solid Materials" is void and superseded by the following: "The entire vertical section which has been cut, shall be placed into the pot for melting."

(3) The Section of 8.2.2.1 "Solid Materials" is void.

(4) The Section of 8.2.3 is void and superseded by the following: "After the solid segment is added to the melter, the material shall be allowed to melt to a uniform viscous state suitable for the installation of the stirrer or paddle. The sample shall then be stirred for one full hour. The oil bath temperature shall be regulated to bring the material to the maximum heating temperature within the one full hour of stirring."

(5) The Section of 8.2.4.1 is void and superseded by the following: "During the one full hour of stirring, check the temperature of the material at maximum 15 minute intervals using a Type K thermocouple with

the calibration verified in accordance with Section 6.1.7 to ensure conformance with the specified temperature requirements. Stop the mechanical stirrer when measuring temperatures. If material temperatures ever exceed the maximum heating temperature, or ever drop below the minimum application temperature after the maximum heating temperature was reached, discard the sample and re-do the heating. Maintain appropriate records of times and temperatures to verify conformance with specification requirements.”

(6) The Section of 8.2.4.2 is void.

e. ASTM D5329 test methods shall include the following changes:

(1) Sections 6.4 and 12.4 “Specimen Preparation” shall have the reference of “177 ml (6 oz.)” replaced with “3 oz.”

(2) Section 6 “Cone Penetration, Non-Immersed” shall be superseded with the following exceptions:

(i) Section 6.5 “Procedure” is void and superseded by the following: “Place the specimen in a water bath maintained at 77 +/- 0.2°F (25 +/- 0.1°C) for two hours immediately before testing. Remove the specimen from the bath and dry the surface by shaking gently to remove free water from the surface of the specimen. Using the apparatus described in Section 6.3, make one determination at or near the center of the specimen. Take care to ensure the cone point is placed on a point in the specimen that is representative of the material itself, and is free of dust, water, bubbles, or other foreign material.”

(ii) Section 6.6 “Report” is void and superseded by the following: “Record the value as the penetration of the specimen in dmm units.”

(3) Section 12 “Resilience” shall be superseded with the following exceptions:

(i) Section 12.5 “Procedure”, void the sentence “Make determinations at three points equally spaced from each other and less than 13mm (1/2 inch) from the container rim.” and supersede with the sentence “Make one determination at or near the center of the tin.”

(ii) Section 12.6 “Report” is void.

2. Silicone Joint Sealer (cold applied)

a. Silicone joint sealers may be either self-leveling or non-sag and shall meet the requirements in Table 1014.01.

Table 1014.01

Silicone Joint Sealer Requirement		
Property	Requirement	Test
As supplied:		
Specific Gravity	1.010-1.515	ASTM D792
Work Time, minimum	10 minutes	
Tack-Free Time, at 77°F (25°C)	20-360 minutes	
Cure Time, at 77°F (25°C), max.	14 days	
Full Adhesion, maximum	21 days	
As cured, at 73.4 +/-3.6°F (23+/- 2°C) and 50+5% RH:		
Ultimate Elongation, minimum		
Durometer Hardness: Non-Sag, Shore A	800%	ASTM D412
Self-Leveling, Shore 00, minimum	10-25	ASTM D2240
Cyclic Joint Movement Capacity	40	ASTM D2240
Tensile Stress, at 150% Elongation	+100% to -50%	ASTM C719
	45 psi	ASTM D412

1014.03 -- Packaging

1. NE – 3405 and NE-3405LM

a. The joint and crack sealer can be packaged in either cardboard box or wholly-meltable type containers.

(1) Cardboard box containers shall be manufactured from double wall kraft board producing a minimum bursting test certification of 350 PSI (241 N/cm²) and using water-resistant adhesives. The use of metal staples or fasteners of any kind will be prohibited for closing the lids of the boxes. Tape or other like material is acceptable.

(i) The sealant in the cardboard box shall be packaged in melttable [300°F (149°C)] polyethylene bag(s).

(2) Wholly-meltable type containers, and any of their components, shall be fully melttable and integrational with the sealant by the time the manufacturer’s minimum application temperature is reached.

(i) The wholly-melted and integrated container must not adversely affect the test specifications of the sealant.

(3) Each individual container shall include information regarding manufacturer, lot or batch number, type of product, minimum application temperature, and maximum heating temperature. The maximum heating temperature must be at least 20°F (11°C) higher than the minimum application temperature.

2. Silicone Joint Sealer

a. Each container shall include information regarding manufacturer and product name.

1014.04 -- Acceptance Requirements

1. NE – 3405 and NE-3405LM

a. Acceptance of the manufactured material is based on pre-approval by either on or off-site sampling. Acceptable Hot Pour Sealant lots are listed on the Department’s Approved Products List.

(1) Department on-site field sampling shall be in accordance with the Department's Materials Sampling Guide.

(2) Off-site (Proxy) sampling shall be in accordance with ASTM D 6690.

(i) Proxy sampling shall be overseen by an outside party approved by the Department, preferably another DOT Agency. Proxy samples shall include a manufacturer's Certificate of Compliance. Proxy samples shall also include a dated signature of origin by the Representative that is not affiliated with the manufacturer, and can either be on the Certificate of Compliance, or on a separate letter.

(ii) For convenience in both sampling and shipping samples, sample containers smaller than a manufacturer's usual production containers are allowed, as long as the sample is a minimum of 1500 grams.

(iii) Samples shall be sent to the Department's Bituminous Laboratory, or alternatively, sent to a Department approved independent laboratory for testing which will be at no cost to the Department. If a Department approved independent laboratory is used, the Department's Bituminous Laboratory shall be notified so that concrete blocks for Bond testing (1014.02 para. 1.c.) can be sent to it.

2. Silicone Joint Sealer

a. Acceptance of applied silicone joint sealers shall be in accordance with the Department's Materials Sampling Guide.

b. Acceptable silicone joint sealer manufacturer products are listed on the Department's Approved Products List.

(1) For products that are not listed, approval may be based upon test results from an independent laboratory submitted to the Department by the manufacturer, and testing by the Department. Approval must be made prior to product use.

SECTION 1015 -- PREFORMED JOINT FILLER

1015.01 -- Description

1. Preformed expansion joint filler shall be furnished in strips of the dimensions specified in the contract.

1015.02 -- Material Characteristics

1. Nonextruding and Resilient Bituminous Type (Fiber Type) preformed joint filler shall conform to the requirements of AASHTO M 213.

2. Bituminous Type (Asphalt Type) preformed joint filler shall conform to the requirements of AASHTO M 33 except it will not be subject to a requirement for brittleness.

3. Preformed joint filler (sponge rubber type) shall be a flexible cellular rubber product meeting the classification requirements of the latest edition of ASTM D 1056 for Type 2, Class A or B, Grade 2 or 3, except that reclaimed rubber shall not be used in the manufacture of the material. The color shall be gray.

1015.03 -- Procedures

1. For structures, the bituminous type (asphalt type) shall be used, unless otherwise shown in the contract or specified in the special provisions.

2. Except for structures, the non-extruding and resilient bituminous type (fiber type) shall be used, unless otherwise shown in the contract or specified in the special provisions.

1015.04 -- Acceptance Requirements

1. Preformed joint fillers that are on the Department's Approved Products List are acceptable.

2. The preformed joint fillers may be accepted based on manufacturer's certification of compliance letters when they are not on the Department's Approved Products List.

SECTION 1016 -- PREFORMED POLYCHLOROPRENE ELASTOMERIC JOINT SEALS

1016.01 -- Description

1. The seal consists of a multiple web design for sealing concrete pavements. The seal is installed with a lubricant adhesive and is designed to seal the joint and reject incompressibles.

1016.02 -- Material Characteristics

1. Preformed polychloroprene elastomeric joint seals shall conform to the requirements of AASHTO M 220.

1016.03 -- Acceptance Requirements

1. Acceptance shall be based on sampling and certification requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1017 -- CAULKING COMPOUND

1017.01 -- Description

1. Caulking compound for use in masonry and other types of structures shall be a one-component oil and/or resin base compound or an acrylic latex compound.

1017.02 -- Material Characteristics

1. One-component oil and/or resin base compounds shall conform to the requirements of ASTM C 570.

2. Acrylic latex compounds shall conform to the requirements of ASTM C 834.

1017.03 -- Acceptance Requirements

1. Caulking compounds approved for use are shown on the Department's Approved Products List.

SECTION 1018 -- EPOXY COMPOUNDS AND ADHESIVES

1018.01 -- Description

1. This Specification provides requirements for two-component, epoxy-resin bonding systems for use in non-load bearing applications and resin adhesives for application to Portland cement concrete.

1018.02 -- Material Characteristics

1. Epoxy-resin bonding systems shall conform to the requirements of ASTM C 881. Approved systems are shown on the Department's Approved Products List.

2. The classification of Epoxy-Resin Bonding Systems is as follows:

a. Type I - For use in non-load bearing applications for bonding hardened concrete and other material to hardened concrete.

Type II For use in non-load bearing applications for bonding freshly mixed concrete to hardened concrete.

Type III For use in bonding skid resistant materials to hardened concrete, and as a binder in epoxy mortars or epoxy concretes.

b. Grade 1 Low viscosity.

Grade 2 Medium viscosity.

Grade 3 Non-sagging consistency.

c. Class A For use below 40°F (4°C); the lowest allowable temperature to be defined by the manufacturer of the product.

Class B For use between 40°F and 60°F (4°C and 15°C).

Class C For use above 60°F (15°C); the highest allowable temperature to be defined by the manufacturer of the product.

Class D For use between 40°F and 65°F (4°C and 18°C).

Class E For use between 60°F and 80°F (15°C and 26°C).

Class F For use between 75°F and 90°F (24°C and 32°C).

1018.03 -- Procedures

1. The compounds shall be of the type and grade specified in the contract or as directed by the Engineer.

2. The class of the compounds shall be selected for use according to climatic conditions at the time of application.

3. All bonding surfaces shall be clean and free of all oil, dirt, grease, or any other materials which would prevent bonding.

4. Mixing and application shall be in strict accordance with the manufacturer's instructions.

1018.04 -- Acceptance Requirements

1. Epoxy-resin bonding systems and resin adhesives approved for use are shown on the Department's Approved Products List.
2. Epoxy compounds that are not on the Department's Approved Products List may be accepted based on a manufacturer's certificate of compliance.

SECTION 1019 -- SEALING COMPOUNDS

1019.01 -- Description

1. The sealing compounds covered are elastomeric single-component compounds.

1019.02 -- Material Characteristics

1. Type I (self-leveling) is a compound which has sufficient flow to give a smooth, level surface when applied in a horizontal joint at temperatures between 40°F and 122°F (4°C and 50°C).

2. Type II (non-sag) is a compound which allows application in vertical joints without sagging at temperatures between 40°F and 122°F (4°C and 50°C).

3. The elastomeric single-component compound shall conform to the requirements of Federal Specification TT-S-230C "Sealing Compound, Elastomeric Type, Single Component".

4. Joint sealing material shall conform to the requirements in Table 1019.01, and documents shall be submitted that confirm the properties in Table 1019.01.

Table 1019.01

Joint Sealing Compound Requirement		
As Supplied:		
Specific Gravity	1.010-1.515	ASTM D 792
Work Time, minutes	10	
Tack-Free Time, at 77°F (25°C), days	20-360	
Cure Time, at 77°F (25°C), days	14 Max.	
Full Adhesion, days	21 Max.	
As Cured - at 73.4± 3.6°F (23±2°C) and 50±5 RH::		
Elongation, Percent	800% Min.	ASTM D 412
Durometer Hardness		
Non-sag, Shore A	10-25	ASTM D 2240
Self-leveling, Shore 00	40 Min.	ASTM D 2240
Joint Movement Capability, Percent	+100/-50 Min.	ASTM C 719
Tensile Stress, psi (kPa) (at 150% elongation)	45 Max. (310 Max.)	ASTM D 412

5. Sampling and testing of sealing compounds shall be in accordance with Federal Specification TT-S-230C for single-component sealing compounds.

1019.03 -- Procedures

1. Single-Component Sealing Compounds include polysulfides and polyurethanes.

2. The single-component sealing compounds (Type I or Type II) may also be used to seal joints in all types of structures where some movement is expected and where a tight seal against dust, dirt, wind, and water is required.

1019.04 -- Acceptance Requirements

1. Sealing compounds on the Department's Approved Products List are acceptable.
2. Sealing compounds that are not on the Department's Approved Products List may be accepted based on a manufacturer's certificate of compliance.

SECTION 1020 -- STEEL BARS FOR CONCRETE REINFORCEMENT

1020.01 -- Description

1. Steel tie bars for longitudinal joint reinforcement in concrete pavements shall be epoxy coated and deformed Grade 40 or 60 billet steel as shown in the contract, Specifications or Special Provisions.

1020.02 -- Material Characteristics

1. Billet steel bars shall conform to the requirements of ASTM A 615/A 615M.

2. Epoxy coatings shall conform to the requirements in Section 1021.

1020.03 -- Acceptance Requirements

1. Acceptance shall be based on sampling, testing, and certification requirements in accordance with the Department's Materials Sampling Guide.

2. Steel may need to meet Buy America requirements.

SECTION 1021 -- EPOXY COATED REINFORCING STEEL

1021.01 -- Description

1. Epoxy coated bars for concrete reinforcement shall conform to the requirements of ASTM A 775/A 775 M, Section 1020, and as shown in the contract. The bars shall be free of contaminants such as oil, grease, paint, slivers, or any other imperfections which may be detrimental to the coating process.

2. All reinforcing bars furnished under this item shall be given a protective coating of a fusion bonded epoxy resin.

1021.02 -- Material Characteristics

1. The coating shall be applied as an electrostatically charged dry powder sprayed onto a grounded steel bar using an electrostatic spray gun. The powder may be applied to either a hot or cold bar. The coated bar shall be given a thermal treatment specified by the manufacturer of the epoxy resin which will provide a fully cured finished coating.

2. The coating material shall be a powdered epoxy resin prequalified by evaluation as described in ASTM A 775/A 775 M. Tests shall be performed by the National Bureau of Standards (NBS), a qualified independent testing laboratory, or a state laboratory approved by the Department's Materials and Research Division. Approval of material by an independent or state laboratory is subject to the Engineer's review of the test data.

3. The manufacturer of the epoxy resin shall also supply the coating applicator with all other information and recommendations essential to the proper use and performance of the powdered resin as a coating. An authorized representative of the manufacturer shall provide written certification to the applicator that the powdered resin furnished for coatings is the exact formulation that was prequalified by the NBS or other testing agency.

4. At the request of the Engineer, the coating applicator shall provide a representative 7 ounce (200 g) sample of the resin powder used to coat each lot of bars. The sample shall be packaged in an air-tight container with identification by lot number.

5. The approved powdered epoxy resins are on the Department's Approved Products List.

6. A suitable patching material compatible with the coating and inert in concrete shall be made available to the Contractor by the manufacturer of the epoxy resin for repair of damaged coating areas at the applicator's plant or in the field. The patching or repair shall be performed in accordance with the recommendations of the material manufacturer.

7. A film thickness after curing of 7 to 12 mils (180 to 300 μm) shall be applied in a uniform, smooth coat with no discontinuities, except as provided herein. Thickness of the film shall be measured on a representative number of bars from each production lot by the same method outlined in ASTM G 12 for measurement of film thickness of pipeline coatings on steel.

8. The coating shall be checked after curing for continuity of coating and shall be free from holes, voids, contamination, cracks, or other damaged areas. The average number of holidays per foot (300 mm) shall not exceed

one holiday per foot (300 mm) of coated bar. An in-line 67.5 volt DC powered detection system with an audible or visual signal shall be used in accordance with the manufacturer's instructions to check the coating for holidays and other defects.

9. Flexibility and Adhesion:

a. The flexibility and adhesion of the coating shall be evaluated on samples of all the bar sizes for each day's production lot.

b. The coated bars shall be capable of being bent 120 degrees around a mandrel of the size specified in Table 1021.01.

c. The bend test shall be made at a uniform rate.

d. The coating on the bars shall show no evidence of cracking or separation from the bar. If a sample's coating shows evidence of cracking or separation, 2 retests shall be conducted on random samples from the same day's production lot.

e. If the results of both retests meet specified requirements, the coated bars represented by the sample shall be accepted.

Table 1021.01

Bend Test Requirements			
English		Metric	
Bar No.	Mandrel Diameter (inches)	Bar	Mandrel Diameter (millimeters)
3	3		
4	4	10	75
		13	100
5	5	16	125
6	6	19	150
7	7	22	175
8	8	25	200
9	9	29	230
10	10	32	250
11	11	36	280
14	17	43	430
18	23	57	580

10. The bending test shall be conducted at room temperature after the specimen has been exposed to room temperature for a sufficient time to insure that it has reached thermal equilibrium. A temperature in the range of 68°F to 86°F (20°C to 30°C) shall be considered room temperature.

11. The coating applicator shall ensure that samples for the bend test will not short the bar lengths specified in the contract.

1021.03 -- Procedures

1. The surface of the bars to be coated shall be clean and free from rust, scale, oil, grease, and similar contaminants.

2. The surface shall be blast cleaned to a near-white metal in accordance with the Steel Structure Painting Council Surface Preparation Specifications SSPC-SP10.

3. All traces of dust and grit from the blasting shall be removed.

4. The coating shall be applied to the cleaned surface as soon as possible after blasting and before visible oxidation of the surface occurs. However, in no case shall the application of the coating be delayed more than 8 hours after blasting without specific approval of the Engineer.

5. In order to protect the coated reinforcement from damage, the Contractor shall use padded or nonmetallic slings and padded straps. Bundled bars shall be handled in a manner which will prevent excessive sagging of bars which will damage the coating. If circumstances require storing coated steel reinforcing bars outdoors for more than two months, protective storage measures shall be implemented to protect the material from sunlight, salt spray and weather exposure. Coated steel reinforcing bars, whether individual bars or bundles of bars, or both, shall be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked bundles, the protective covering shall be draped around the perimeter of the stack. The covering shall be secured adequately, and allow for air circulation around the bars to minimize condensation under the covering. Coated steel reinforcing bars, whether individual bars or bundles of bars, or both, shall be stored off the ground on protective cribbing. The bundled bars shall not be dropped or dragged. If, in the opinion of the Engineer, the coated bars have been extensively damaged, the material will be rejected. The Contractor may propose, for the approval of the Engineer, alternate precautionary measures.

6. The Engineer may defer final inspection and approval of the bar coating integrity and repairs until the bar mat is in place and all handling is completed. A reasonable amount of coating damage due to fabrication and handling may be allowed depending on the number, extent, size, and location of such damaged areas. The Engineer shall be the sole judge of which imperfections in the coating need not be repaired.

7. The bars shall be fabricated and placed as shown in the contract and as specified in Section 707.

8. Epoxy Repairs:

a. Patching materials supplied or recommended by the manufacturer of the powdered resin shall be used to repair the coating and shall be applied to provide a minimum film thickness of 5 mils (125 μm) over the bare area. Areas to be patched shall be clean and free of surface contaminants. They shall be properly treated in accordance with the resin manufacturer's recommendations before detrimental oxidation occurs.

b. Care should be taken during the patching procedure to assure that the coating thickness on the area adjacent to the patched area does not exceed 15 mils (375 μm). Extensive areas of damaged coating, exceeding that which is unavoidable in careful handling and shipping, may be cause for rejection of the damaged bars.

c. In no case, however, shall the total bar surface area covered by patching material exceed 5%. (The 5% total bar surface area is the combined area for repairs done in the fabricator's shop and those done in the field.)

d. Proper repairs shall be the Contractor's responsibility even when the work is done by an applicator, fabricator, or other subcontractors.

9. The identification of all reinforcing bars (manufacturer, heat number, and size) shall be maintained by the fabricator throughout the fabrication and coating process to assure that the coated, fabricated bars are identified with proper tags for final shipment to the job site (tags should show size, heat number, and mark).

10. Certification:

a. The coating applicator shall furnish with each shipment a written certificate stating that all bars have been coated in accordance with the resin manufacturer's recommendations and these Specifications.

b. The certification shall include for each bar size the preheat temperatures, cure times, thickness charts, holidays detected, and bend test results.

1021.04 -- Acceptance Requirements

1. Plant Approval:

a. A plant intending to supply epoxy coated reinforcing steel under these Specifications shall be inspected and approved by Department's representatives before making shipments to job sites. The plant shall notify the Department's Materials and Research Division 30 days before processing any material. A date and time of inspection will be arranged by the Department's Materials and Research Division and the plant.

b. Once a plant is inspected and approved, the applicator may ship the coated bars on the basis of a certificate of compliance which lists the material shipped and states that the material complies with these Specifications.

c. The inspection and approval of a plant does not constitute a blanket-type approval. The coating applicator's plant will be subject to additional in-plant inspections if, at any time, in the opinion of the Engineer, the quality of the coated bars appears to be below specification requirements.

2. Coated bars will be inspected at the destination before any bars are incorporated in the work.

3. The coated bars will be inspected on the job site for handling defects, coating thickness, and continuity of coating. A 67.5 volt DC holiday detector will be used for determination of continuity of coating.

4. In addition to the testing done at the coating applicator's plant (continuity, flexibility, adhesion, and film thickness), two 6 foot (1.8 m) samples of the coated bar (for tension testing and bend testing) of each size bar and each heat number shall be sent to the Department's Materials and Research Laboratory, Lincoln, Nebraska. These bars will be properly identified with tags showing the size and heat number.

SECTION 1022 -- DOWEL BARS

1022.01 -- Description

1. Coated dowel bars for use across transverse joints shall conform to the requirements of AASHTO M 254.

2. Coated dowel bars for use across transverse joints shall consist of a steel core with an organic covering and shall comply with the requirements of AASHTO M 254, Corrosion Resistant Coated Dowel Bars except:

a. The steel cores shall be smooth round bars of the diameters shown in the contract and shall comply with ASTM A 615/A 615M, Grade 40 or 60 (300 or 420). ASTM A 36, Grade 36 steel is an acceptable substitute, provided the steel meets or exceeds the chemical and mechanical requirements of ASTM A 615, Grade 40.

b. The coating on the lateral surface of the dowel may be eliminated for approximately 2 inches (50 mm) on one end of the dowel for welding purposes. Sheared or cut ends of fabricated dowels may be coated or un-coated, at the discretion of the fabricator or supplier.

c. Both Type A and Type B coated dowel bars shall be coated with a bond breaker shown on the Department's Approved Products List, dipped in asphalt or paraffin, or greased in accordance with the specified requirements as shown in the contract.

1022.02 -- Acceptance Requirements

1. A plant supplying coated dowel bars under these Specifications shall meet the Acceptance Requirements as set forth in Section 1021 for Epoxy Coated Reinforcing Steel. A certification by the manufacturer of the coating material and/or the coating applicator is required. The certification shall consist of a statement to the effect that the coating material represented conforms to AASHTO M 254 and the requirements in this Section. The certifications shall be furnished in triplicate and include copies of the test results. The coating applicator shall also furnish 3 copies of the mill test showing physical and chemical test results of the steel used in the fabrication of the coated bars.

2. In addition to these certificates, two 6-foot (1.8 m) samples of the coated bar (for tension testing and bend testing) of each size bar and each heat number shall be sent to the Department's Materials and Research Laboratory, Lincoln, Nebraska. These bars will be properly identified with tags showing the size and heat number.

SECTION 1023 -- COLD-DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT

1023.01 -- Description

1. Cold-drawn steel wire for concrete reinforcement shall conform to the requirements of AASHTO M 32.

1023.02 -- Acceptance Requirements

1. Acceptance shall be based on sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1024 -- WELDED STEEL WIRE FABRIC FOR CONCRETE REINFORCEMENT

1024.01 -- Description

1. Steel welded wire fabric, plain, for concrete reinforcement shall conform to the requirements of AASHTO M 55M/M 55.

2. Steel welded wire fabric, deformed, shall conform to the requirements in AASHTO M 221M/M 221.

1024.02 -- Acceptance Requirements

1. Acceptance shall be based on sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1025 -- STEEL WIRE FOR PRESTRESSED CONCRETE UNITS

1025.01 -- Description

1. Steel wire for parallel wire assemblies for post-tensioning shall conform to the requirements of ASTM A 421.

1025.02 -- Acceptance Requirements

1. Acceptance shall be based on sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1026 -- STEEL STRAND FOR PRESTRESSED CONCRETE UNITS

1026.01 -- Description

1. The steel strand for prestressed concrete piling, sheet piling, and girder units shall conform to the requirements of ASTM A 416/A 416M and those described in the contract.

2. Low relaxation strands shall be allowed in the fabrication of prestressed concrete piling and sheet piling. No mixing of stress relieved and low relaxation strands shall be allowed on any project.

1026.02 -- Acceptance Requirements

1. Acceptance shall be based on sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1027 -- DEFORMED METAL CENTER JOINT AND METAL KEYWAY

1027.01 -- Description

1. Deformed metal center joint and metal keyway shall be fabricated of coated iron or steel sheets and shall meet the following requirements:

a. Metal Center Joint:

(1) Metal center joint sections shall be manufactured from sheets no less than 18 gauge [0.05 inch (1.3 mm)] thick and shall be of the size and trapezoidal shape shown in the contract. The sections shall be punched along the centerline of the narrow face of the trapezoid to admit the tie bars required by the contract and also at intervals of not greater than 2 feet (600 mm) to receive pins that are driven vertically into the subgrade to support the metal center joint.

b. Metal Keyway:

(1) The trapezoidal shaped section of the metal keyway shall be manufactured from sheets no less than 24 gauge [0.0276 inch (700 μ m)] thick and shall be of the size shown in the contract. The metal keyway section shall be punched along the centerline of the narrow face of the trapezoid to admit the tie bars required by the contract. The metal leg for the keyway shall be manufactured from sheets no less than 18 gauge [0.05 inch (1.3 mm)] thick.

1027.02 -- Acceptance Requirements

1. Acceptance shall be based on visual inspection by the Engineer to assure the material meets contract requirements.

SECTION 1028 -- SUPERPAVE ASPHALTIC CONCRETE

1028.01 -- Description

1. a. Superpave Asphaltic Concrete is a Contractor-designed mix.
 - b. The Contractor shall be required to define properties using a gyratory compactor that has met the Superpave evaluation test procedures, during mix design and production.
2. Job Mix Formula
 - a. Before production of asphaltic concrete, the Contractor shall submit, in writing, a tentative Job Mix Formula (JMF) on the NDOT Mix Design Submittal Form for verification and approval to the Department.
 - b. The JMF shall be determined from a mix design for each mixture. A volumetric mixture design in accordance with AASHTO R 35 as modified within this Specification will be required. The mixture shall be prepared using the following:
 - (1) Mixture Conditioning of Hot Mix Asphalt (HMA), AASHTO R 30. The mixture for the Superpave specimens and maximum specific gravity mixture shall be aged for 2 (two) hours at compaction temperature.
 - (2) Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of the SHRP Gyratory Compactor, AASHTO T 312.
 - c. The JMF shall identify:
 - (1) The virgin mineral aggregates and pit locations
 - (2) RAP and source locations
 - (3) Hydrated lime or Warm Mix Additive
 - (4) Mineral filler
 - (5) The percent passing value for each specified sieve for the individual and blended materials
 - d.
 - (1) The Contractor shall submit the following, at a minimum, for basic mix verification: 1 (one) uncoated, proportioned 22 lb. (10,000 gram) sample of the blended mineral aggregates for consensus properties and specific gravity testing, for all mix types except SPS.
 - (2) The Contractor has the option of submitting the following for a more detailed mix design verification; 2 (two) proportioned 22 lb. (10,000 gram) samples of the blended mineral aggregates (which are precoated with hydrated lime, if lime is used) and two one-quart (liter) samples of the proposed PG Binder to be used in the mixture to the Department Materials and Research Central Laboratory at least 15 NDOT working days before production of asphaltic concrete.
 - (3) Submitted with these samples shall be a copy of the Contractor's results for all Superpave mix design tests.
 - (4) Mix design shall include at a minimum:
 - (i) The bulk specific gravity (Gsb), which shall be 2.585, for data purposes and as information only, for all mixes.

(ii) The target binder content. The binder content will be determined by ignition oven results. A correction factor of 0.3% will be added to the ignition oven results for mixes containing hydrated lime, and an adjustment factor of 0.1% will be added to the ignition oven results for mixes containing WMA.

(iii) The supplier and grade of PG Binder.

(iv) The maximum specific gravity of the combined mixture (Rice).

(v) The bulk specific gravity (Gmb) and air voids at N initial (Nini), N design (Ndes) and N maximum (Nmax) of the gyratory compacted specimens.

(vi) Voids in the Mineral Aggregate (VMA) and Voids Filled with Asphalt (VFA) at Ndes.

(vii) Fine Aggregate Angularity (FAA) and specific gravity, Coarse Aggregate Angularity (CAA).

(viii) Location description and/or legal descriptions and producers of materials used in the mix.

(ix) Dust to Binder Ratio

(x) JMF compaction temperatures from NDOT Gyratory Temperature Table (See Table 1028.11).

(xi) The hydrated lime content.

3. Quality Control Program:

a. The Contractor shall establish, provide, and maintain an NDOT approved Quality Control (QC) Program. The QC Program shall detail the methods and procedures that will be taken to assure that all materials and completed construction conforms to all contract requirements. The QC program shall be updated and submitted annually for review and approval. A copy of the QC Program shall be kept on file in the QC lab trailer.

b. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract, the Contractor shall assume full responsibility for placing a pavement that meets the contract specification requirements.

c. The Contractor shall not begin any construction of asphalt pavements or production of materials without an approved QC Program and approved JMF

4. Contractor's Lab Equipment:

a. The Contractor shall calibrate and correlate the testing equipment according to the procedures described for the individual tests and conduct tests in conformance with specified testing procedures as outlined during the annual laboratory approval provided by NDOT Materials and Research Division.

5. QC Testing Plan:

a. The testing plan shall provide that the samples be collected in accordance with the Department statistically based procedure of random sampling.

b. The Contractor may add any tests necessary to adequately control production.

c. All QC test results shall be reported on the latest version of the Department’s provided Superpave software by the Contractor with a copy provided to the Engineer within 1 (one) week after the tests are complete. Daily review by the Engineer shall be allowed. At the completion of the asphalt production, the Contractor shall submit to the Department a final copy of the Superpave test results on electronic recording media (CD, email, flash drive, etc.).

d. Procedures shall be defined to perform corrective action when any mix properties are out of specification when plant and production problems occur, when laydown problems occur such as, but not limited to: rutting, segregation, surface voids, tearing, contamination, irregular surfaces, surface irregularities.

1028.02 -- Material Characteristics

1. The type of PG Binder will be shown in the contract, except for the following:

a. SLX mixes shall be 58V-34 with 0.7% of an approved WMA additive.

b. SRM mixes shall be 58H-34 with 0.9% of an approved WMA additive.

2. Recycled Asphalt Pavement:

a. The Contractor may submit to the State a proposal to supplement the virgin aggregates of the asphaltic concrete mix with a Contractor’s specified percentage of RAP. The Contractor is responsible for investigating and maintaining the quality and verifying the quantity of the RAP material. The RAP must be pre-processed by fractionating, screening, and or crushing prior to use to a size such that the combined hot mix meets the required gradation. The mat shall not exhibit any visual defects or cold spots from RAP conglomeration.

b. In recycled asphaltic concrete mixtures, the allowable percent of RAP will be as shown in Table 1028.01.

Table 1028.01

Asphaltic Concrete Type	Percent, RAP	
	Minimum	Maximum
SPS	0	65
SPR	0	55
SPH	0	35
SLX	20	35
SRM	35	65

3. Aggregates:

a. Aggregates for use in superpave asphaltic concrete shall be tested on an individual basis.

b. With the exception of Asphaltic Concrete Type SPS the blended mineral aggregate shall not contain more than 80% limestone on the final surface lift of asphaltic concrete.

c. Asphaltic Concrete Type SLX shall contain a minimum of 20% Crushed Rock Chips (with a minimum of 45% retained on the #4 sieve and a maximum of 5% passing the #200 sieve).

d. Asphaltic Concrete Type SRM shall contain a minimum of 10% Crushed Rock (with a maximum of 20% passing the #4 sieve).

e. Asphaltic Concrete Type SPR, SLX, and SRM may contain a total maximum of 10% of the virgin material that is composed of natural, uncrushed aggregate by manmade methods commonly known as but not limited to: 47B gravel, 2A gravel, gravel surfacing, sluice sand, blow sand, waste sand, fill sand, road gravel, roofing gravel, hot mix sand or gravel, coarse sand, fine sand, plaster sand, masonry sand, pit run sand or gravel. For clarification on any proposed gravel, contact the Department Flexible Pavements Engineer.

f. Chat or coal sand will not be allowed in any mix.

g. Crushed rock material for use in asphaltic concrete, 1/4 inch (6.35 mm) and smaller, screenings and manufactured sand shall have a Sodium Sulfate loss of not more than 12% by mass at the end of 5 (five) cycles. Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.

h. Quartzite and granite shall conform to the requirements of Subsection 1033.02, Paragraph 4, a. (8). Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.

i. Crushed rock (Limestone) and Dolomite shall conform to the requirements of Paragraph 4.a. (4), (5) and (6). of Subsection 1033.02 of the Standard Specifications, Sampling size and frequency shall adhere to the current Department Materials Sampling Guide.

j. Soundness tests shall not be required for fine sand.

k. Once the satisfactory quality of aggregates from a source has been established, sufficient additional soundness tests will be performed to insure the continued satisfactory quality of the material, as determined by the Department's Materials Sampling Guide.

l. Aggregate consensus properties may be performed on material prior to the application of hydrated lime.

m. The coarse aggregate angularity value of the blended aggregate material shall meet or exceed the minimum values for the appropriate asphaltic concrete type as shown in Table 1028.02.

Table 1028.02
Coarse Aggregate Angularity
(ASTM D 5821)

Asphaltic Concrete Type	CAA (minimum)
SPS	--
SPR	83
SPH	95/90*
SLX	--
SRM	65

* Denotes two faced crushed requirements

n. The fine aggregate angularity value of the blended aggregate material shall meet or exceed the minimum values for the appropriate asphaltic concrete type as shown in Table 1028.03.

o. The specific gravity for calculation of the Fine Aggregate Angularity (FAA) shall be determined on a washed combined aggregate sample of the material passing the No. 8 (2.36 mm) sieve and retained on the No. 100 (150 μ m) sieve. The Contractor will determine the specific gravity to be used in the calculation of FAA mixture design value(s) and, if verified by the Department Aggregate Laboratory, this same value can be used throughout production. The verification value determined by the Department Aggregate Laboratory will be on a combined aggregate sample supplied by the Contractor that is representative of the material proposed or being used during production. The specific gravity to be used throughout production to calculate FAA values will be the Contractor's verified value or the Department determined value (whenever verification is not made) and will be noted on the Mix Design. Changes in aggregate percentages during production may require determination of a revised specific gravity for FAA.

Table 1028.03
Fine Aggregate Angularity
(AASHTO T304 Method A)

Asphaltic Concrete Type	FAA (minimum)
SPS	--
SPR	43.0
SPH	45.0
SLX	43.0
SRM	42.0

p. Dust to binder ratio is the ratio of the percentage by weight of aggregate finer than the No. 200 (75 μ m) sieve to the asphalt content expressed as a percent by weight of total mix. The dust to binder ratio shall be within 0.70 and 1.70 for all mixes except SRM. SRM dust to binder ratio shall be within 0.70 and 1.90.

q. The blended aggregate shall conform to the gradation requirements specified in the following Tables.

Table 1028.04

Gradation Control Points for SPH 0.5 Inch

English Sieve (Metric)	0.5 Inch Control Points (Percent passing)	
	Minimum	Maximum
1 inch (25 mm)	100.0	
3/4 inch (19 mm)	100.0	100.0
1/2 inch (12.5 mm)	90.0	100.0
3/8 inch (9.5 mm)		90.0
No. 8 (2.36 mm)	28.0	58.0
No. 16 (1.18 mm)		
No. 30 (600 μ m)		
No. 50 (300 μ m)		
No. 200 (75 μ m)	2.0	10.0

Table 1028.05

Gradation Control Points for Type SRM

(Metric)	(Percent passing)	
	Minimum	Maximum
3/4 inch (19 mm)	92.0	98.0
3/8 inch (9.5 mm)	80.0	92.0
No. 8 (2.36 mm)	42.0	60.0
No. 50 (300 μ m)	10.0	22.0
*No. 200 (75 μ m)	4.0	12.0

Table 1028.06

Gradation Control Points for SLX

English Sieve (Metric)	SLX Control Points (Percent passing)	
	Minimum	Maximum
3/4 inch (19 mm)	100.0	100.0
1/2 inch (12.5 mm)	98.0	100.0
3/8 inch (9.5 mm)	93.0	100.0
No. 4 (4.75 mm)	70.0	87.0
No. 8 (2.36 mm)	45.0	65.0
No. 16 (1.18 mm)	25.0	41.0
No. 30 (600 μ m)	15.0	31.0
No. 50 (300 μ m)	10.0	21.0
No. 200 (75 μ m)	4.0	10.0

Table 1028.07

Gradation Control Points for SPR

English Sieve (Metric)	SPR Control Points (Percent passing)	
	Minimum	Maximum
3/4 inch (19 mm)	98.0	100.0
1/2 inch (12.5 mm)		
3/8 inch (9.5 mm)	81.0	89.0
No. 4 (4.75 mm)		
No. 8 (2.36 mm)	46.0	56.0
No. 16 (1.18 mm)		
No. 30 (600 μ m)		
No. 50 (300 μ m)	12.0	21.0
No. 200 (75 μ m)	4.0	9.0

Table 1028.08

Gradation Control Points for SPR (Fine)

English Sieve (Metric)	SPR (Fine) Control Points (Percent passing)	
	Minimum	Maximum
3/4 inch (19 mm)		
1/2 inch (12.5 mm)		
3/8 inch (9.5 mm)	81.0	96.0
No. 4 (4.75 mm)		
No. 8 (2.36 mm)	46.0	56.0
No. 16 (1.18 mm)		
No. 30 (600 μ m)		
No. 50 (300 μ m)	12.0	21.0
No. 200 (75 μ m)	4.0	9.0

Table 1028.09

Gradation Control Points for Type SPS

English Sieve (Metric)	Control Points (Percent passing)	
	Minimum	Maximum
1 inch (25 mm)	100.0	
3/4 inch (19 mm)	94.0	100.0
1/2 inch (12.5 mm)	81.0	100.0
No. 4 (4.75 mm)	70.0	90.0
No. 8 (2.36 mm)	42.0	70.0
No. 16 (1.18 mm)	29.0	43.0
No. 30 (600 μ m)	19.0	34.0
No. 50 (300 μ m)	11.0	20.0
No. 200 (75 μ m)	2.0	10.0

1028.03 -- Acceptance Requirements

1. Mix Criteria:

a. The target value for the air voids of the SPH Asphaltic Concrete shall be 4% ($\pm 1\%$) at the Ndes number of gyrations. For Type SPS Asphaltic Concrete the air voids at Ndes shall be a minimum of 1.5% with a maximum of 5.0%. For Type SPR Asphaltic Concrete the air voids shall be 3% ($\pm 1\%$) at the Ndes number of gyrations.

b. The design criteria for each mixture shall be determined from Tables 1028.10, 1028.11, and 1028.12.

Table 1028.10

**Gyratory Compaction Effort
(Average Design High Air Temperature <39 degrees C)**

Asphaltic Concrete Type	Nini	Ndes	Nmax
SPS	6	40	62
SPR	7	65	100
SPH	8	95	150
SLX		50	
SRM		65	

Table 1028.11

Gyratory Compaction Temperatures

Mix Type	Percent RAP	Compaction Temp °F
SPS	0-25	270 \pm 5
	26-65	280 \pm 5
SPR	0-35	280 \pm 5
	36-55	290 \pm 5
SPH	0-35	300 \pm 5
SLX	20-35	280 \pm 5
SRM	35-65	290 \pm 5

Table 1028.12

Minimum Binder Content

Mix Type (Metric)	Minimum Binder Content, Percent
SPS	4.8
SPR	5.0
SPH	5.1
SLX	5.3
SRM	4.5

c. During production of Lot #1 and randomly selected lots thereafter, the Contractor shall provide to the Department 6 (six) properly prepared gyratory samples for AASHTO T 283 testing for all mixtures except

Asphaltic Concrete Type SPS. Superpave mixtures shall contain 1.25% hydrated lime as specified in the Special Provision “Hydrated Lime for Asphaltic Mixtures”. Each Superpave mixture shall be tested for moisture sensitivity in accordance with AASHTO T 283. The 6 inch (150 mm) specimens shall be compacted in accordance with AASHTO T 312 to 7% (\pm 0.5%) air voids at 95 mm in height and evaluated to determine the Tensile Strength Ratio (TSR).

2. The Contractor shall make Mix adjustments when:

a. The mix does not meet the current approved JMF or any other mix properties or requirements of the contract.

b. Surface voids create a surface or texture that does not meet the criteria of Sections 502 and 503 in these Standard Specifications.

c. Rutting occurs.

3. The Contractor shall inform the Engineer when changes in mixture properties or materials used occur for any reason. Changes such as, but not limited to, types or sources of aggregates or changes in grades, sources, properties or modification procedures (if modified) of PG Binders. The Department may require a new job mix formula, mix design and moisture sensitivity test. The new proposed job mix formula shall be in accordance with the requirements as stated above.

4. Mix adjustments at the plant are authorized within the limits shown in Table 1028.13 as follows:

a. The adjustment must produce a mix with the percent air voids and all other properties as stated in these Specifications.

b. All adjustments must be reported to the Engineer.

c. The adjustment values in Table 1028.13 will be the tolerances allowed for adjustments from the Department verified mix design “Combined Gradation” target values which resulted from production or mix design adjustments, but cannot deviate from Superpave gradation criteria. Mix adjustments for individual aggregates, including RAP, greater than 25% of the original verified mix design proportion or greater than 5% change in the original verified mix design percentage, whichever is greater, may require the Contractor to submit a new mix design, as determined by the Engineer. The Contractor is responsible for requesting new mix design targets as they approach these tolerances, failure to do so may result in a suspension of operations until a new mix design is approved.

Table 1028.13

Aggregate Adjustments	
Sieve Size	Adjustments
1 inch (25 mm), 3/4 inch (19 mm), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm), No. 4 (4.75 mm)	\pm 6%
No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 μ m), No. 50 (300 μ m)	\pm 5%
No. 200 (75 μ m)	\pm 2%

5. Sampling and Testing:

a. The Contractor shall take samples at frequencies identified by the Engineer, according to the Department statistically based procedure.

The samples shall be approximately 75 lbs (34 kg) and split according to AASHTO T 248 to create a companion sample. This sample splitting can be either at: 1) the sampling location, with the Department taking custody of their sample at that time or 2) after being transported to the test facility in an insulated container, with the Department taking custody of their sample at that time as determined by the Engineer. The details of sampling, location, splitting etc. shall be determined at the pre-construction conference.

b. All samples transported to the test facility and companion samples within the Lot shall be identified by attaching or faxing the lab calculation sheet from the latest version of the superpave software, stored, and retained by the Contractor until the Department has completed the verification testing process. Transporting of all samples will be under the observation of Department.

c. (1) The sample shall be taken from the roadway, behind the paver before compaction or from the windrow. For SPS mixes, the Contractor has the option to obtain the samples directly at the plant.

(2) At least one QC sample shall be tested for every 1,000 tons of plant produced mix.

(i) If, at the completion of the project, the final lot consists of less than 5,000 tons of asphaltic concrete, 1 (one) sample for each 1,000 tons or fraction thereof, shall be taken and tested.

(3) Additional sampling and testing for the Contractor's information and quality control may be performed at the Contractor's discretion. Any additional testing will not be used in pay factor determination.

(4) (i) When cold feed samples are being taken, the acquisition shall be timed such that the material in the sample represents, as close as possible, the same material in the sample taken behind the paver. If cold feeds are sampled and tested by Contractor, a split of that sample must be submitted with the hot mix subplot sample. The Contractor will be notified what subplot (a minimum of 1 (one) subplot per lot) sample must be tested for FAA and CAA from the blended cold feed material according to the Department random sampling schedule. All other FAA and CAA subplot samples may be taken from the randomly selected portion of the blended cold feed material or obtained from the random samples taken behind the paver. Samples shall be taken under the observation of Department and split according to AASHTO T 248, with the Department taking custody of their sample at that time.

(ii) For projects using RAP material the FAA shall be established as follows: a RAP sample will be processed through an ignition oven and then combined with the proportioned amount of virgin aggregate defined by the mix design and then proceeding with FAA and CAA testing.

d. The sample shall be compacted immediately while still hot (additional heating may be required to raise the temperature of the sample to compaction temperature).

e. Each production sample shall be tested as follows:

(1) Bulk Specific Gravity (Gmb) shall be determined for each specimen in accordance with AASHTO T 166 Bulk Specific Gravity of

Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens. One specimen shall be compacted for each production sample.

(2) One Theoretical Maximum Specific Gravity (Gmm) test for each production sample of uncompacted mixture shall be determined in accordance with AASHTO T 209 procedure 13.1. Weight in water - Maximum Specific Gravity of Bituminous Paving Mixtures.

(3) (i) The Blended Aggregate Bulk Specific Gravity (Gsb) shall be 2.585 for information only for all mixes.

(ii) FAA - AASHTO T 304 Method A. The pour time of the test sample into the funnel shall be completed in 5 ± 1 seconds.

(iii) CAA - ASTM 5821. For SPR mixes, CAA testing and results are only required on the cold feed verification test for the lot.

(4) The laboratory air voids shall be determined in accordance with AASHTO T312 and T269.

(5) (i) The percent of PG Binder shall be determined for each QC test. The percent of PG Binder will be computed by ignition oven results. A correction factor of 0.3% will be added to the ignition oven results for mixes containing hydrated lime.

(ii) The gradations shall be determined for each QC test using AASHTO T 30.

(6) Except as noted in this Subsection, all sampling and testing shall be done as described in the Department Materials Sampling Guide and Standard Method of Tests.

f. Testing Documentation:

(1) All test results and calculations shall be recorded and documented on data sheets using the latest version of Department provided "Superpave" software. A copy containing complete project documentation will be provided to the Department at the completion of asphalt production.

g. Superpave Software:

(1) QC charts from the software shall be made available for review by the Engineer at any time.

(2) As a minimum, the following values shall be reported on Department provided software:

(i) Laboratory Gyratory density.

(ii) Ignition oven or cold feed aggregate gradations for all Superpave sieves will be reported.

(iii) PG Binder content shall be plotted to the nearest 0.01% by ignition oven results in accordance with AASHTO T 308.

(iv) The theoretical maximum specific gravity (Rice) to the nearest 0.001% will be reported.

(v) Laboratory Gyratory air voids at Ndes shall be plotted to nearest 0.1%. Laboratory Gyratory air voids, at Nini, Ndes and Nmax shall be reported to nearest 0.1%.

(vi) FAA and CAA of the asphaltic concrete for both cold feed and ignition oven samples will be reported to the nearest 0.1% for FAA

and 1% for CAA. A minimum of one subplot FAA and CAA cold feed sample per lot will be tested and recorded on Department provided software.

(vii) VMA content shall be plotted to nearest 0.1% and VFA shall be reported to the nearest 0.1%.

(viii) Dust to Binder ratio to the nearest 0.01 will be reported.

6. Verification Sampling and Testing:

a. The Department will select and test at random one of the subplot samples within a Lot for verification and report results.

b. The results of Contractor QC testing will be verified by the Department's verification tests. Any samples outside of the tolerances in Table 1028.15 and 1028.16 will result in an Independent Assurance (IA) review of testing and may result in the Department test results being applied.

(1) On any given Lot, if the results of Air Void verification testing and its companion QC testing are within 1.0% air voids, the Air Void verification for the entire Lot is complete and the Contractor test results will be used to determine the pay factors. If the Air Void verification test results and the companion QC test results are outside the above tolerance, the results from the verification test will be used to determine the pay factor for that subplot. Any or all of the remaining four Department subplot samples may be tested and the Department subplot test results may be applied to the respective sublots and the resulting pay factors will apply.

(2) On any given Lot, if the results of the FAA verification testing and its companion QC testing are within 0.7%, the FAA verification for the entire Lot is complete and the Contractor test results will be used to determine the pay factor. If the FAA verification test results and the companion QC test results are outside the above tolerance, the results from the verification test will be used to determine the pay factor for that subplot. Any or all of the remaining four Department subplot samples may be tested and the Department subplot test results may be applied to the respective sublots and the resulting pay factors will apply.

c. When verification tests are within testing tolerance but results show a consistent pattern of deviation from the QC results, the Engineer may cease production and/or request additional verification testing or initiate a comprehensive IA review.

Table 1028.15
Asphaltic Concrete Testing Tolerances

Test	Tolerance
Asphalt Content by Ignition Oven	0.5%
Gyratory Density	0.020
Maximum Specific Gravity	0.015
Bulk Dry Specific Gravity (Gsb)	0.020
FAA	0.7%
CAA	10%
Field Core Density	0.020
Air Voids	1.0%

Table 1028.16
Blended Aggregate Gradation
Testing Tolerances

Sieve Size	Tolerance
3/4 inch (19 mm), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm), No. 4 (12.5 mm), No. 8 (2.36 mm)	6%
No. 16 (1.18 mm), No. 30 (600 μ m), No. 50 (300 μ m)	5%
No. 200 (75 μ m)	3%

d. Independent Assurance (IA) Review of Testing:

(1) The Contractor shall allow the Department personnel access to their laboratory to conduct IA review of technician testing procedures and apparatus. Any deficiencies discovered in testing procedures will be reported by the department and corrected by the Contractor.

(2) During IA review, the Department personnel and the Contractor will split a sample for the purpose of IA testing. The samples selected will be tested in the Department Branch Laboratory. Any IA test results found to be outside of defined testing tolerances above will be reported. The Contractor shall verify the testing apparatus and make corrections if the apparatus is out of tolerance.

(3) See Section 28 of the Department's Materials Sample Guide for more information on IA testing.

e. If the project personnel and the Contractor cannot reach agreement on the accuracy of the test results, the Department will be asked to resolve the dispute, which will be final. It is the Contractor's responsibility to obtain a large enough sample size for any referee testing (a total sample size of 6000 grams, to be retained by the Department after splitting, is recommended for FAA testing). All dispute resolutions will be in accordance with the Quality Assurance Program requirements in the Department's Materials Sampling Guide.

7. Production Tolerances, Acceptance, and Pay Factors

Table 1028.17
Production Tolerances*

Test	Allowable Deviation from Specification
Dust to Asphalt Ratio	None
Coarse Aggregate Angularity	- 5% below Min.
Fine Aggregate Angularity for SPR, SLX, and SRM	- 0.2% below Min. for cold feed or - 0.5% below Min. for ignition oven
Fine Aggregate Angularity for all other mixes	- 0.5% below Min. for cold feed or - 1.0% below Min. for ignition oven
Minimum Binder Content	None

* These tolerances are applied to the mix design specification values, not the submitted mix design targets.

a. The Contractor shall notify the Engineer whenever a test result approaches the Specification limits.

b. When any single test result for FAA testing falls outside the allowable production tolerances in Table 1028.17, the material represented by this test will be accepted with a 20% penalty or rejected, as determined by the Engineer. For all other tests, when any single test result, on the same mix property, from two consecutive QC samples fall outside the allowable production tolerances in Table 1028.17, the material represented by these tests will be accepted with a 20% penalty or rejected, as determined by the Engineer.

c. The Contractor has the responsibility to cease operations when specifications are not being met.

d. Acceptance and pay factors for Asphaltic Concrete Type SPS will be based on compacted in place average density and joint density.

e. When a control strip is not constructed, the pay factor for the running average of four air voids shall be fixed at 1.0 for the first three asphaltic concrete sublots.

(1) When there is a production tolerance pay factor penalty as stated in Paragraph 7.b. subsection 1028.03 this penalty percentage will be entered in the Superpave Asphalt Pay Factor Summary under production specifications for each subplot affected.

f. The pay factors for the single test air voids and moving average of four air voids pay factors will be determined in accordance with Table 1028.18.

Table 1028.18 (SPR)
Acceptance Schedule
Air Voids - N_{des}

Air voids test results for Asphaltic Concrete Type SPR	Pay Factor	
	Moving average of four	Single test
Less than 0.5%	50% or Reject	50% or Reject
0.5% to 0.9%	50% or Reject	50%
1.0% to 1.4%	50% or Reject	95%
1.5% to 1.9%	90%	95%
2.0% to 2.4%	100%	100%
2.5% to 3.5%	102%	104%
3.6% to 4.0%	100%	100%
4.1% to 4.5%	95%	95%
4.6% to 5.0%	90%	95%
5.1% to 5.5%	50% or Reject	90%
5.6% to 6.0%	50% or Reject	50%
6.1% and over	50% or Reject	50% or Reject

Table 1028.18 (SPH)
Acceptance Schedule
Air Voids - N_{des}

Air voids test results for SPH Asphaltic Concrete	Pay Factor	
	Moving average of four	Single test
Less than 1.5%	50% or Reject	50% or Reject
1.5% to 1.9%	50% or Reject	50%
2.0% to 2.4%	50% or Reject	95%
2.5% to 2.9%	90%	95%
3.0% to 3.4%	100%	100%
3.5% to 4.5%	102%	104%
4.6% to 5.0%	100%	100%
5.1% to 5.5%	95%	95%
5.6% to 6.0%	90%	95%
6.1% to 6.5%	50% or Reject	90%
6.6% to 7.0%	50% or Reject	50%
7.1% and over	50% or Reject	50% or Reject

Table 1028.18 (SLX)
Acceptance Schedule
Air Voids - N_{des}

Air voids test results for Asphaltic Concrete Type SLX	Pay Factor	
	Moving average of four	Single test
Less than 0.5%	50% or Reject	50% or Reject
0.5% to 0.9%	50% or Reject	50%
1.0% to 1.4%	50% or Reject	95%
1.5% to 1.9%	90%	95%
2.0% to 2.4%	100%	100%
2.5% to 3.5%	102%	104%
3.6% to 4.0%	100%	100%
4.1% to 4.5%	95%	95%
5.1% to 5.5%	50% or Reject	90%
5.6% to 6.0%	50% or Reject	50%
6.1% and over	50% or Reject	50% or Reject

Table 1028.18 (SRM)
Acceptance Schedule
Air Voids - N_{des}

Air voids test results for Asphaltic Concrete Type SRM	Pay Factor	
	Moving average of four	Single test
Less than 0.4%	50% or Reject	50% or Reject
0.5% to 0.9%	50% or Reject	95%
1.0% to 1.4%	90%	95%
1.5% to 1.9%	100%	100%
2.0% to 3.0%	102%	104%
3.1% to 3.5%	100%	100%
3.6% to 4.0%	95%	95%
4.1% to 4.5%	90%	95%
4.6% to 5.0%	90%	100%
5.1% to 5.5%	50% or Reject	90%
5.6% to 6.0%	50% or Reject	50%
6.1% and over	50% or Reject	50% or Reject

8. Asphalt Concrete Density Samples:

a. The Contractor shall perform density tests under direct observation of Department personnel. The Contractor shall establish the method of testing in the preconstruction conference and shall test in accordance with the AASHTO T 166, NDOT T 587, or as otherwise described in these Special Provisions. The Contractor shall insure that the proper adjustment bias and/or correction factors are used and accessible to Department personnel along with all other inputs when NDOT T 587 is

selected. All correlation factors and test results shall be generated and reported on the Department Superpave Software. When AASHTO T 166 is being used, the Department will observe the Contractor taking, transporting, and testing the cores. The Department will take immediate custody of the cores at the completion of the testing. All disputed values determined using NDOT T 587 will be resolved using AASHTO T 166.

b. The Contractor shall determine the density of samples by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice).

Note: The individual QC test value of the Maximum Mix Specific Gravity (Rice), determined by AASHTO T 209, will be used to calculate the density of each corresponding core.

c. The Contractor shall cut cores the first day of work following placement of the mixture. The core samples shall be a minimum of a 3 inch (75mm) diameter.

d. Normally, 1 (one) sample for determination of density will be taken from each subplot (750 tons) (680 Mg) at locations determined by the Engineer.

e. The average density of the lot shall be used to compute the pay factor for density. Exceptions to the sampling and testing of core samples for the determination of density are as follows:

(1) When the nominal layer thickness is 1 inch (25 mm) or less, the sampling and testing of density for this layer will be waived. However, regardless of layer thickness, Asphaltic Concrete Type SLX will be monitored for density. For SLX, an initial rolling pattern shall be completed to determine the rolling pattern that will target a minimum of 92.5% density. The Contractor shall monitor the density through a combination of rolling pattern and field testing as deemed necessary by the Engineer. The Contractor will use steel wheel compactors only, rubber tire rollers will not be allowed.

(2) When the average thickness of the 5 cores for a lot is 1 inch (25 mm) or less, the testing of density samples for this lot will be waived.

(3) When the nominal layer thickness and the average of the original 5 (five) cores for a lot are both more than 1 inch (25 mm), but some of the cores are less than 1 inch (25 mm) thick, additional cores shall be cut at randomly selected locations to provide 5 (five) samples of more than 1 inch (25 mm) thickness for the determination of the pay factor for density.

f. (1) If, at the completion of the project, the final lot consists of less than one lot of asphaltic concrete, a minimum of 3 (three) samples, or 1(one) sample for each subplot or fraction thereof, whichever is greater, shall be taken and tested for density.

(2) The test results shall be averaged and the density pay factor based on the values shown in Table 1028.19.

(3) Should the average of less than 5 (five) density tests indicate a pay factor less than 1.00, additional density samples to complete the set of 5 (five) shall be taken at randomly selected locations and the density pay factor based on the average of the 5 (five) tests.

Table 1028.19

Acceptance Schedule Density of Compacted Asphaltic Concrete	
Average Density (5 Samples, Percent of Voidless Density)	Pay Factor
Greater than 92.4	1.00
Greater than 91.9 to 92.4	0.95
Greater than 91.4 to 91.9	0.90
Greater than 90.9 to 91.4	0.85
Greater than 90.4 to 90.9	0.80
Greater than 89.9 to 90.4	0.70
89.9 or Less	0.40 or Reject

g. If requested by the Contractor, check tests for all density tests in the original set, taken no later than the working day following the receipt of all test results for the lot, will be allowed in lots with a density pay factor of less than 1.00. No re-rolling will be allowed in these lots. Locations for check tests will be provided by the Engineer from the Random Sampling Schedule. The average density obtained by the check tests shall be used to establish the density pay factor for the lot.

h. The location of density samples are identified by the Random Sampling Schedule. When the random location is noted as zero or the lane width (i.e., zero or 12 ft. on a 12-foot lane), the core shall be cut with the outer edge of the core barrel no greater than 4 inches away (laterally) from the edge of the top of the mat for an unconfined edge or from the edge of the top of the hot mat (joint) for a confined edge. If using a nuclear gauge, the 4 inches would be measured to the edge of the gauge base. The percent density value at these edge-of-lane locations shall be adjusted upward by 2.5%, but to a value of no greater than 92.5%, and the resultant value used in determining the density pay factor. No initial value of 92.5% or greater shall be adjusted.

9. Basis of Payment:

For each subplot of Asphaltic Concrete Type SPS, SPR SPH, SLX, and SRM, the asphaltic concrete shall be paid for each ton of "Asphaltic Concrete Type _____" placed and accepted. The incentive/disincentive shall be calculated on a lump sum basis based on the unit price, tonnage and quality pay factors. This will be a product of all applicable pay factors, including density and smoothness. This factor will be calculated on NDOR software and will provide for a weighted pay factor for each type of Asphaltic Concrete on the project, and then summed up and paid for as a single incentive/disincentive as a lump sum. The tonnage that is applicable toward this incentive/disincentive shall only be tonnage that is paid for by 'mainline roadway and shoulder tonnage items' and for the full thickness and tonnage paid for and accepted. No incentive will be paid for project patching or tonnage used for maintenance patching.

SECTION 1029 -- PERFORMANCE GRADED BINDER

1029.01 -- Description

1. Performance Graded (PG) binder shall conform to the requirements of AASHTO M332 Table 1. PG binder shall also conform to the Department PG+ specifications (Table 1029.01) when classified as a modified binder.

- a. The test of Direct Tension, AASHTO M332 Table 1, is omitted.
- b. The test of J_{nriff} , AASHTO M332 Table 1, is omitted.

2. The Performance Graded Binder shall be supplied by a supplier that is certified by the Department.

a. A supplier may request certification by contacting the Nebraska Department of Transportation, Materials and Research Division, Flexible Pavement Engineer.

b. A certified supplier must furnish a quality control program to the Department Bituminous Laboratory for review and approval. The program shall follow, at a minimum, the guidelines of AASHTO R26 with references to AASHTO M320 to include AASHTO M332.

c. A certified supplier must be a participant in one or more of the following PG Binder Groups:

- (1) AASHTO Materials Reference Laboratory (AMRL)
- (2) Western Cooperative Testing Group (WCTG)
- (3) Combined States Binder Group (CSBG)
- (4) A PG Binder round robin Group approved by the

Department

d. A certified supplier must maintain, meet and follow the requirements of the group or groups in which they participate, to maintain certification by the Department. In addition, active participation is required to maintain certification by the Department. Active participation will include submitting of round robin sample results.

(1) For suppliers that desire to provide product while approved PG Binder Group membership is pending, a temporary certification may be issued for a period of up to one year. Split sample testing will be required prior to receiving a temporary certification. Split sample testing will be done on all grades of binder that the supplier intends to supply during the temporary certification period. The supplier will have up to one year to become certified by participating in and following the requirements of one or more of the approved PG Binder Groups, and to meet all other conditions for certification.

e. A certified supplier may be asked to supply to the Department: past round robin results, laboratory inspection reports, reasons for and investigative reports on outlying results, quality control testing results, technician training and/or proficiency testing reports.

f. A certified supplier will agree to inspection of their plant or terminal without notice anytime during production or supplying of material to the Department. The inspection may also include the supplier's laboratory.

g. If desired, a certified supplier can voluntarily submit samples of PG binder proposed for use to the Department Materials and Research

Bituminous Laboratory for courtesy testing prior to Asphalt production. The test results will be for Information-Only.

h. Certification will be withdrawn from a supplier when one or more of the following conditions exist:

(1) Inability to consistently supply material meeting specifications as outlined herein.

(2) Failure to maintain an acceptable quality control program.

(3) The failure to meet one or more of the conditions of being a certified supplier as outlined, but not limited to only these conditions.

i. Notification of decertification of a supplier will be submitted in writing by the Department. The notification will include the reason(s) why decertification occurred. PG Binders from a decertified source will not be accepted for use on Department projects.

j. If a supplier has lost certification and seeks to be recertified, the following steps are required:

(1) Supplier shall fulfill the requirements outlined above for gaining Certified Supplier status. This may include the submittal of material samples to ensure specifications compliance before recertification approval.

(2) Supplier shall submit documentation to the Department Flexible Pavement Engineer explaining the cause(s) of decertification outlined in the notification, and the actions that are being taken to correct the problem(s) identified by the Department.

1029.02 -- Material Characteristics

1. Modified Performance Grade binders shall meet the following specifications:

a. All specified binders with a grade temperature spread of 92°C or greater, shall be defined as modified.

b. The PG Binder shall meet the Multiple Stress Creep Recovery (MSCR) specifications of the following Table:

Table 1029.01

PG+ Specifications

AASHTO T350 MSCR Average Percent Recovery @ 3.2 kPa for modified PG binders	
AASHTO M332 Performance Grade	Test Temperature of 58°C
58S - 34	---
58H - 34	30 Min.
58V - 34	55 Min.
58E - 34	75 Min.

c. The binder shall incorporate a blend of base asphalt and the use of the elastomer modifiers styrene-butadiene (SB), styrene-butadiene-styrene (SBS), or styrene-butadiene-rubber (SBR).

(1) Polyphosphoric Acid (PPA) may be used as an additional modifier to elastomer modifiers and shall not exceed 0.50% maximum PPA

addition (by weight of binder). The total phosphorous content of the PPA-modified PG Binder shall not exceed 1900 ppm. The total phosphorous content shall be determined as per ASTM D1091, ASTM D6443, or ASTM D6481.

(i) To determine specifications compliance, the Department requires a sample of the base asphalt binder, a sample of the PPA, and supplier-prepared varying PPA percentage modified binder samples. These samples shall be sent to the Department Bituminous Laboratory prior to project Asphalt production.

(2) Crumb rubber may be used as an additional modifier to elastomer modifiers. If crumb rubber is used:

(i) Paragraph 5.4 (solubility) of AASHTO M332 is then void.

(ii) Paragraph 5.5 (micron requirement) of AASHTO M332 is then void.

d. The composite material shall be thoroughly mixed at the asphalt refinery or terminal prior to (for tank storage) or as (in-line blending) being loaded into the transport vehicle.

(1) The modified binder shall be heat and storage stable and shall not separate when handled and stored as per the supplier's recommendations.

(2) The composite material shall be homogenous, and shall not demonstrate evidence of localized gelation or over-crosslinking of polymers. The composite material shall not otherwise contain any other non-homogenous conglomerations.

2. Unmodified Performance Grade Binders are defined as specified binders with a grade temperature spread of less than 92°C.

1029.03 -- Procedure

1. A Material Certification shall be submitted to the Engineer prior to construction or when switching suppliers, stating the type of any modifier(s) being used. The Material Certification must also state that the material has not been air blown or oxidized.

a. If the PG Grade modification process of the PG Binder includes the use of PPA (Polyphosphoric Acid) and/or crumb rubber, then the Material Certification must also state the type of all modifiers used in the formulation. If PPA is used, the Material Certification must state the percent PPA in the binder, and also state and confirm the total phosphorous content of the PPA modified binder.

2. The Contractor shall receive from the supplier, instructions on the proper storage and handling of each grade and shipment of PG Binder.

3. Substitution of a PG Binder, which exceeds the upper and/or lower grade designations from what is specified, requires advance notification to, and approval by, the Engineer. The substitution of the PG Binder shall also be identified in the sample identification submittals.

4. PG Binder Lots and their respective samples are defined as follows:

a. Each 200 tons of liquid PG Binder grade incorporated into the production of Asphalt, or final portion thereof, will be a binder lot.

b. A binder lot will include only one PG Binder grade, or will include a blend of grades as defined in paragraph 5.

c. A binder lot will include only one supplier of the PG Binder.

(1) If a Contractor needs to switch binder suppliers during the production of a binder lot, it is the Contractor's responsibility to ensure both the compatibility and the specifications compliance of the mixture of the respective binder products. The supplier designation of the lot will be listed as "mixed suppliers" if the binder lot sample was taken after this occurs.

d. The Engineer must be notified and approve of the intent to blend binder grades, or to switch binder suppliers, prior to either occurrence.

e. All binders shall be sampled at the rate of at least one sample per binder lot.

(1) The sample shall consist of a two-quart (half gallon) can and shall be taken by the Contractor's Certified Sampling Technician, with confirmation by Department personnel. The sample shall be taken at the plant from the line between the storage tank and the mixer, or from the tank supplying material to the line, at a location from which material sampled is representative of the material in the line to the mixer. The sampling process shall follow procedures of the Department's Materials Sampling Guide.

(2) When the tested PG Binder is in compliance, the binder lot will be accepted and the sample will be discarded. If the tested PG Binder does not comply, then the pay factor of the PG Binder lot represented by the sample shall be adjusted according to Table 1029.02, and Table 1029.03 (if modified).

(3) When a total PG Binder grade type on a project is less than 200 tons, a minimum of one PG Binder lot sample is required. If the PG Binder does not comply with test specifications, then the pay factor of the PG Binder lot shall be adjusted according to Table 1029.02, and Table 1029.03 (if modified).

5. Blending of differing PG Binder grades at the hot mix plant site will be allowed only with prior approval, and with the following restrictions:

a. The resultant blend of grades will meet PG+ (if modified binder), and/or AASHTO M332 specifications when tested as $\pm 3^{\circ}$ C of the specified PG Binder grade.

b. The sample of the blended material will be considered as a lot sample, and it will be taken during initial production following the blending of the binders.

c. The lot sample of the blended material shall have a pay factor applied as per Table 1029.02, and Table 1029.03 (if modified), when not meeting specifications.

d. The blended sample's identification form shall note the blending conditions and provide a statement that the sample is a blend of grades.

e. The next lot sample, following the sample representing the blend, will be tested as the specified binder grade for the asphalt mixture being produced and shall meet AASHTO M332 and PG+ (if modified), specifications.

f. For modified PG Binders, only blending of the same type of elastomer modifiers listed in 1029.02 Paragraph 1.c. will be allowed.

6. The Nebraska Department of Transportation, Materials and Research Bituminous Laboratory, will do selective testing on each Binder Lot. When any test result shows a lot sample not meeting specifications, that lot sample and any adjacent previous, and any adjacent following lot sample received will be tested for complete specifications compliance. Adjacent lot sample testing will then continue in this manner until tested samples meet all specifications, or there are no more lot samples remaining to be tested.

7. All lot samples as tested are subject to the Pay Factors listed in Table 1029.02, and also Table 1029.03 if modified, below:

Table 1029.02
Tests of AASHTO M332 Pay Factor Table ¹

Test and Specification	Test Results	Pay Factor
Original Binder Dynamic Shear, $G^*/\sin \delta$, kPa Min. 1.00	> 0.99	1.00
	0.97 - 0.99	0.95
	0.94 - 0.96	0.90
	0.91 - 0.93	0.85
	< 0.91	0.70 or Reject
Rolling Thin Film Oven Residue, Standard Traffic "S", MSCR $J_{nr3.2}$ Max. 4.5 kPa^{-1}	<4.6	1.00
	4.6	.95
	4.7	.90
	4.8	.85
	>4.8	.70 or Reject
Rolling Thin Film Oven Residue, Heavy Traffic "H", MSCR $J_{nr3.2}$ Max. 2.0 kPa^{-1}	<2.1	1.00
	2.1	.95
	2.2	.90
	2.3	.85
	>2.3	.70 or Reject
Rolling Thin Film Oven Residue, Very Heavy Traffic "V", MSCR $J_{nr3.2}$ Max. 1.0 kPa^{-1}	<1.1	1.00
	1.1	.95
	1.2	.90
	1.3	.85
	>1.3	.70 or Reject
Rolling Thin Film Oven Residue, Very Heavy Traffic "E", MSCR $J_{nr3.2}$ Max. 0.5 kPa^{-1}	<0.6	1.00
	0.6	.95
	0.7	.90
	0.8	.85
	>0.8	.70 or Reject
Pressure Aging Vessel Residue Dynamic Shear, "S", $G^* \sin \delta$, kPa Max. 5000	< 5001	1.00
	5001 - 5200	0.95
	5201 - 5400	0.90
	5401 - 5600	0.85
	> 5600	0.70 or Reject
Pressure Aging Vessel Residue Dynamic Shear, "H", "V", "E", $G^* \sin \delta$, kPa Max. 6000	< 6001	1.00
	6001 – 6050	.95
	6051 – 6100	.90
	6101 – 6150	.85
	>6150	.70 or Reject

Test and Specification (cont'd)	Test Results	Pay Factor
Pressure Aging Vessel Residue BBR m-Value Min. 0.300	>0.350	1.05
	0.300 – 0.350	1.00
	0.295 – 0.299	0.95
	0.290 – 0.294	0.90
	0.285 – 0.289	0.85
	<0.285	0.70 or Reject
Pressure Aging Vessel Residue BBR Creep Stiffness, mPa Max. 300	< 200	1.05
	200 - 300	1.00
	301 - 310	0.95
	311 - 320	0.90
	321 - 330	0.85
	> 330	0.70 or Reject

Table 1029.03

PG + Pay Factor Table ¹

AASHTO T350 Multiple Stress Creep Recovery (MSCR) @ 58°C Test and Specifications	Test Results	Pay Factor
AASHTO M332 Performance Grade 58H-34 Average Percent Recovery @ 3.2 kPa Min. 30%	> 29	1.00
	29	0.95
	28	0.90
	27	0.85
	< 27	0.70 or Reject
AASHTO M332 Performance Grade 58V-34 Average Percent Recovery @ 3.2 kPa Min. 55%	> 54	1.00
	54	0.95
	53	0.90
	52	0.85
	< 52	0.70 or Reject
AASHTO M332 Performance Grade 58E-34] Average Percent Recovery @ 3.2 kPa Min. 75%	> 74	1.00
	74	0.95
	73	0.90
	72	0.85
	< 72	0.70 or Reject
Pressure Aging Vessel Residue BBR Creep Stiffness, mPa Max. 300	< 200	1.05
	200 - 300	1.00
	301 - 310	0.95
	311 - 320	0.90
	321 - 330	0.85
	> 330	0.70 or Reject

¹ If a lot sample has more than one test that results in a reduced pay factor (less than 1.00) from either or both of the above Pay Factor Tables, the single largest pay factor reduction will be the one used in determining the lot pay factor. If a lot sample passes all testing (1.00 or greater), and one or more test pay factors are 1.05, the pay factor of 1.05 will be the one used in determining the lot pay factor.

8. When all lot samples have been received and tested, a final pay factor of all the PG Binder per Asphalt type will be calculated and applied as follows:

a. The final pay factor is the average of all lot sample pay factors. The final pay factor cannot exceed 1.000.

Example Calculations:

4 Binder Lots Asphalt: $\frac{0.95 + 1.05 + 1.00 + 0.85}{4} = 0.962$ Final Pay Factor

3 Binder Lots Asphalt: $\frac{0.95 + 1.05 + 1.05}{3} = 1.017$ = Final Pay Factor of 1.000

b. The final pay factor will be applied to the contract unit price of asphalt binder.

c. The Engineer will determine if lots that have a test pay factor of 0.70 or Reject will be removed. If 0.70 or Reject material is left in place, a price factor of 0.70 will be the determined lot pay factor. The final pay factor will be applied to the contract unit price of asphalt binder.

(1) Removal and replacement will be at no additional cost to the Department.

(2) If any lot was removed, a new lot pay factor will be determined by testing of the replacement material.

9. When the testing of a PG binder lot sample shows test results that are outside of specification limits, the initial process of resolving the sample failure will include the following actions, as appropriate:

a. The Department Bituminous Laboratory may conduct retesting of the remaining portion of the sample as determined necessary to confirm the original test result(s).

b. The Department Bituminous Laboratory will notify the Department project personnel, who will in turn notify the Contractor. All parties will arrange to investigate all aspects of the testing, loading, handling and delivery of the material in question. The Contractor and Department project personnel shall report their findings to the Bituminous Laboratory.

c. The Department Bituminous Laboratory will collect and compile all information provided.

d. The Department Bituminous Laboratory will issue a standard report of tests for all samples tested, to include any resulting final pay factor deductions or removals. A copy of the report of tests will be distributed to the District and the Construction Division. The District will then provide a copy to the Contractor. PG Binder Supplier requests for a copy of this report will be directed to the Contractor.

10. If the Contractor wishes to dispute any results after testing and investigations have been completed on any failing lot sample(s) that subjected the final pay factor from paragraph 8 to less than 1.000, the Department will select an independent laboratory for referee testing to take place on the remaining portion of the sample(s).

a. Only the Contractor can initiate dispute resolution, and request referee testing. The request must be made, in writing, to the Department Construction Division within 30 days of awareness of final pay factor determination. Otherwise dispute resolution is forfeited.

b. The identity of the independent laboratory will not be revealed until the selected laboratory has completed the referee testing, and the Department Bituminous Laboratory has submitted a final report of the results.

c. If the independent lab's tests indicate failing results and pay deductions equal to or greater than the Department's, the Contractor will reimburse the Department for the cost of testing. If the independent lab's tests indicate that the material meets specification, or is at a pay deduction less than the Department's, the Department will assume the cost of testing. When the independent lab's tests indicate a pay deduction, the lesser of the Department's and the independent lab's deductions will be applied.

SECTION 1030 -- LIQUID ASPHALTS

1030.01 -- Description

1. Medium-Curing Cutback Asphalt is the accepted Department's liquid asphalt.

1030.02 -- Material Characteristics

1. Cutback asphalts shall conform to the AASHTO M 82, Medium-Curing Type requirements with the following changes:

a. Note "a" of Table 1 is void.

b. Note "b" of Table 1 is amended to read: In lieu of viscosity of the residue, the Department specifies the test of penetration with a specification of 120 to 250 dmm for all grades.

c. Due to the advent of low-sulfur petroleum formulations, some of which are used as diluent in the fluxing of cutback materials production, the Table 1 test requirements of Flash Point (tag, open cup), and Distillation, percent by volume of total distillate at the temperatures of 225°C (437°F) and 260°C (500°F), are removed.

1030.03 -- Procedures

1. Medium-Curing cutback asphalts shall be stored, heated, transferred, or otherwise handled, as per Manufacturer's recommendations.

1030.04 -- Acceptance Requirements

1. Liquid asphalts will be accepted as described in the Department's *Materials Sampling Guide*.

SECTION 1031 -- EMULSIFIED ASPHALT (ANIONIC)

1031.01 -- Description

1. Emulsified asphalt (anionic) shall conform to the requirements below. All test methods are AASHTO methods. All AASHTO Testing Standards are as per the 2015 Edition.

1031.02 -- Material Characteristics

1. Emulsified asphalt (anionic) samples shall comply with test requirements when tested after being stored at room temperature of 73 +/- 4°F (23 +/- 2°C) for a period of up to 14 days after sampling.

2. HFE-150, HFE-300, and HFE-1000 shall meet the requirements in Table 1031.01.

Table 1031.01

HFE-150 - sand seal, chip seal, armor coat, especially with more graded or dusty materials.		
	Min.	Max.
Tests on emulsion:		
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	50	400
Settlement, % (note 1)		5
Sieve Test, % (note 1)		0.10
Residue by distillation, %	65	
Tests on distillation residue:		
Penetration, dmm.	150	250
Solubility in Trichloroethylene, %	97.5	
Float Test, 60°C (140°F), sec.	1200	
HFE-300 – used for warm weather windrow mixes, pug mill mixes, base stabilization, and cold in-place recycling.=		
	Min.	Max.
Tests on emulsion:		
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	50	400
Settlement, % (note 1)		5
Sieve Test, % (note 1)		0.10
Residue by distillation, %	65	
Oil Distillate, %		7
Tests on distillation residue:		
Penetration, dmm.	300	
Solubility in Trichloroethylene, %	97.5	
Float Test, 60°C (140°F), sec.	1200	
HFE-1000 - winter windrow mix.		
	Min.	Max.
Tests on emulsion:		
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	50	400
Residue by distillation, %	65	
Oil Distillate, %		7
Tests on distillation residue:		
Viscosity by Vacuum Capillary Viscometer, Poise (note 2)	20	90
Penetration, dmm.	300	
Float Test, 60°C (140°F), sec.	1200	

Note 1: See note "A" of AASHTO M 140.

Note 2: Cannon-Manning type. Size selection determined by a flow time of closest to 60+ seconds.

3. HFMS-2P shall meet the requirements in Table 1031.02, and below.

Table 1031.02

HFMS-2P - used for polymer modified armor coat or chip seal, especially with more graded or dusty materials.		
	Min.	Max.
Tests on emulsion:		
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	50	400
Storage Stability, percent (note 1)		1.0
Sieve Test, percent (note 1)		0.10
Demulsibility, 50 ml 0.1N CaCl ₂ , percent	40	
Residue by distillation, percent (note 2)	65	
Oil Distillate, percent		3
Tests on distillation residue:		
Penetration, dmm.	100	200
Ductility, cm.	45	
Float Test, 60°C, sec.	1200	
Elastic Recovery, 25°C (77°F), percent	55	

Note 1: See note "A" of AASHTO M 140.

Note 2: The distillation shall be taken to 350 +/-5°F, and held for 20 minutes, and otherwise in accordance with AASHTO T 59.

a. The solubility in trichloroethylene of the base stock asphalt binder shall be greater than 99.0%.

b. All base stock asphalt binder must be modified prior to emulsification with styrene-butadiene or styrene-butadiene styrene block copolymers. HFMS-2P shall contain no latex polymer.

4. HFMS-2L shall meet the requirements below.

a. HFMS-2L shall meet all specifications of HFMS-2P with the following exceptions.

(1) The test of Elastic Recovery is omitted.

(2) The base stock asphalt binder shall be polymerized with a total minimum of 3.0% polymer solids by weight of the base stock asphalt binder. The polymers can be exclusively latex, or any combination of styrene-butadiene rubber latex, SB, SBS, SBR, or polychloroprene latex. The polymerization process shall be at least partly latex, and the latex is only allowed to be added during a co-milling emulsification process.

5. RS-2 shall meet the specifications of AASHTO M 140.

6. SS-1 shall meet the specifications of AASHTO M 140.

7. SS-1H shall meet the specifications of AASHTO M 140.

1031.03 -- Acceptance Requirements

1. Emulsified asphalt (anionic) will be accepted as described in the Department's *Materials Sampling Guide*.

SECTION 1032 -- EMULSIFIED ASPHALT (CATIONIC)

1032.01 -- Description

1. Emulsified asphalt (cationic) shall conform to the requirements below. All test methods are AASHTO methods unless otherwise noted. All AASHTO Testing Standards are as per the 2015 Edition.

1032.02 -- Material Characteristics

1. Emulsified asphalt (cationic) samples shall comply with test requirements when tested after being stored at room temperature of 73 +/- 4°F (23 +/- 2°C) for a period of up to 14 days after sampling.

2. CMS-1 shall comply with the test requirements in Table 1032.01.

Table 1032.01

Tests on emulsion:	Specification
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	50 – 500
Settlement, percent, maximum (note 1)	5
Storage Stability, percent, maximum (note 1)	1.0
Sieve Test, percent Retained, maximum (note 1)	0.5
Residue by Distillation, percent, minimum	65
Oil Distillate, percent, maximum	12
Tests on distillation residue:	
Penetration, dmm., minimum	300
Solubility in Trichloroethylene, percent, minimum	97.0
Viscosity, Saybolt Furol, 82°C (180°F), sec. (note 2)	200 - 600
Note 1: See note “b” of AASHTO M 208	
Note 2: Kinematic to Saybolt Furol conversion as per ASTM D2161.	

3. CSS-1 shall meet the specifications of AASHTO M 208.

4. CSS-1H shall meet the specifications of AASHTO M 208.

5. CRS-2 shall meet the specifications of AASHTO M 208.

6. CRS-2P shall meet the specifications of AASHTO M 316 with the following changes.

Table 1032.02

Test	Specification
Penetration, dmm.	100-150
Ductility, 25°C (77°F), cm., minimum	40
Elastic Recovery, percent, minimum	55
Storage Stability, percent	See note “b” of AASHTO M 208
Sieve Test, percent	See note “b” of AASHTO M 208
Force Ratio Test	Not Required

a. Evaporation residue: Distillation will be used for residue percentage determination and all residue testing. The distillation will be taken to $350 \pm 5^\circ\text{F}$, and held for 20 minutes and otherwise in accordance with AASHTO T 59.

b. Paragraph 3.1 of AASHTO M 316 is void and superseded by the following:

3.1 CRS-2P - A cationic emulsion made with base asphalt binder modified with styrene-butadiene or styrene-butadiene styrene block copolymers. All base stock asphalt used must be modified before emulsification. CRS-2P shall contain no latex polymer.

7. CRS-2L shall meet the specifications of AASHTO M 316 with the following changes:

Table 1032.03

Test	Specification
Penetration, dmm	65 - 130
Ductility, 25°C (77°F), cm., minimum	40
Softening Point, °F, minimum	130
Storage Stability, percent	See note "b" of AASHTO M 208
Sieve Test, percent	See note "b" of AASHTO M 208

a. Evaporation residue: Distillation will be used for residue percentage determination and all residue testing. The distillation will be taken to $350 \pm 5^\circ\text{F}$, and held for 20 minutes and otherwise in accordance with AASHTO T 59.

b. Paragraph 3.2 of AASHTO M 316 is void and superseded by the following:

3.2 CRS-2L - A cationic emulsion made with base asphalt binder modified with styrene-butadiene rubber latex or polychloroprene latex. All base stock asphalt used must be modified during a co-milling emulsification process exclusively, and through the use of the latex polymers listed above only.

c. The test of Solubility in trichloroethylene of the residue is waived, but as stated in AASHTO M 316, the Solubility of the base asphalt binder shall be greater than 99.0%.

8. CRS-2VHL shall meet the following specifications:

Table 1032.04

Tests on emulsion:	Specification
Viscosity, Saybolt Furol, T 59, 50°C (122°F), sec.	75 – 300
Residue by Distillation, percent, minimum (note 1)	65
Oil Distillate, percent, maximum	3
Storage Stability, percent, maximum (note 2)	1.0
Demulsibility, percent, minimum	40
Sieve Test, percent Retained, maximum (note 2)	0.10
Particle Charge	Positive
Tests on distillation residue:	
Penetration, dmm.	65 – 130
Ductility, 25°C (77°F), cm., minimum	40
Softening Point, °F, minimum	135

Note 1: The distillation shall be taken to 350 +/- 5°F, and held for 20 minutes, and otherwise in accordance with AASHTO T 59.

Note 2: Test requirement is waived if successful application of the material has been achieved in the field.

a. The solubility of the base asphalt binder shall be greater than 99.0%.

b. All polymer shall be added as either styrene-butadiene rubber latex or polychloroprene latex only, and only during a co-milling emulsification process. The latex polymer solids content shall be 3.0% minimum by weight of the base asphalt binder.

9. CQS-1H polymer-modified for Microsurfacing shall meet the following specifications:

a. The emulsion for use in this work shall conform to the specifications of CQS-1H in AASHTO M 208 except as otherwise noted in Table 1032.05.

Table 1032.05

Tests on emulsion:	Specification
Storage Stability, percent, maximum	1.0
Settlement, 24 hours, percent, maximum	1.0
Residue, percent, minimum (note 1)	62
Tests on residue:	
Softening Point, °F, minimum	135
Solubility in trichloroethylene, percent	Waived

Note 1: The distillation shall be taken to 350 +/- 5°F, and held for 20 minutes, and otherwise in accordance with AASHTO T 59.

b. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. The polymer solids content shall be a minimum of 3.0% by weight of the base asphalt binder.

1032.03 -- Acceptance Requirements

1. Emulsified asphalt (cationic) will be accepted as described in the Department's *Materials Sampling Guide*.

SECTION 1033 -- AGGREGATES

1033.01 -- Description

1. Mineral aggregates shall be crushed rock, broken stone, gravel, sand-gravel, coarse sand, fine sand, or a mixture of these materials composed of clean, hard, durable, and uncoated particles. Crushed rock shall be crushed limestone, dolomite, granite, quartzite, or other ledge rock approved for the intended purpose by the Department's Materials and Research Engineer.

2. This combined aggregate gradation using Class R aggregate is to optimize aggregate blends utilizing more locally available materials.

a. Achieving a uniform gradation for Class R may require the use of two or more different aggregates. It is the responsibility of the contractor to meet additional material characteristics requirements; such as, but not limited to particle shape, cubicity, angularity, etc., when designing a mix.

1033.02 -- Material Characteristics

1. Sampling and Testing Procedures:

a. All materials shall be sampled and tested in accordance with Table 1033.01. All material source locations and quarries must be approved by the Department prior to use.

Table 1033.01

Sampling and Testing Procedures	
Procedure	Method
Sampling	NDOT T 2
Sieve Analysis	NDOT T 27
Clay Lumps, Shale, and Soft Particles	NDOT T 504
Abrasion	AASHTO T 96
Freeze and Thaw Soundness	NDOT T 103
Specific Gravity and Absorption (course aggregate)	AASHTO T 85
Specific Gravity and Absorption (fine aggregate)	AASHTO T 84
Total Evaporable Moisture Content of Aggregates by Drying	AASHTO T 255
Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test	AASHTO T 176
Sodium Sulfate Soundness	AASHTO T 104
Calcium Carbonate	NDOT C 25
Organic Impurities	AASHTO T 21
Mortar-Making Properties= Reducing Field Samples of Aggregate to Testing Size	AASHTO T 71
Lightweight Pieces in Aggregates	AASHTO T 248 NDOT T 113

2. General Aggregate Properties:

a. Aggregates shall be free from injurious quantities of dust, soft or flaky particles, loams, alkali, organic matter, paper, wood, or other deleterious matter as determined by the Engineer.

b. Dolomite as herein defined is a magnesium limestone containing calcium carbonate and magnesium carbonate in approximately a 4 to 3 ratio.

c. The calcium carbonate content of limestone shall be at least 80% (computed as CaCO_3 from the value determined for CaO).

d. Fine sand shall have at least 95% of its particles pass the No. 10 (2.0 mm) sieve and no more than 25% pass the No. 200 (75 μm) sieve. This definition applies to the sodium sulfate soundness test.

e. Once an aggregate's soundness and abrasion quality has been determined, additional quality testing for soundness and abrasion loss will be at the Engineer's discretion.

f. All aggregates or combined aggregates that have been washed or coming from a wet pit shall be stockpiled for a minimum of 48 hours before being introduced into concrete.

3. Portland Cement Concrete Aggregate:

a. Fine Aggregate:

(1) Aggregate shall be washed and composed of clean, hard, durable and uncoated particles.

(2) Aggregates produced from wet pits by pumping must be adequately washed by means approved by the Department.

(3) Aggregates from dry pits shall be adequately washed by means approved by the Department and have a Sand Equivalent value not less than 90 in accordance with AASHTO T 176.

(i) If the Sand Equivalent is less than 90, the Engineer may elect to stop aggregate production until such a time ASTM C 109 has been completed. The aggregate, when subjected to the test for mortar-making properties, shall produce a mortar having a compressive strength at the age of 7 days equal to or greater than that developed by mortar of the same proportions and consistency made of the same cement and aggregate after the aggregate has been washed to a sand equivalent greater than 90. Materials failing to produce equal or greater strength shall be unacceptable.

(4) Aggregate for concrete shall have a soundness loss of not more than 10% by weight at the end of 5 cycles using Sodium Sulfate Soundness test AASHTO T 104.

(5) The weight of the aggregate shall not contain more than 0.5% clay lumps.

(6) Aggregate subjected to the colorimetric test for organic impurities which produces a color darker than the standard shall be further tested for its mortar-making properties in accordance with AASHTO T 71. The Engineer may elect to stop aggregate production until such a time AASHTO T 71 testing has been completed.

(i) Aggregate, when subjected to the test for mortar-making properties, shall produce a mortar having a compressive strength at the age of 7 days equal to or greater than that developed by mortar of the same proportions and consistency made of the same cement and aggregate after the aggregate has been treated in a 3% solution of sodium hydroxide. Materials failing to produce equal or greater strength shall be unacceptable,

except when determined to be acceptable under the provisions of Subsection 105.03.

(7) Aggregate shall meet the requirement in Tables 1033.02A, 1033.02B and 1033.03C.

(8) Lightweight pieces (measured by percent by volume values) shall not exceed 3.5%. For Class R aggregate, fine aggregate is defined as any material passing a No. 4 sieve.

Table 1033.02A

AGGREGATE SPECIFICATION RANGE											
Percent Passing											
Percentage		1½"	1"	¾"	½"	3/8	No.4	No.10	No.20	No.30	No.200
Class A	Max	--	--	--	--	100	100	90	--	40	3
	Min	--	--	--	--	100	92	64	--	10	0
Class B	Max	--	100	--	--	--	97	70	--	40	3
	Min	--	100	--	--	--	77	50	--	16	0
Class C	Max	--	100	--	--	--	88	50	--	20	3
	Min	--	100	--	--	--	44	24	--	4	0

Table 1033.02B

Aggregate Classes and Uses	
Aggregate Class	Concrete Description
A	Overlay Concrete SF
B	47BD, 47B-HE, 47B-OL, PR 1 and PR 3
C	BX

b. Coarse Aggregate:

(1) Aggregate shall consist of Limestone, Quartzite, Dolomite, Gravel and Granite composed of clean, hard, durable, and uncoated particles.

(2) The percent of clay lumps, shale, or soft particles shall not exceed the following amounts:

Clay Lumps.....	0.5%
Shale.....	1.0%
Soft Particles.....	3.5%
Lightweight Pieces.....	3.5%

(3) Any combination of clay lumps, shale and soft particles (all percent by weight values), plus the lightweight pieces (a % by volume value) shall not exceed 3.5%. For Class R aggregate, coarse aggregate is defined as any materials retained on a No. 4 sieve.

(4) Aggregate for concrete shall be free of coatings that will inhibit bond and free of injurious quantities of loam, alkali, organic matter, thin or laminated pieces, chert, or other deleterious substances as determined by the Engineer.

(5) Aggregate for concrete shall not have a soundness loss greater than 8.0% by weight at the completion of 16 cycles of alternate freezing and thawing.

(6) Aggregates for concrete shall have a Los Angeles Abrasion loss percentage of not more than 40.

(7) All fractions passing the No.4 sieve shall meet quality requirement of soundness loss of not more than 10% by weight at the end of 5 cycles using sodium sulfate solution.

(8) The ledge rock shall be tested according to ASTM C 1260.

(i) The mortar bars for the ASTM C 1260 shall not exceed 0.10% expansion at 28 days.

(a) If the proposed coarse aggregate exceeds 0.10% expansion at 28 days, the aggregate proportions used on the project shall be tested in accordance to ASTM C 1567.

i. The ASTM C 1567 mortar bars shall be composed of Interground/blended cement being used on the project.

ii. If the expansion is greater than 0.10%, the coarse aggregate shall not be used.

(9) Aggregate shall meet the requirements in Tables 1033.03A, B, and C.

Table 1033.03A

Aggregate Specification Range											
Percent Passing											
Percentage		1½"	1"	¾"	½"	3/8	No.4	No. 10	No. 20	No. 30	No. 200
Class E	Max	100	100	90	--	45	12	--	*4	--	3
	Min		92	66		15	0		0		0
Class F	Max	--	--	100	100	90	30	8	--	--	3
	Min			96	40	4	0				0

*If the No. 200 sieve is less than 1.5% passing, the No.20 sieve could be increased to maximum of 6% passing.

Table 1033.03B

Aggregate Classes and Uses	
Aggregate Class	Concrete Description
E	47BD, 47B-HE, PR 1 and PR 3
F	47B-OL, Overlay Concrete SF

c. Combined Aggregates:

(1) The Contractor shall design and meet the specification requirements. It is the Contractor's responsibility to provide desirable mix properties; such as, but not limited to, workability, resistance to segregation, stable air void system, good finishing properties and good consolidation properties.

(2) The combined blended aggregate shall meet the requirement in Table 1033.03C and 1033.03D.

Table 1033.03C

*Class R - Combined Aggregate Gradation Limits (Percent Passing)								
Sieve Size	1 ½ inch	1 inch	¾ inch	No.4	No.10	No.30	No. 50	No. 200
Max	100	100	98.0	70.0	50.0	30.0	12.0	3.0
Min	-	92.0	85.0	45.0	31.0	8.0	2.0	0

* Refer to Subsection 1002.04, Paragraph 1.b.(8) for the traditional 47B Mix Design

Table 1033.03D

Aggregate Classes and Uses	
Aggregate Class	Concrete Description
R	47B

d. Aggregate Production and Testing:

(1) Any change greater than 3% in the original verified constituent percentage of the combined aggregates gradation will be considered non-compliant. Any change of the combined gradation targets must remain within the Combined Aggregate Gradation Limits in Table 1033.03C. The Contractor shall resubmit a new mix design if the material is deemed non-compliant in accordance with Subsection 1002.04, Paragraph 1.

(2) The blended gradation tolerance ranges from the approved mix design are established in Table 1033.03E.

(i) The Contractor shall assume the responsibility to cease operations when the specifications are not met. Production shall not be started again without the approval of the Engineer.

Table 1033.03E

Blended Aggregate Production Tolerances

Sieve Size	Tolerances
No. 4 or greater	+ 5%
No. 10 to No. 30	+ 4%
No. 50	+ 3%
Minus No. 200	± 1%

(3) Ledge rock and aggregate from a dry pit shall be uniformly saturated with water before it is used. The wetting shall begin 24 hours before concrete mixing to allow complete saturation.

4. Bituminous Aggregate:

Table 1033.04A

Asphalt Combined Aggregate Grading Band Tolerance			
Band "A" Mix [1/2 inch (12.5 mm)]			
[To Be Used When Total Thickness Is 4 Inches (100 mm) Or Less]			
	% Passing		
Sieve Size	Min.		Max.
1 inch (25.0 mm)	100%		
3/4 inch (19.0 mm)	98%		100%
1/2 inch (12.5 mm)	94%		100%
3/8 inch (9.50 mm)	80%		98%
No. 4 (4.75 mm)	52%		88%
No. 10 (2.00 mm)	32%		70%
No. 30 (600 μm)	17%		38%
No. 50 (300 μm)	10%		24%
No. 200 (75 μm)	3%		7%

Table 1033.04B

Asphalt Combined Aggregate Grading Band Tolerance			
Band "B" Mix [3/4 inch (19 mm)]			
[To Be Used When Total Thickness Is Greater than 4 Inches (100 mm)]			
	% Passing		
Sieve Size	Min.		Max.
1 inch (25.0 mm)	100%		
3/4 inch (19.0 mm)	98%		100%
1/2 inch (12.5 mm)	76%		93%
3/8 inch (9.5 mm)	60%		88%
No. 4 (4.75 mm)	42%		78%
No. 10 (2.00 mm)	27%		60%
No. 30 (600 μm)	14%		38%
No. 50 (300 μm)	8%		21%
No. 200 (75 μm)	3%		7%

a. Bituminous aggregate shall have the following characteristics:

(1) Aggregate shall meet the requirements in Tables 1033.04A and B.

(2) The combined aggregate's compliance shall be tested on an individual aggregate basis.

(3) Tests to determine compliance with the quality requirements for gravel shall be performed on the "Pre-Crushed" gradation.

(4) Crushed rock for asphaltic concrete shall not contain deleterious substances in a quantity to exceed the following percentage by weight:

- Clay Lumps and Shale..... 1.5
- Soft Particles..... 3.5

(5) Any combination of shale, clay, or soft particles shall not exceed 3.5% by weight.

(6) All fractions of a crushed rock gradation shall be produced from the same type of material. The chemical and physical characteristics of the fraction passing the No. 4 (4.75 mm) sieve shall be substantially the same as those of the material which may be produced in the laboratory from the fraction which is retained on the No. 4 (4.75 mm) sieve. Crushed rock for asphaltic concrete shall have a percentage loss of not more than 8.0% by mass at the end of 16 cycles of the freezing and thawing test.

(7) Quality:

(i) When any fraction of a mineral aggregate, except for crushed rock for use in asphaltic concrete, is of a nature adapted for the Los Angeles Abrasion Test, it shall have a loss percentage of not more than 40.

(ii) Mineral aggregates, except for crushed rock for asphaltic concrete, shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

(8) Quartzite, granite, and chat used in Asphalt Concrete shall have a soundness loss of not more than 12 % by weight at the end of 5 cycles using sodium sulfate solution. The Los Angeles Abrasion Test shall have a loss percentage of not more than 40, and the "D" Grading is void.

(9) Maximum percentages established for limestone exclude recycled materials.

b. Soil type mineral filler, fly-ash mineral filler, or limestone dust which is produced as a by-product of sugar beet refining will not be allowed.

c. Mineral filler shall consist of pulverized crushed rock, broken stone, gravel, sand-gravel, sand, or a mixture of these materials that conforms to the following requirements:

	Min.	Max.
Total Percent Passing the No. 50 (300 μ m) Sieve	95	100
Total Percent Passing the No. 200 (75 μ m) Sieve	80	100
Plasticity Index [material passing the No. 200 (75 μ m) Sieve]	0	3

d. At the start of production, one sample of mineral filler will be analyzed for its properties by the Department's Materials and Research Laboratory. If the sample is approved, no further tests will be required for the project. If the sample fails to meet the requirements, then further tests will be required.

e. When determining the maximum percentage of limestone in the mix, the recycled materials will not be considered.

5. Bituminous Sand Aggregate:

Table 1033.05

Bituminous Sand Aggregate Gradation Limits		
Sieve Size	Percent Passing	
	Min.	Max.
3/8 inch (9.50 mm)	---	---
No. 4 (4.75 mm)	---	---
No. 10 (2.00 mm)	---	---
No. 50 (300 μm)	100	60
No. 200 (75 μm)	33	12

a. Cold-mixed bituminous mixtures shall consist of approved inert mineral matter.

b. If soil type filler is approved for use, it shall be pulverized to the extent that 100% will pass the 1/2 inch (12.5 mm) sieve and at least 90% will pass the No. 10 (2.00 mm) sieve before combining with other aggregates.

c. Aggregate shall meet the requirements in Table 1033.05.

6. Surfacing Aggregates:

a. Gravel aggregate for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 40.

b. Gravel aggregate for surfacing shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

c. Aggregate shall meet requirements in Table 1033.06 or 1033.07, as applicable.

Table 1033.06

Gravel Surfacing Gradation Limits		
Sieve Size	Percent Passing	
	Target Value	Tolerance
1 inch (25.0 mm)	100	0
No. 4 (4.75 mm)	78	±17
No. 10 (2.00 mm)	16	*
No. 50 (300 μm)	---	---
No. 200 (75 μm)	3	±3
* A deduction from contract bid price will be made as specified in Section 310, Table 310.01.		

d. The gravel aggregates for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 40.

e. Gravel aggregates for surfacing shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

Table 1033.07

Crushed Rock for Surfacing Gradation Limits		
Sieve Size	Percent Passing	
	Target Value	Tolerance
1 inch (25.00 mm)	100	0
No. 4 (4.75 mm)	40	+20
No. 10 (2.00 mm)	15	+15
No. 50 (300 μ m)	---	---
No. 200 (75 μ m)	5	+5

f. Crushed rock for surfacing shall consist of clean, hard particles of crushed limestone, quartzite, or dolomite.

g. Crushed rock for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 45.

h. Crushed rock for surfacing shall have a percent loss of not more than 30 at the end of 16 cycles of the freezing and thawing test.

7. **Base Course:**

Table 1033.08

Crushed Rock				
Sieve Size	Crushed Rock for Base Course		Crushed Rock Screenings for Base Course	
	Percent Passing			
	Target Value	Tolerance	Target Value	Tolerance
1 1/2 inch (37.5 mm)	100	0		
3/4 inch (19.0 mm)	80	+15	100	0
3/8 inch (9.50 mm)	53	+17	73	+17
No. 4 (4.75 mm)	---	---	55	+15
No. 10 (2.00 mm)	20	+10	---	---
No. 20 (850 μ m)	---	---	28	+12
No. 200 (75 μ m)	5	+5	13	+7

a. Base Course Aggregate shall be crushed rock or broken stone or a mixture of these materials composed of clean, hard, durable, and uncoated particles.

b. Quality:

(1) Crushed rock shall be crushed limestone, dolomite, granite, quartzite, or other ledge rock approved for the intended purpose by the Department's Materials and Research Engineer.

(2) Dolomite as herein defined is a magnesium limestone containing calcium carbonate and magnesium carbonate in approximately a 4 to 3 ratio.

(3) All sizes of crushed rock for base course shall be produced from the same type of material. The chemical and physical characteristics of the fraction passing the No. 4 (4.75 mm) sieve shall be substantially the same as those of the material which may be produced in the laboratory from the fraction which is retained on the No. 4 (4.75 mm) sieve.

(4) Crushed rock for base course shall not contain shale, clay lumps, or other deleterious substances in a quantity to exceed a total of 2.5% based on the dry mass of the fraction retained on the No. 4 (4.75 mm) sieve.

(5) Crushed rock for base course shall be free from injurious quantities of dust, soft or flaky particles, loams, alkali, organic matter, paper, wood, or other deleterious material.

(6) The Los Angeles Abrasion loss percentage shall not exceed 45.

(7) Crushed rock for base course shall have a percentage loss of not more than 14 at the end of 16 cycles of the freezing and thawing test.

(8) The absorption of crushed rock for a base course shall not exceed 5.0% by weight.

(9) The product of the plasticity index (using wet preparation AASHTO T 146) of the fraction of the crushed rock for base course passing the No. 40 (425 μm) sieve and the percent of the crushed rock passing the No. 200 (75 μm) sieve shall not exceed 48. When the fraction of the crushed rock for a base course passing the No. 200 (75 μm) sieve does not exceed 4%, the plasticity index will not be determined and the product of the plasticity index and the percent passing the No. 200 (75 μm) sieve will not be a requirement for such material.

(10) The plasticity index (using dry preparation AASHTO T 87) of the crushed rock screenings passing the No. 40 (425 μm) sieve shall not exceed 4.

c. Crushed rock shall meet gradation requirements in Table 1033.08.

8. Foundation Course:

Table 1033.09

Foundation Course Mixture		
Sieve Size	Percent Passing	
	Target Value	Tolerance
1 inch (25.0 mm)	100	0
No. 10 (2.00 mm)	62	+12
No. 40 (425 μm)	34	+8
No. 200 (75 μm)	9	+3

Table 1033.10

Crushed Concrete Foundation Course Gradation Requirements		
Sieve Size	Target Value (Percent Passing)	Tolerance
1 1/4 inch (31.5 mm)	100	0
1 inch (25.0 mm)	95	± 5
3/4 inch (19.0 mm)	81	±12
No. 4 (4.75 mm)	38	±12
No. 10 (2.00 mm)	24	±11
No. 40 (425 µm)	9	± 5
No. 200 (75 µm)	3	± 3

a. Soil binder from local pits shall be pulverized to the extent that at least 90% will pass a 1/2 inch (12.5 mm) sieve and at least 60% will pass a No. 10 (2.00 mm) sieve. The binder shall be pulverized before it is mixed with the other aggregates.

b. Any fraction of a mineral aggregate is of a nature adapted for the Los Angeles Abrasion Test, the loss percentage shall not be more than 40.

c. Mineral aggregates shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

d. Foundation course material shall meet the requirements in Table 1033.09 or 1033.10, as applicable.

1033.03 -- Procedures

1. Freshly washed or pumped aggregates shall be drained for 12 hours before use.

2. Protection of Material:

a. It is the Contractor's responsibility to protect materials from harmful contamination, segregation, excessive degradation, or other changes in the physical or chemical state or degree of uniformity.

b. If any detrimental change has taken place in the materials after the acceptance samples have been taken and tested, the right is reserved to retest and reject that part of the previously accepted material which is found unsatisfactory or require the Contractor to correct the deficiencies by reprocessing or providing other material meeting specification requirements.

3. Handling of Material:

a. The use of crawler-type equipment will be allowed in the stockpiling of fine aggregate and sand gravel aggregates.

b. Aggregate shall be removed from stockpiles with cranes, loaders, conveyors, or other approved equipment.

c. The use of crawler equipped dozers or end loaders will not be allowed in the stockpiling or the removal of crushed rock aggregates if the aggregate is damaged by the equipment.

4. Care shall be exercised to avoid segregation or degradation of aggregates or the inclusion of foreign material in the aggregates while they are being removed from the stockpiles.

5. Storage of Material:

a. Each aggregate that is to be stockpiled, either at the producer's plant or at the site of the work, shall be stockpiled separately.

b. Similar materials from different sources of supply shall not be mixed or stored in the same pile or used alternately in the same class of construction or mix without permission from the Engineer.

c. Materials which become intermixed (i.e., with other sources or different gradations) or which become contaminated by foreign materials shall not be used.

d. Aggregates shall not be stockpiled against the supports of proportioning devices or scales.

6. Properly drained aggregates unloaded and handled by conveyor systems may be deposited directly into the batch hoppers provided the equipment and procedures used will furnish aggregate of uniform gradation and moisture content.

7. It shall be the obligation of the contractor or concrete producer to maintain a uniform gradation and moisture content in each aggregate used during the handling and batching operations.

8. Similar materials produced by pumping from different pits in the Platte River Valley shall be considered to be from the same source.

1033.04 -- Acceptance Requirements

1. Aggregates will be accepted based on the requirements of this Section and sampling and testing requirements as described in the Department's *Materials Sampling Guide*.

SECTION 1034 -- SOIL BINDER

1034.01 -- Description

1. Soil binder shall consist of fine particles of sand, silt, and clay approved by the Engineer.

1034.02 -- Material Characteristics

1. Soil binder shall have at least 85% passing the No. 200 (75 μ m) sieve, and shall have a plasticity index not less than 8 nor greater than 25.

1034.03 -- Sampling and Testing Procedures

1. Sampling and testing shall be performed in accordance with the methods listed below:

Sampling	AASHTO T 2, AASHTO T 248
Preparation.....	AASHTO T 87
Sieve Analysis	AASHTO T 27
Plasticity Index	AASHTO T 89, AASHTO T 90

1034.04 -- Acceptance Requirements

1. Soil binder will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1035 -- CORRUGATED METAL PIPE

1035.01 -- Description

1. Corrugated metal pipe, pipe-arches, and underdrains shall be zinc-coated (galvanized) steel, aluminum-coated steel, or Grade 10/10 polymer pre-coated steel.

1035.02 -- Material Characteristics

1. Corrugated metal pipe, pipe-arches, and underdrains shall conform to the applicable requirements of AASHTO M 36 or ASTM A 929.

2. Zinc-coated steel or aluminum-coated steel materials shall not be mixed in any installation.

3. Bolts, nuts, washers and all other hardware items used with coupling bands shall be galvanized in accordance with AASHTO M 232 (ASTM A 153) or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50.

4. In the repair of damaged coating on elbows, pipe and special fittings which are fabricated by methods which damage their coating, both the interior and exterior surfaces of the damaged area shall be thoroughly cleaned and all traces of welding flux and weld spatter shall be removed. The cleaned area shall then be painted with zinc-rich paint at the fabricating plant, in accordance with Section 1061.

5. The mass of metallic coating may be determined by the use of magnetic thickness gages in accordance with ASTM E 376. In cases of dispute, additional samples shall be tested in accordance with AASHTO T 65 or AASHTO T 213, as applicable.

6. Unless otherwise specified in the contract, the minimum sheet thickness for metal culverts shall be as follows:

Table 1035.01

Nominal Diameter Inches (mm)	Sheet Thickness Inches (mm)
8 thru 24 (200 – 600)	0.057 (1.45)
30 thru 36 (760 – 900)	0.072 (1.83)
42 thru 54 (1060 – 1370)	0.101 (2.57)
60 thru 72 (1520 – 1830)	0.129 (3.28)
Over 72 (1830)	0.159 (4.04)

7. Coupling or connecting bands with projections (often referred to as simple bands) are not acceptable.

1035.03 -- Acceptance Requirements

1. Corrugated metal pipe will be accepted based on the requirements of this Section and sampling and testing requirements as described in the *Department's Materials Sampling Guide*.

SECTION 1036 -- METAL FLARED-END SECTIONS

1036.01 -- Description

1. Flared-end sections for corrugated metal pipe shall be zinc-coated (galvanized) steel or aluminum-coated steel.

1036.02 -- Material Characteristics

1. Material used in the manufacturing of flared-end sections shall conform to the applicable requirements of AASHTO M 36 or ASTM A 929.

2. Metal flared-end sections shall be of the design shown on the contract.

3. Bolts, nuts, washers and all other hardware items used with coupling bands shall be galvanized in accordance with AASHTO M 232 (ASTM A 153) or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50.

4. In the repair of damaged coating on flared-end sections which are fabricated by methods which damage their coating, both the interior and exterior surfaces of the damaged area shall be thoroughly cleaned and all traces of welding flux and weld spatter shall be removed. The cleaned area shall then be painted with zinc-rich paint at the fabricating plant, in accordance with Section 1061.

5. The mass of metallic coating may be determined by the use of magnetic thickness gages in accordance with ASTM E 376. In cases of dispute, additional samples shall be tested in accordance with AASHTO T 65 or AASHTO T 213, as applicable.

6. Unless otherwise specified in the contract, the minimum sheet thickness for fabricating metal flared-end sections shall be as follows:

Table 1036.01

Nominal Diameter Inches (mm)	Sheet Thickness Inches (mm)
12 thru 24 (300-600)	0.057 (1.45)
30 thru 36 (760-900)	0.072 (1.83)
42 thru 84 (1060-2100)	0.101 (2.57)

7. Coupling or connecting bands with projections (often referred to as dimple bands) are not acceptable.

1036.03 -- Acceptance Requirements

1. Metal flared-end sections will be accepted based on the requirements of this section and sampling and testing requirements as described in the *Department's Materials Sampling Guide*.

SECTION 1037 -- REINFORCED CONCRETE PIPE, MANHOLE RISERS, AND FLARED-END SECTIONS

1037.01 -- Description

1. This Specification provides the Department's criteria for Reinforced Concrete Pipe (Round, Elliptical, Pipe-Arch), Reinforced Concrete Manhole Risers, and Concrete Flared-End Sections.

1037.02 -- Material Characteristics

1. Aggregates shall conform to the requirements of Section 1033 with the exceptions that the requirements for gradation and calcium carbonate content are waived.

2. Each flared-end or pipe section shall have all AASHTO required markings indented, scribed, or marked with permanent water-proof marking paint on the inside top (lift hole side) of each section at the time of manufacture. Furthermore, each section shall also have as a minimum requirement, the class and date of manufacture scribed or indent printed on the outside of the pipe.

3. Reinforced concrete pipe shall be the class as permitted in the contract.

4. Round Reinforced Concrete Pipe:

a. Round reinforced concrete pipe shall conform to the requirements of AASHTO M 170/M 170M-95 with the exception of the minimum circumferential reinforcing (in²/ft (mm²/m) of pipe wall) for 15, 21 and 24 inch (375, 450, 600 mm) Class III pipe, as shown below.

b. AASHTO M 170/M 170M-95 Specifications are modified as follows:

c. Only single inner cage, circular reinforcing is allowed for Class III, 15, 18, 21, and 24 inch (375, 450, 525, 600) round RCP as shown:

Table 1037.01

Pipe Size (in) [mm]	Class	Minimum Circumferential Reinforcing (in ² /ft of Pipe Wall) (cm ² /m)
15 [375]	III	0.08 (1.7)
18 [450]	III	0.10 (2.1)
21 [525]	III	0.12 (2.5)
24 [600]	III	0.14 (3.0)

5. Reinforced concrete arch pipe shall conform to the requirements of AASHTO M 206/M 206M-95.

6. Reinforced concrete elliptical pipe shall conform to the requirements of AASHTO M 207/M 207M-95.

7. Precast reinforced concrete manhole risers, steps, and tops shall conform to the requirements of AASHTO M 199.

8. Concrete flared-end sections shall be of the design shown in the contract and in conformance with the applicable requirements of AASHTO M 170/M 170M-95, Class II pipe, AASHTO M 206/M 206M-95, Class A-II pipe, or AASHTO M 207/M 207M-95, Class HE-II pipe for the diameter of pipe on which it is to be installed.

1037.03 -- Acceptance Requirements

1. Reinforced concrete pipe, manhole risers, and flared-end sections will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1038 -- PLASTIC PIPE

1038.01 -- Description

1. High density polyethylene (HDPE), polyvinyl chloride (PVC), and other Department approved plastic pipes are authorized for use as stipulated in the contract.

1038.02 -- Material Characteristics

1. High density polyethylene (HDPE) pipes and fittings shall conform to the following Specification requirements for the size required:

Table 1038.01
Polyethylene Pipe

Size	Specification	Description
15 to 36 in (375 to 900 mm)	AASHTO M 294	Corrugated Polyethylene, Type C (Cell Class 335420C)
15 to 60 in (375 to 1500 mm)	AASHTO M 294	Corrugated Polyethylene, Type S (Cell Class 335420C)
15 to 60 in (375 to 1500 mm)	ASTM F 894	Profile Wall, OP, RSC 160 (Cell Class 335434C)
15 to 60 in (375 to 1500 mm)	ASTM F 2562	Steel Reinforced Thermoplastic Ribbed Pipe (Cell Class 345464C)

2. Polyvinyl Chloride (PVC) [Cell Classification 12454C or 12364C (as determined by ASTM D-1784) if applicable] pipe and fittings shall conform to the following Specification requirements for the size required:

Table 1038.02
Polyvinyl Chloride Pipe

English Size (Metric)	Specification	Description
18 to 48 in (450 to 1200 m)	ASTM F 679	Gravity Sewer Pipe & Fittings
15 to 48 in (375 to 1200 m)	ASTM F 794	Profile Gravity Sewer Pipe & Fittings, DWCP, OP, Series 46
15 to 48 in (375 to 1200 m)	ASTM F 949	Corrugated Sewer Pipe w/smooth Interior with Fittings
15 in (375 m)	ASTM D 2680	Composite Sewer Pipe
15 in (375 mm)	ASTM D 3034	Type PSM Sewer Pipe & Fittings, SDR 35

3. Plastic pipe for underdrains shall conform to the requirements of AASHTO M 252, ASTM F 405, ASTM F 794 or ASTM F 949 for perforated or non-perforated pipe. Perforations for ASTM F 794 PVC pipe shall be slotted as per ASTM F 949.

4. Metal flared-end sections shall conform to the requirements in Section 1036.

5. A 10 foot (3 m) sample of each size and type of plastic pipe shall be sent to the Department for testing, before being incorporated into the project.

1038.03 -- Acceptance Requirements

1. Plastic pipe will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the *Department's Materials Sampling Guide*.

SECTION 1039 -- DUCTILE IRON PIPE

1039.01 -- Description

1. Ductile iron pipe for water and other liquids shall meet the requirements of ANSI A21.51.
2. Fittings for ductile iron pipe shall meet the requirements of ANSI A21.10.
3. Joints for ductile iron pipe shall meet the requirements of ANSI A21.11.
4. When required in the contract, ductile iron pipe shall be encased with Class C polyethylene encasement material conforming to the requirements of ANSI A21.5.

1039.02 -- Acceptance Requirements

1. Ductile iron pipe will be accepted based on the requirements of this Section and a manufacturer's Certificate of Compliance, indicating compliance with the requirements in this Section.

SECTION 1040 -- STEEL PIPE AND STRUCTURAL TUBING

1040.01 -- Description

1. Steel pipe shall conform to the requirements of ASTM A 53 Grade B.
2. Steel structural tubing for bridges shall conform to the requirements of ASTM A 500, Grade B.

1040.02 -- Acceptance Requirements

1. Steel pipe and structural tubing will be accepted based on the requirements of this Section and a manufacturer's certified test report showing compliance with the requirements in this Section.

SECTION 1041 -- DRAIN TILE

1041.01 -- Description

1. Concrete drain tile shall conform to the "Extra-Quality Drain Tile" requirements of AASHTO M 178.

1041.02 -- Acceptance Requirements

1. Drain tile will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1042 -- STRUCTURAL PLATE PIPE

1042.01 -- Description

1. Galvanized steel structural plate for pipe, pipe-arches, and arches shall conform to the requirements of AASHTO M 167, with the exception that units on which the spelter coating has been damaged shall be repaired in accordance with Section 1061.

2. Aluminum alloy structural plate for pipe, pipe-arches, and arches shall conform to the requirements of AASHTO M 219.

1042.02 -- Acceptance Requirements

1. Structural pipe plate will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1043 -- FLAP GATES

1043.01 -- Description

1. Flap gates shall be a double-hinged type furnished in accordance with the dimensions shown in the contract. The gates approved for use shall be furnished with seats and anchor devices or be factory mounted on the corrugated metal pipe.

1043.02 -- Material Characteristics

1. The gates shall consist of a flap and a seat with a circular opening of the size shown in the contract. The flaps and seats shall be designed to withstand the maximum hydraulic head above the centerline of the gate.

2. The gates shall be designed to open and close under a differential head of 0.2 foot (61 mm) and shall provide a watertight seat against backflow.

3. The cast iron gates shall be manufactured in accordance with the requirements of ASTM A 126 Class B.

4. Any devices necessary to fasten the gate to the culvert pipe must be approved by the Engineer.

1043.03 -- Acceptance Requirements

1. Flap gates approved for use are shown in the contract.

SECTION 1044 -- BAR GRATES FOR FLARED END SECTIONS

1044.01 -- Description

1. This Specification covers bar grates for use with metal and reinforced concrete flared-end sections.

1044.02 -- Material Characteristics

1. Bar grates shall be constructed as described in the contract. Bar grates shall be fabricated from plates and round smooth bars complying with the requirements of ASTM A 36/A 36M or ASTM A 575, Grade 1020.

2. Coatings

a. Paint

(1) Two separate coats of paint shall be applied to the grates in accordance with Section 709.

(2) The first coat shall be inorganic zinc-silicate primer.

(3) The second coat shall be brown or beige paint.

(4) All painting may be done in the shop.

(5) All paint shall comply with the requirements of Section 1077.

b. TGIC Polyester Coating

(1) Acceptable coating materials are on the Department's Approved Products List.

(2) Apply the coating as recommended by the manufacturer (3 mil (76 μ m) minimum).

c. Galvanized

(1) Hot-dip galvanized in accordance with ASTM A 123.

1044.03 -- Acceptance Requirements

1. Bar grates will be accepted on the basis of a fabricator's certificate showing compliance with these Specifications.

SECTION 1045 -- STRUCTURAL STEEL

1045.01 -- Description

1. Structural steel, unless otherwise specified, shall be furnished in accordance with the general requirements for delivery of structural steel, ASTM A 6/A 6M (Zone 2 requirements).

1045.02 -- Material Characteristics

1. Structural steel shall conform to the requirements shown in the contract.

2. Notch toughness is mandatory for structural steel designated in the contract as main tension members. The structural steel shall meet the longitudinal Charpy V-notch tests as specified in the ASTM Nonfracture Critical and Fracture Critical Impact Test Requirement Tables.

3. Sampling and testing procedures shall be in accordance with AASHTO T 243.

4. Impact requirements shall be as shown in the contract.

1045.03 -- Steel Plate Substitution

1. The Contractor may use either English or Metric steel plates in accordance with Table 1045.01.

Table 1045.01

English-Metric Steel Plate Substitution Table			
Metric (millimeters)	English (inches)	Metric (millimeters)	English (inches)
9	3/8	32	1 1/4
10	3/8	35	1 3/8
11	7/16	38	1 1/2
12	1/2	40	1 5/8
14	9/16	45	1 3/4
16	11/16	50	2
18	3/4	55	2 1/4
20	13/16	60	2 3/8
22	7/8	70	2 3/4
25	1	80	3 1/4
28	1 1/8	90	3 1/2
30	1 1/4		

SECTION 1046 -- END WELDED STUDS

1046.01 -- Description

1. End welded studs shall conform to the requirements of the AWS Standard Specifications.

SECTION 1047 -- WELDING ELECTRODES AND FLUXES

1047.01 -- Description

1. All welding electrodes and fluxes shall conform to the requirements of the American Welding Society (AWS) Standard Specifications.

1047.02 -- Material Characteristics

1. Shielded metal-arc welding electrodes shall conform to AWS Specifications for Mild Steel Covered Arc-Welding Electrodes.

2. Submerged-arc welding electrodes and flux shall conform to AWS Specifications for Bare Mild Steel Electrodes and Fluxes for Submerged-Arc Welding.

3. Gas metal-arc welding electrodes shall conform to AWS specifications for Mild Steel Electrodes for Gas Metal-Arc Welding.

4. Flux-cored arc welding electrodes shall conform to AWS specifications for Mild Steel Electrodes for Flux-Cored Arc Welding.

SECTION 1048 -- STEEL FORGINGS

1048.01 -- Description

1. Steel forgings shall conform to the requirements of AASHTO M 102.

1048.02 -- Acceptance Requirements

1. Steel forgings shall be accepted based on a manufacturer's certified test report that indicates the material meets the requirements in AASHTO M 102.

SECTION 1049 -- COLD-FINISHED BARS AND SHAFTING

1049.01 -- Description

1. Cold-finished bars and shafting shall conform to the requirements of ASTM A 108.

1049.02 -- Acceptance Requirements

1. Cold-finished bars and shafting shall be accepted based on a manufacturer's certified test report indicating the material meets the requirements in ASTM A 108.

SECTION 1050 -- STEEL CASTINGS

1050.01 -- Description

1. Carbon steel castings shall conform to the requirements of ASTM A 27/A 27M, Grade 70-36.

1050.02 -- Acceptance Requirements

1. Steel castings shall be accepted based on a manufacturer's certified test report indicating the material meets the requirements in ASTM A 27/A 27M.

SECTION 1051 -- IRON CASTINGS

1051.01 -- Description

1. Iron castings shall conform to the requirements of ASTM A 48, Class No. 35B.
2. Malleable iron castings shall conform to the requirements of ASTM A 47, Grade 32510 or ASTM A 47M, Grade 22010.
3. Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 60-40-18.

1051.02 -- Acceptance Requirements

1. Iron castings will be accepted based on the requirements of this Section and a manufacturer's certificate of compliance indicating compliance with the requirement in this Section.
2. The manufacturer shall furnish a certificate stating that the material used in the manufacturing of the castings meets the requirements of the specifications.
3. When castings are shipped from tested stock, this certificate need not be furnished.

SECTION 1052 -- GALVANIZED SHEET METAL

1052.01 -- Description

1. Galvanized sheet metal shall conform to the requirements of ASTM A 653/A 653M. The sheet metal shall be at least 24 gauge [0.028 inch (0.70 mm)] thick and have a coating weight conforming to coating designation G 115/Z 350.

1052.02 -- Acceptance Requirements

1. Galvanized sheet metal will be accepted based on the requirements of this Section and a manufacturer's certified test report showing compliance with the requirements in this Section.

SECTION 1053 -- SHEET ZINC

1053.01 -- Description

1. Sheet zinc shall conform to the requirements of ASTM B 69, Type II. Zinc sheet shall be at least 24 gauge [0.028 inch (0.70 mm)] thick.

1053.02 -- Acceptance Requirements

1. Sheet zinc will be accepted based on the requirements of this Section and a manufacturer's certificate of compliance indicating compliance with the requirement in this Section.

SECTION 1054 -- SHEET ALUMINUM

1054.01 -- Description

1. Sheet aluminum shall conform to the requirements of ASTM B 209M, alloy 5052-H38. Aluminum sheet shall be at least 0.03 inch (0.75 mm) thick.

1054.02 -- Acceptance Requirements

1. Sheet aluminum will be accepted based on the requirements of this Section and a manufacturer's certificate of compliance indicating compliance with the requirements in this Section.

SECTION 1055 -- SHEET LEAD

1055.01 -- Description

1. Sheet lead shall conform to the requirements of ASTM B 29 for chemical copper lead. The lead sheet shall be of uniform thickness and shall be free from cracks, seams, slivers, scale, and other defects. Unless otherwise specified, lead sheet shall be 1/8 inch (3 mm) in thickness with a permissible tolerance of 1/32 inch (0.79 mm).

1055.02 -- Acceptance Requirements

1. Sheet lead will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1056 -- STEEL SHEET PILES AND SHEET PILE CORNERS

1056.01 -- Description

1. Steel sheet piles and steel sheet pile corners shall conform to the requirements of ASTM A 328/A 328M.
2. All steel sheet piling shall be of the style, dimensions, and weight specified in the contract.

1056.02 -- Acceptance Requirements

1. Steel sheet piles and sheet pile corners will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1057 -- LOW CARBON STEEL FASTENERS

1057.01 -- Description

1. This Specification covers requirements applicable to low-carbon steel standard fasteners, non-headed anchor bolts, and the nuts and washers used with each.

1057.02 -- Material Characteristics

1. Bolt threads may be cut or rolled and shall meet the latest ANSI thread tolerances for the specified thread series.

2. All threads shall be full and sound.

3. The specified diameter of the bolt shall be taken to mean the overall diameter of the threads.

4. The diameter of the shank shall in all cases be not less than the root diameter of the thread.

5. Low carbon bolts and nuts shall conform to ASTM A 307 or ASTM F 568.

6. Low carbon washers shall conform to ANSI B 18.22.M or ANSI B 18.22.1.

7. Washers used with low carbon bolts may be plain or hardened.

8. The Contractor may provide either English or metric bolts in accordance with Table 1058.01.

1057.03 -- Acceptance Requirements

1. Low carbon steel fasteners will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1058 -- HIGH TENSILE BOLTS, NUTS, AND WASHERS

1058.01 -- Description

1. All high strength bolts shall meet the requirements in ASTM A 325/A 325M and the modification in this Section.

2. All high strength nuts shall meet the requirements in ASTM A 563/A 563M, or ASTM A 194 and the modifications in this Section.

3. Hardened steel washers shall meet the requirements in ASTM F 436/F 436M and the modifications in this Section.

4. All bolts, nuts, and washers shall be plain (uncoated) unless otherwise specified.

5. Other fasteners or fastener assemblies not referenced in this Specification, such as those conforming to the requirements of ASTM F 1852, may be used subject to the approval of the Engineer and must be tested and approved by the Department before use provided that:

a. They meet materials, manufacturing, and chemical composition requirements of AASHTO M 164 (ASTM A 325).

b. They meet mechanical property requirements of the same specification in full-size tests.

c. The body diameter and bearing areas under the head and nut, or their equivalent, shall not be less than those provided by a bolt and nut of the same nominal dimensions described in Section 6 of the AASHTO LRFD Bridge Design Specifications.

(1) Such alternate fasteners may differ in other dimensions from those of the bolts, nuts, and washers specified in Section 6 of the AASHTO LRFD Bridge Design Specifications.

1058.02 -- Material Characteristics

1. Bolts:

a. The maximum tensile strength for bolts with a diameter that is equal to or less than 1 inch (25 mm) shall be 150,000 psi (1034 MPa). Bolts with diameters that are larger than 1 inch (25 mm) shall have a maximum tensile strength equal to 120,000 psi (827 MPa).

b. Type 3 bolts, nuts, and washers must be used to assemble "weathering" steel structures. When structures are painted, the bolts and the compatible nuts and washers may be Type 1 or Type 3.

2. Nuts:

a. If nuts are to be galvanized (hot dip or mechanically galvanized), they shall be heat treated grade 10S or 10S3 (2H, DH, or DH3).

b. Plain (uncoated) nuts shall be grades 8S or 8S3 (2, C, D, or C3) with a minimum Rockwell hardness of B89 (Brinell hardness of 180), or heat treated grades 10S or 10S3 (2H, DH, or DH3).

c. If nuts are to be galvanized, they shall be tapped oversize the minimum amount required for proper assembly. The amount of overlap in the nut shall be so the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of ASTM Specifications as indicated for nuts in Subsection 1058.01 above.

d. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

3. Marking:

All bolts, nuts, and washers shall be marked according to the appropriate ASTM Specifications.

1058.03 -- Acceptance Requirements

1. Bolts:

a. Proof load tests (ASTM F 606/F 606M, Method 1) are required. The minimum frequency of tests shall be as specified in ASTM A 325/A 325M.

b. Wedge tests on full size bolts (ASTM F 606/F 606M) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. The minimum frequency of testing shall be as specified in ASTM A 325/A 325M.

c. If galvanized bolts are specified, the thickness of the zinc coating shall be checked by taking measurements on the wrench flats or on top of the bolt head.

d. The Contractor may use either English or metric bolts in accordance with Table 1058.01.

Table 1058.01

Metric/English Bolt Substitution Table **	
Equivalent * Bolt Sizes	
Metric (millimeters)	English (inches)
M6	1/4
M8	5/16
M10	7/16
M12	1/2
M14	9/16
M16	5/8
M20	3/4
M22	7/8
M24	1
M27	1 1/8
M30	1 1/4
M36	1 1/2
M42	1 3/4
M48	2
M56	2 1/4
M64	2 1/2
M72	2 3/4
M80	3 1/4
M90	3 1/2
M100	4
* All bolts on any structure must be all English or all Metric. Mixing is not allowed.	
** The maximum bolt hole sizes shall be as described in Section 6 of the AASHTO LRFD Bridge Design Specifications.	

2. Nuts:

a. Proof load tests (ASTM F 606/F 606M) are required. The minimum frequency of tests shall be as specified in ASTM A 563/A 563M, or ASTM A 194/A 194M. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping, and lubricating.

b. If galvanized nuts are specified, the thickness of the zinc coating shall be checked by taking measurements on the wrench flats.

3. Washers:

Hardened steel washers shall be tested in accordance with ASTM F 436/F 436M. If galvanized washers are specified, hardness testing shall be performed after galvanizing. (The coating shall be removed before taking hardness measurements.)

4. Assemblies:

a. Rotational capacity tests are required and shall be performed on all plain or galvanized (after galvanizing) bolt, nut, and washer assemblies by the manufacturer or distributor before shipping.

b. (1) Except as modified herein, the rotational capacity test shall be performed according to ASTM A 325/A 325M.

(2) Each combination of bolt production lots, nut lots, and washer lots shall be tested as an assembly.

(3) A rotational capacity lot number shall be assigned to each combination of lots tested.

(4) The minimum frequency of testing shall be 2 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 bolts that are too short to be assembled in the calibrator, see Subsection 1058.03, Paragraph 4.b.(9).

(6) (i) The minimum nut rotation, from a snug-tight condition equal to 10% of the minimum bolt tension (minimum bolt tension is equal to 70% of the minimum tensile load), shall be:

(a) 240 degrees (2/3 turn) for bolt lengths less than or equal to 4 diameters.

(b) 360 degrees (1 turn) for bolt lengths greater than 4 diameters and less than or equal to 8 diameters.

(c) 480 degrees (1 1/3 turn) for bolt lengths greater than 8 diameters.

(ii) During the tightening process, the Contractor should continuously monitor the fastener tension on the calibration device, the bolt torque indicated on the torque wrench dial, as well as the relative rotation of the nut with respect to the snug-tight position. After snug-tightening the nut to the appropriate tension (shown in the tables below), the nut shall be rotated until the minimum bolt tension (as shown in the appropriate table) has been reached. The bolt torque reading should be recorded as close as possible to the minimum bolt tension. This torque must be less than or equal to the calculated torque obtained from the following formula:

Torque Formula	
$T_m \leq T_c = 0.25 PD$	
Where:	T_c = calculated torque in ft. lbs. (Newton-meters)
	T_m = measured torque in ft. lbs. (Newton-meters)
	P = measured bolt tension in pounds (Newtons)
	D = bolt diameter in feet (meters) (values shown in tables below)

(7) If the above torque-tension relationship has been satisfied, rotation of the nut should continue (past the rotation point where the minimum bolt tension-torque was taken) in the tightening direction to complete the minimum nut rotation shown in Paragraph 4.b.(6) of this Subsection. The tension reached at this rotation shall be equal to or greater than the turn test tension (equal to 1.15 times the minimum bolt tension). The snug tension, minimum bolt tension, and the turn test tension are shown in Table 1058.02.

Table 1058.02

Bolt Tension Requirements									
SI Standard									
Bolt Diameter (millimeters)	16	20	22	24	27	30	36		
Diameter (meters)	0.016	0.020	0.022	0.024	0.027	0.030	0.036		
10% Snug Tension (kilonewtons)	9	14	18	21	27	33	48		
Minimum Bolt Tension (kilonewtons)	91	142	176	205	267	326	475		
Turn Test Tension (kilonewtons)	105	163	202	236	307	375	546		
US Standard									
Bolt Diameter (in)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Diameter (ft)	0.042	0.052	0.063	0.073	0.083	0.094	0.104	0.115	0.125
10% Snug Tension (kips)	1	2	3	4	5	6	7	9	10
Minimum Bolt 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) If the torque-tension relationship or the rotation-tension relationship as determined in Paragraphs 4.b.(6) and 4.b.(7) of this Subsection does not meet requirements, the fastener assembly lot represented by these test samples shall not be used. However, if allowed by the Engineer, the complete fastener assembly lot represented by these failed test samples may be cleaned, relubricated, and then resubmitted for evaluation.

(9) Bolts that are too short to test in a Skidmore-Wilhelm calibrator may be tested in a steel joint using steel shims with proper hole size and thickness so as to place 3 to 5 exposed threads within the joint. The minimum turn-test tension requirement of Paragraph 4.b.(7) of this Subsection need not apply since there is no way of measuring tension. However, the torque value at proper installation rotation shall be determined as follows: The nut must be snug tightened using the same effort (or torque) required to reach the 10% snug tension as shown in the appropriate unit section of Table 1058.02. This "snug-torque" value may be determined by using longer bolts from the same lot that will fit in the calibrator. After match-marking the nut after snug-tightening, the nut shall be rotated to the minimum rotation required for turn-of-nut installation (equal to 1/2 of the

rotation values shown in Paragraph 4.b.(6) of this Subsection). The torque value obtained at this installation rotation must not exceed the torque as computed by the formula in Paragraph 4.b.(6) of this Subsection using a value of P equal to the turn test tension shown in the appropriate unit section of Table 1058.02.

5. Reporting:

a. The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO or ASTM Specifications shall be recorded on the appropriate document.

b. The location where tests are performed and the date of tests shall be reported on the appropriate document.

6. 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. Recent calibration documentation (calibrations performed at least on a yearly basis) for testing machines, as well as torque and tension measuring equipment used for performing said tests, shall be provided upon request by the Engineer.

1058.04 -- Documentation

1. Mill Test Report(s) (MTR):

a. MTR shall be furnished for all mill steel used in the manufacture of bolts, nuts, or washers.

b. MTR shall indicate the place where the material was melted and manufactured.

2. Manufacturer Certified Test Report(s) (MCTR):

a. The manufacturer of the bolts, nuts, and washers shall furnish test reports (MCTR) for the item furnished.

b. Each MCTR shall show the relevant information required according to Subsection 1058.03.

c. The manufacturer performing the rotational capacity test shall include on the MCTR:

(1) The lot number of each of the items tested.

(2) The rotational capacity lot number as required in Subsection 1058.03, Paragraph 4.b.(3).

(3) The results of the tests required in Subsection 1058.03, Paragraph 4.b.

(4) The pertinent information required in Subsection 1058.03, Paragraph 5.b.

(5) A statement that the MCTR for the items meets this Specification and the appropriate ASTM Specification.

(6) The location where the bolt assembly components were manufactured.

3. Distributor Certified Test Report(s) DCTR:

a. The DCTR shall include MCTR for the various bolt assembly components.

b. The rotational capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.

c. The DCTR shall show the results of the tests required in Subsection 1058.03, Paragraph 4.b.

1058.05 -- Shipping

1. Bolts, nuts, and washers 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. The container shall be permanently marked with the rotational capacity lot number such that identification will be possible at any stage before installation.

2. The appropriate MTR, MCTR, or DCTR shall be supplied to the Engineer for acceptance before installation.

SECTION 1059 -- ZINC COATING ON HARDWARE

1059.01 -- Description

1. This Specification covers zinc coatings applied on iron and steel hardware not otherwise covered, such as bolts, nuts, screws, nails, fittings, and other miscellaneous general hardware.

1059.02 -- Material Characteristics

1. Zinc coated hardware shall be hot dipped to conform to the requirements of ASTM A 153 or mechanically coated to conform with AASHTO M 298, Class 50.

1059.03 -- Acceptance Requirements

1. Acceptance will be based on requirements identified in this Specification and those in the Department's *Materials Sampling Guide*.

SECTION 1060 -- GALVANIZED CABLE CLAMPS

1060.01 -- Description

1. Galvanized cable clamps shall be drop-forged steel or malleable iron and shall have a uniform zinc coating conforming to the requirements of AASHTO M 30, with the exception that the weight of coating shall be determined by the use of magnetic thickness test method ASTM E 376.

1060.02 -- Acceptance Requirements

1. Acceptance will be based on requirements identified in the Department's *Materials Sampling Guide*.

SECTION 1061 -- REPAIR OF DAMAGED METALLIC COATINGS

1061.01 -- Description

1. This Section describes methods that are used to repair damaged zinc coatings, aluminum coatings, and aluminum-zinc alloy coatings on surfaces that have been damaged in fabrication, transporting, handling, installation, or welding. Damaged surfaces shall be repaired by the Contractor without additional cost to the Department.

2. The material used for repair shall provide a minimum coating thickness of at least 2 mils (50 μm) with one application.

3. The coating material may be applied under shop or field conditions.

1061.02 -- Material Characteristics

1. Repair Method 1 -- Zinc-Based Solder Alloys:

a. The Contractor shall use zinc alloy solders for this repair method. The most common types of solder are zinc-cadmium and zinc-tin-lead alloys having liquidus temperatures in the ranges from 518°F to 527°F (270°C to 275°C) and 446°F to 500°F (230°C to 260°C), respectively. (The liquidus temperature is that temperature above which an alloy is completely molten.) The solders can be used in rod form or as powders.

b. Surface Preparation:

(1) The Contractor shall clean the surface to be reconditioned using a wire brush, a light grinding action, or mild blasting so a smooth reconditioned coating will adhere. Surface preparation shall extend into the surrounding, undamaged coating.

(2) If the area to be reconditioned includes welds, the Contractor shall remove all flux residue and weld spatter by blast cleaning or mechanical means (chipping).

(3) The Contractor shall preheat the area to be reconditioned to at least 600°F (315°C) and shall not overheat [beyond 750°F (400°C)], or allow the surrounding coating to be burned. The Contractor shall wire brush the surface that is to be reconditioned during preheating.

(4) The Contractor shall rub the cleaned, preheated area with the repair stick to deposit an evenly distributed layer of the zinc alloy. When powdered zinc alloys are used, the powder shall be sprinkled on the cleaned, preheated surface and spread out with a spatula or similar tool. The minimum thickness of the coating shall be as specified.

(5) When the repair has been made, the Contractor shall remove the flux residue by rinsing with water or wiping with a damp cloth.

(6) The thickness measurements shall be made with either a magnetic or electromagnetic gauge to ensure the proper thickness was applied.

2. Repair Method 2 -- Zinc-Rich Paint:

a. Zinc-rich paints are usually based on organic binders that are pre-mixed and formulated specifically for use on steel surfaces. Zinc-rich paint is suitable for repairing damaged coatings, provided the dried film contains a minimum of 65% zinc dust by weight.

b. Surface Preparation:

(1) The Contractor shall clean the surfaces to be reconditioned so that the surface is dry, free of oil, grease, and corrosion products.

(2) Where anticipated field service conditions include immersion, the Contractor shall blast clean the surface in accordance with SSPC-SP5, White Metal. For less critical field exposure conditions, the surface shall be blast cleaned to near-white metal in accordance with SSPC-SP10 to a 1 to 2 mils (25 to 50 μm) anchor pattern, as a minimum.

(3) Where circumstances do not allow blast cleaning, it is permissible to power disk-sand areas to be repaired to bright metal. To ensure that a smooth reconditioned coating can be achieved, surface preparation shall extend into the surrounding undamaged coating.

(4) If the area to be reconditioned includes welds, the Contractor shall remove all flux residue and weld spatter by blast cleaning or mechanical means (chipping).

(5) The Contractor shall spray or brush-apply the zinc-rich paint to the prepared area. The paint shall be applied as recommended by the paint manufacturer in a single application employing multiple-spray passes to achieve the dry film thickness specified.

(6) Coating thickness measurements are made with either a magnetic or electromagnetic gauge to ensure the proper thickness was applied.

3. Repair Method 3 -- Sprayed Zinc (Metallizing):

a. This method involves the application of a zinc or aluminum coating by spraying the surface to be repaired with droplets of molten metal using wire, ribbon, or powder processes.

b. When an aluminum coating is to be metallized, metallizing shall be done with an aluminum wire or ribbon containing not less than 99% aluminum.

c. When a zinc coating is to be metallized, it shall be done with zinc wire, ribbon, or powder containing not less than 99.9% zinc.

d. Surfaces to be reconditioned by metallizing shall be clean, dry, and free of oil, grease, and corrosion products.

e. If the area to be reconditioned includes welds, all flux residue and weld spatter of a size or type that cannot be removed by blast cleaning or mechanical means, i.e., chipping, etc., shall first be removed.

f. The surface to be reconditioned shall be blast cleaned in accordance with SSPC-SP5, White Metal.

g. To ensure that a smooth reconditioned coating can be achieved, surface preparation shall extend into the surrounding undamaged coating.

h. The coating shall be applied to the clean and dry surface by means of metal spraying pistols fed with either zinc wire, ribbon, zinc powder, or aluminum wire or ribbon. The sprayed coating shall be applied as

soon as possible after surface preparation and before visible deterioration of the surface has occurred.

i. The surface of the sprayed coating shall be of uniform texture and free of lumps, coarse areas, and loosely adherent particles.

j. The minimum thickness of the sprayed coating shall be as specified.

k. Coating thickness measurements shall be made with either a magnetic or electromagnetic gauge to ensure that the proper thickness was applied.

SECTION 1062 -- ZINC-COATED AND ALUMINUM-COATED STEEL WIRE STRAND

1062.01 -- Description

1. This Section covers zinc-coated and aluminum-coated steel wire strand or cable suitable for use as guys, messengers, span wires, and similar uses.

1062.02 -- Material Characteristics

1. Zinc-coated steel wire strand or cable shall conform to the requirements of ASTM A 475 and, unless otherwise specified, shall meet the requirements listed below.

a. Strand for use as tie cables shall be 7 wire "Common" grade with a "Type I" zinc coating.

b. Strand for use as span wire, messengers, and guy wire shall be 3/8 inch (9.52 mm) diameter, 7 wire, "High-Strength" grade cable with a "Class A" zinc coating.

c. Strand for use as traffic signal tie wire shall be 1/4 inch (6.35 mm) diameter, 7 wire, "Siemens-Martin" grade cable with a "Class A" zinc coating.

2. Aluminum-coated steel wire strand or cable shall conform to the requirements of ASTM A 474 and, unless otherwise specified, shall meet the strength grade requirements above.

1062.03 -- Acceptance Requirements

1. Zinc-coated and aluminum-coated steel wire strand will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1063 -- ZINC-COATED AND ALUMINUM-COATED CARBON STEEL WIRE

1063.01 -- Description

1. This Specification covers zinc-coated (galvanized) and aluminum-coated (aluminized) carbon steel wire for use as tie wires in the construction of fence and for other purposes as specified.

2. The wire shall be specified by its diameter in inches (millimeters) as shown in the contract.

1063.02 -- Material Characteristics

1. Zinc-coated (galvanized) carbon steel wire shall be medium temper with a Class 1 coating conforming to the requirements of ASTM A 641M.

2. Aluminum-coated (aluminized) carbon steel wire shall be medium temper conforming to the requirements of ASTM A 809.

1063.03 -- Acceptance Requirements

1. Zinc-coated and aluminum-coated carbon steel wire will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1064 -- FENCES

1064.01 -- Description

1. This Section covers chain-link fence, woven wire fence, barbed wire fence, and the posts, fabric, wire, staples, ties, and fittings used in the construction of these fences.

1064.02 -- Material Characteristics

1. Chain-link Fence:

a. Approved types:

(1) Zinc-coated steel chain-link fence fabric shall conform to the requirements of ASTM A 392. The fabric shall be zinc-coated after weaving with a Class 2 coating.

(2) Aluminum-coated steel chain-link fence fabric shall conform to the requirements of ASTM A 491. The fabric shall be aluminum-coated before weaving.

(3) Zinc 5% aluminum-mischmetal alloy-coated steel chain link fence shall conform to the requirements of ASTM F 1345. The fabric shall be coated before weaving with a Class 2 coating.

(4) Vinyl-coated steel chain-link fence fabric shall conform to the requirements of Federal Specification RR-F-191/1. The vinyl coating shall be thermally bonded over the fabric and be the color shown in the contract.

(5) The fabric shall be the height specified in the contract. Wire shall be 9 gauge [0.148 inch (3.76 mm)] in diameter. Mesh openings shall be 2 inches (50 mm).

b. Steel Fence Posts, Braces, and Rails:

(1) Tubular steel pipe used for line posts, end posts, corner posts, pull posts, top rail, and brace rail shall be of the nominal pipe size (NPS) shown in the contract.

(2) Tubular steel pipe shall conform to the requirements of ASTM F 1083 Schedule 40 pipe. Pipe shall be coated in accordance with ASTM F 1043, Types A or C.

(3) Tubular steel pipe other than ASTM F 1083 Schedule 40 pipe meeting the outside dimensional requirements of ASTM F 1083 Schedule 40 pipe may be used provided the product of the yield strength of the pipe multiplied by its section modulus is not less than the product of the section modulus of an equivalent diameter F 1083 Schedule 40 pipe multiplied by 25,800 psi (180 MPa). Pipe meeting these requirements shall be hot-dipped galvanized in accordance with the applicable requirements of ASTM F 1083 or be coated as follows:

(i) The exterior surface shall be hot-dipped galvanized with a minimum of 0.9 oz/ft² (275 g/m²) and have a uniform, chromate conversion coating applied. The hot dipped galvanized exterior shall also be top coated with a clear organic coating such as urethane or polyurethane (the chromate conversion coating being applied either as a separate treatment or simultaneously with the organic topcoat).

(ii) The interior surface shall have a protective coating of zinc-rich paint with a minimum thickness of 0.3 mils (7.6 μm) or a hot-dipped zinc interior coating of not less than 0.35 oz/ft² (107g/m²).

(iii) Pipe conforming to these requirements shall meet the applicable coating specification requirements of AASHTO M 181 for Grade 2 pipe.

(4) The manufacturer, fabricator, or supplier shall furnish the Engineer with test reports and a certificate of compliance stating that the material furnished meets these *Specification* requirements.

c. Roll Formed and "C" Sections for Posts, Braces, and Top Rail:

(1) End, corner, and pull posts shall be 3 1/2 inches x 3 1/2 inches (89 mm x 89 mm) roll formed sections with integral fabric loops. Posts shall weigh 5.15 lb/ft (7.66 kg/m) after galvanizing with a maximum weight tolerance of 2 1/2% and a minimum yield strength of 35,000 psi (240 MPa). Posts shall be coated in accordance with ASTM F 1043, Types A or C.

(2) Line posts shall be 2.2 inches x 1.7 inch (56 mm x 43 mm) "C" Sections with a weight of 2.64 lb/ft after galvanizing with a maximum weight tolerance of 2 1/2% and a minimum yield strength of 45,000 psi (310 MPa). Posts shall be coated in accordance with ASTM F 1043, Types A or C.

(3) Top rails and braces shall be 1 5/8 inches x 1 1/4 inches (41 mm x 32 mm) roll formed sections with a weight of 1.35 lb/ft (2.0 kg/m) after galvanizing with a maximum weight tolerance of 2 1/2% and a minimum yield strength of 35,000 psi (240 MPa). Top rails and braces shall be coated in accordance with ASTM F 1043, Types A or C.

d. Vinyl Coated Fence Posts:

Vinyl coated fence posts shall meet the requirements of Federal Specification RR-F-191/3 and RR-F-191/4. Posts, top rails, and braces shall be Class 1 (Steel pipe), Class 3 (Formed steel), Class 4 (Steel H sections), or Class 6 (Steel square sections). Posts shall be of the length and color shown in the contract. The vinyl coating shall be thermally bonded.

e. Ties and Fasteners:

(1) Ties and fasteners shall be made from at least 11 gauge [0.12 inch (3 mm)] diameter steel wire conforming to the requirements of Section 1063. Aluminum alloy wire 7 gauge [0.144 inch (3.65 mm)] in diameter having a minimum tensile strength of 20,000 psi (138 MPa) and a minimum elongation of 8% may also be used.

(2) Ties and fasteners for vinyl coated steel chain-link fence shall meet the requirements of Federal Specification RR-F-191/4, and be the same color as the fabric. The vinyl coating shall be thermally bonded.

2. Woven Wire Fence:

a. The woven wire fence fabric shall be 47 inches (1190 mm) high, have 10 horizontal wires, and have stay wires spaced on 6-inch (150 mm) centers. The intermediate line wires shall have a minimum

breaking strength of 685 pounds (3050 N). The top and bottom wires shall have a minimum breaking strength of 1030 pounds (4590 N).

b. Approved Types:

(1) Zinc-coated steel woven wire fence fabric shall conform to the requirements of ASTM A 116 except that the minimum zinc coating shall be 0.80 oz/ft² (244 g/m²).

(2) Aluminum-coated steel woven wire fence fabric shall conform to the requirements of ASTM A 584.

c. Fence Posts:

(1) Wood Posts shall conform to the requirements of Section 1075.

(2) Tubular steel posts shall conform to Paragraph 1.b. of this Subsection.

(3) Studded "T" steel line posts shall meet the requirements of ASTM A 702.

d. Staples:

Staples for fastening fence materials to wood posts shall be made of steel wire at least 9 gauge [0.148 inch (3.75 mm)] in diameter and have 1 1/2 inches (38 mm) long barbed or serrated prongs.

e. Ties and Fasteners:

Ties and fasteners shall conform to Paragraph 1.e. of this Subsection.

f. Tension Wire and Cross Ties:

Tension wire and cross ties shall be smooth steel wire at least 9 gauge [0.148 inch 3.75 mm]] in diameter conforming to the requirements of Section 1063.

3. Barbed Wire Fence:

a. Zinc-coated and aluminum-coated steel barbed wire.

(1) Zinc-coated steel barbed wire shall be 12 1/2 gauge [0.099 inch (2.51 mm)] in diameter conforming to the requirements of ASTM A 121 with a Class 3 coating. The barbs shall be 2 point at 4 inch (100 mm) centers or 4 point at 5 inch (125 mm) centers.

At his/her option, the Contractor may furnish two-strand high tensile strength steel barbed wire, 0.067 inch (1.70 mm) in diameter, meeting the requirements of ASTM A 121 except that the minimum zinc coating shall be 0.80 oz/ft² (244 g/m²). The barbs shall be 4 point, 16-½ gauge (0.058 inch) (1.47 mm), at 5-inch (125 mm) centers.

(2) Aluminum-coated steel barbed wire shall be 12-½ gauge (0.099 inch) (2.51 mm) in diameter conforming to the requirements of ASTM A 585. The barbs shall be 4 point, 14 gauge (0.080 inch) (2.03 mm) at 5-inch (125 mm) centers.

b. Fence Posts:

(1) Wood posts shall conform to the requirements of Section 1075.

(2) Studded "T" steel line posts shall meet the requirements of ASTM A 702.

c. Ties and Fasteners:

(1) Staples shall conform to Paragraph 2.d. of this Subsection.

(2) Wire fasteners shall conform to Paragraph 1.e.(1) of this Subsection.

d. Tension Wire and Cross Ties:

(1) Tension wire and cross ties shall conform to Paragraph 2.f. of this Subsection.

4. Fittings, Hardware, and Accessories:

a. All fittings, hardware, and accessories for use with chain-link, woven wire, and barbed wire fencing shall be pressed or rolled steel, forged steel, cast steel, or malleable iron, as appropriate, and have sufficient strength and other properties to meet the industry requirements for the fence's intended use.

b. Malleable iron and steel castings, bolts, nuts, and similar threaded fasteners and nails shall be galvanized in accordance with the requirements of Section 1059.

c. All other fittings and hardware items 1/8 inch (3 mm) thick and larger shall be galvanized in accordance with the requirements of the ASTM A 123.

d. Tubular steel posts shall have heavy malleable iron caps galvanized to meet the requirements in ASTM A 153. The caps shall provide a drive fit over the posts to exclude moisture.

5. Vinyl-coated fence accessories shall meet the requirements of Federal Specification RR-F-191/4 and be the same color as the fabric. The vinyl coating shall be thermally bonded.

1064.03 -- Acceptance Requirements

1. Fences will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1065 -- POLYSTYRENE BOARD FILLERS

1065.01 -- Description

1. This Specification covers the use of polystyrene board as it is used to form concrete.

1065.02 -- Material Characteristics

1. Polystyrene board shall have a minimum flexural strength of 35 psi (240 kPa), as determined by ASTM C 203. It shall also have a compressive yield strength between 16 psi and 40 psi (110 kPa and 275 kPa) at 5% by volume compression.

2. When the contract requires a facing surface of 1/8 inch (3 mm) thick hard board, then the hard board shall conform to ANSI A 135.4.

1065.03 -- Acceptance Requirements

1. Polystyrene board and hard board will be considered acceptable for use when the Contractor submits a manufacturer's certificate of compliance for the conformance with these Specifications, and approval for use is given by the Department's Materials and Research Division.

SECTION 1066 -- W-BEAM AND THRIE-BEAM GUARDRAIL

1066.01 -- Description

1. Galvanized W-beam and Thrie-beam guardrail shall be as shown in the contract.

1066.02 -- Material Characteristics

1. All parts shall be interchangeable with similar parts from other manufacturers.

2. Materials for W-beam and Thrie-beam guardrail shall conform to the requirements in AASHTO M 180, Type I Class A.

3. Wood posts and blocks shall conform to the requirements in Section 1075.

4. Plates and other steel items shall conform to the requirements in ASTM A 36/A 36M.

5. The galvanized bolts shall conform to the requirements in ASTM F 568 Class 4.6.

6. Steel posts shall conform to the requirements in Section 1067.

7. End shoes shall meet the requirements of AASHTO M 180 Class B and be at least 10 gauge [0.138 inch (3.5 mm)] thick steel.

8. All anchor rods and plates, unless otherwise specified, shall conform to the physical requirements of ASTM A 36/A 36M.

9. Turnbuckles and clevises shall be steel forgings conforming to the requirements of ASTM A 668, Class B. The forgings shall be annealed before being machined.

1066.03 -- Acceptance Requirements

1. W-beam and Thrie-beam guardrail will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1067 -- STEEL GUARDRAIL POSTS AND SPECIAL POSTS

1067.01 -- Description

1. This Specification covers steel "W 6X9" (W 150x14)" beam sections used as an alternate for treated timber guardrail line posts.

1067.02 -- Material Characteristics

1. "W 6X9" (W150 x 14)" beam sections for use as beam guardrail line posts shall be fabricated from steel complying with the requirements of ASTM A 36/A 36M, A 588/A 588M, or A 242/A 242M and conforming to the size, weight, and dimensions shown on the designated plans. All welding shall be in accordance with AWS Specifications.

2. Bolts shall be as shown in the contract. Galvanized bolts are required, and they shall conform to ASTM F 568 Class 4.6 or A 307. ASTM A 325, Type 3 bolts may be used with ASTM A 588/A 588M or ASTM A 242/A 242M steel without galvanizing.

3. Posts, blocks, and all necessary hardware fabricated from ASTM A 36/A 36M steel shall be galvanized in accordance with ASTM A 123.

4. "W 6X9" (W150 x 14)" beam sections are not authorized for the following uses:

- a. Curved beam guardrail (CRT posts and adjacent 4 posts).
- b. End anchorage assembly - alternate design (at the last post).
- c. Terminal sections (BCT, MELT, SRT, BEST, ET 2000, SKT 350).
- d. The 7 posts located at the tip of a bullnose.

1067.03 -- Acceptance Requirements

1. Steel guardrail posts and special posts will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the Department's *Materials Sampling Guide*.

SECTION 1068 -- ELASTOMERIC BEARINGS AND LAMINATED BEARING PADS

1068.01 -- Description

1. Elastomeric bearings and laminated bearing pads shall conform to the requirements of the current AASHTO LRFD Bridge Design Specifications.

1068.02 -- Acceptance Requirements

1. AASHTO tests required for the elastomeric material and steel shall be performed in an approved laboratory at no cost to the Department.

2. Samples and certification shall be furnished in accordance with Department's *Materials Sampling Guide*.

SECTION 1069 -- TEMPORARY PAVEMENT MARKING

1069.01 -- Description

1. This Specification covers temporary pavement marking tape ASTM D 4592 (Type I and II), Raised Pavement Markers (RPM), overlay markers, and pavement marking paint.

1069.02 -- Material Characteristics

1. Temporary Pavement Marking Tape, Type I:

a. Temporary pavement marking tape, Type I, shall be made with a tape-like material manufactured from a thin sheet of malleable aluminum coated with a white or yellow binder. It shall be reflectorized with glass beads and backed with a pressure-sensitive adhesive.

b. The tape shall be 4 inches (100 mm) wide, and the reflectorizing glass beads shall have an index of refraction of not less than 1.90.

2. Temporary Pavement Marking Tape, Type II:

a. Temporary pavement marking tape, Type II, shall be a mixture of high quality polymeric materials and pigments with glass beads throughout the pigmented portion of the film and reflectorized with glass beads bonded to the top surface.

b. The film shall be precoated with a pressure-sensitive adhesive. Unless otherwise specified, the temporary pavement marking shall be 4 inches (100 mm) wide and the reflectorizing glass beads shall have an index of refraction of not less than 1.90.

c. A nonmetallic medium shall be incorporated to facilitate removal either manually or with a recommended roll-up device. The tape shall be capable of being easily removed from asphalt and Portland cement concrete surfaces intact (or in large pieces), at temperatures above 41°F (5°C).

d. Removal shall be accomplished without the use of heat, solvents, grinding, or sandblasting.

3. Raised Pavement Markers:

a. Raised pavement markers shall consist of a plastic shell having a minimum width of 4 inches (100 mm) and maximum height of 0.79 inch (20 mm) with one or more prismatic reflective faces with a minimum of 0.38 square inches (2.45 cm²) of reflective surface for each direction required to reflect incident light.

b. The marker shall be fitted with pressure-sensitive adhesive for application to a primed surface.

4. Overlay markers:

a. Overlay markers shall be made from impact-resistant polyurethane plastic.

b. The marker's approximate dimensions are 4 inch (100 mm) width by 2 inch (50 mm) height. The marker shall have 1 or 2 (as required to be seen) micro-prismatic reflective faces [approximate dimension 1/4 inch x 4 inches (6 mm x 100 mm)].

c. The base of the marker shall be fitted with a butyl rubber pad. Overlay markers shall not be used in place of raised pavement markers, tape, or paint.

5. Temporary pavement marking paint and glass beads shall be shown in the contract. Any commercially available reflectorized traffic paint may be acceptable if the contract does not specify the type of paint.

1069.03 -- Acceptance Requirements

1. Acceptable temporary pavement markings, except paint and glass beads, are shown on the Department's Approved Products List.

2. Temporary pavement markings not on the Department's Approved Products List shall be approved by the Engineer before use.

SECTION 1070 -- HIGHWAY SIGNS

1070.01 -- Description

1. Materials authorized for use in constructing highway signs, Type A and Type B, are listed in this Section.

1070.02 -- Material Characteristics

1. Reflective Sheeting:

a. The reflective sheeting for sign reflectorization shall meet the requirements of ASTM D 4956.

b. All reflective sheeting for Type A and Type B signs shall be Type IV sheeting.

2. Overlay Panels:

a. Overlay panels for Type B signs shall be at least 0.04 inch (1 mm) thick sheet aluminum (ASTM B 209M Alloy 6061-T6) surfaced with reflective sheeting. The type and color of the reflective sheeting shall be as shown in the contract.

b. Panels cut from coil sheet will not be accepted.

3. Letters, numerals, symbols, and borders for "Type B Signs" shall be reflective materials meeting the requirements of ASTM D 4956 for Type IV sheeting direct applied or detachable copy.

4. Signs shall meet the size and shape requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways.

5. Reflective background sheeting for all signs shall conform to ASTM D 4956.

6. Routemarkers:

a. The State, U.S., and Interstate Highway routemarkers to be used as legend units on Type B signs shall be fabricated from at least 0.08 inch (2 mm) thick sheet aluminum alloy 6061-T6 (ASTM B 209M) and shall be processed in accordance with the reflective sheeting manufacturer's recommendations.

b. Reflectorized sheeting shall conform to AASHTO M 268.

c. Color and sizes of routemarkers shall be shown in the contract.

d. The routemarkers shall be attached to the sign background in the same manner as the other legend units.

e. Special designs on the State routemarker shall be obtained from the Department's Traffic Engineer.

7. Supports:

a. Supports for Type A and Type B signs shall be steel beam or wood breakaway posts. The size, shape, construction, and weight per foot (meter) shall be specified in the contract.

b. The sign supports shall be cut off at the same elevation as the top of the sign.

c. The steel beam breakaway posts and stub post steel shall comply with ASTM A 36/A 36M with a working stress of 20,000 psi (138 MPa).

d. After all post fabrication is completed, the posts shall be hot-dipped galvanized in accordance with ASTM A 123.

e. The steel for base connection plates and fuse plates shall comply with ASTM A 36/A 36M. The fuse plate shall be hot-dip galvanized in compliance with ASTM A 123.

f. The base connection and fuse plate bolts, nuts, and washers shall be as shown in the contract and galvanized to conform with ASTM A 153.

g. The stub post shall be hot-dip galvanized in accordance with ASTM A 123 after all holes have been drilled, slots cut, and base plates welded. The galvanizing shall extend a minimum of 6 inches (150 mm) below the base plate.

h. Treated timber sign posts shall conform to the requirements of Subsection 1075.06.

8. Brackets and Fasteners:

a. Mounting brackets for Type A signs shall be aluminum alloy 6063-T6 (ASTM B 221M) or steel (ASTM A 36/A 36M) galvanized to conform to the requirements of ASTM A 123. Thickness and dimensions shall conform to those shown on the contract.

b. The steel sign bolts for Type A signs shall be stove bolts 3/8 inch (9 mm) in diameter and in lengths as required. The steel bolts, nuts, and washers shall be in accordance with Section 1058.

c. An aluminum angle, 1 1/2 inch x 1 1/2 inch x 0.188 inch thick (38 mm x 38 mm x 4.75 mm thick) for use with extrusheet and extruded sign brackets on wood posts, shall be alloy 6061-T6 complying with ASTM B 308/B 308M.

d. Post clips shall be aluminum alloy 356.0 conforming to ASTM B 108. Post clips and sign bracket bolts shall be aluminum alloy 2024-T4 conforming to ASTM B 211. Locknuts for aluminum bolts shall be aluminum alloy 2017-T4 conforming to ASTM B 211M.

e. The sign brackets and fasteners specified above shall not be paid for directly but shall be considered subsidiary to the items for which direct payment is made.

9. Type A and B Backing Material:

a. Type A signs shall be fabricated from Alloy 6061-T6 or 5052-H38 (ASTM B 209M) sheet aluminum.

(1) The sign blanks shall be free from laminations, blisters, slivers, open seams, pits from heavy rolled-in scale, ragged edges, holes, turned down corners, or other defects which may affect their appearance or use.

(2) All blanks shall be uniform in thickness and flat.

(3) All shearing, cutting, and punching shall be done before preparation of blanks for application of reflectorizing material.

(i) The sheared edges of all blanks shall be straight and free from tears and raggedness.

(ii) All corners shall be rounded as shown in the contract.

(iii) All punched or drilled holes shall be round and free from tears, raggedness, or distortion of the metal.

(4) Sign blanks cut from coil sheet will not be accepted.

(5) All thicknesses shall be as required in the contract.

(6) All sign blanks shall be given a chromate conversion coating meeting the requirements of ASTM B 449 Class 2. The chromate coating shall be suitable for use as a paint base and for corrosion protection.

b. Type B Signs shall be fabricated from extrusheet panels constructed of Alloy 3003-H18 (ASTM B 209M) flat sheets and Alloy 6063-T6 or 5052-H38 (ASTM B 221M) extruded stiffeners. The flat sheets shall be at least 0.08 inch (2 mm) thick, and the stiffeners shall have the dimensions shown in the contract. The panels shall be made in widths of 12 inches, 18 inches, 24 inches, and 36 inches (300 mm, 450 mm, 600 mm, and 750 mm) as specified in the contract.

1070.03 -- Acceptance Requirements

1. Materials for highway signs will be accepted on the basis of compliance with the requirements of these Specifications.

SECTION 1071 -- POSTS AND FASTENERS FOR HIGHWAY SIGNING

1071.01 -- Description

1. This Section covers galvanized or painted enamel steel posts, flexible posts, and zinc or cadmium plated fasteners for use in highway signing for other than Type A and Type B signs.

1071.02 -- Material Characteristics

1. a. Sign posts shall be a standard "U" or channel shape. The posts shall be flange type, and the length shall be shown in the contract. The posts may be light or heavy duty.

b. Steel posts for signs shall be made from hot-wrought carbon steel or rail steel conforming to the requirements specified in ASTM A-702 (Steel B).

c. All holes shall be at least 3/8 inch (9.5 mm) diameter. They shall be punched or drilled in each post and spaced 1 inch (25 mm) from center to center, $\pm 1/16$ inch (± 1.5 mm), beginning with the first hole at 1 inch (25 mm) from the top of the post. Punching shall be done so that there will be no cracks or burs radiating from the holes.

d. (1) Painted posts shall be cleaned of all loose scale before finishing and painted with one or more coats of weather resistant enamel (black or green, as specified).

(2) The finish shall produce a glossy appearance with satisfactory elastic and adhering properties.

(3) The paint film thickness shall not be less than 1.5 mils (38 μ m).

(4) After drying, the finish shall not crack or chip from the metal when struck a light blow with a hammer.

(5) The paint coating shall show no appreciable change in adhesion or appearance when immersed in water at room temperature for a period of 72 hours.

e. Galvanized posts shall be hot-dip galvanized after fabrication in accordance with ASTM A 123.

f. Painted posts which have been heavily scratched or marred in shipment and galvanized posts which have their galvanizing damaged shall be rejected.

g. (1) Light-duty post shall be at least 2 inches (50 mm) and not more than 2 1/2 inches (38 mm) wide on the side of the post to which the sign is to be fastened.

(2) The post's weight shall be at least 1.12 lb/ft (1.6 kg/m), and the post shall have at least 15 and not more than 20 holes.

(3) Light-duty posts shall be painted black or dark green.

h. (1) Heavy-duty posts shall be at least 3 inches (75 mm) and not more than 3 1/2 inches (90 mm) wide on the side of the post to which the sign is to be fastened.

(2) The post's weight shall not be less than 2.5 lb/ft (3.75 kg/m), and the post shall have at least 50 and not more than 60 holes.

(3) Heavy-duty posts may be painted black, green, or be galvanized.

- 3. a. Fasteners shall be round or pan head machine screws meeting the dimensional requirements of ASTM F 568 Property Class 4.6 with metric coarse threads meeting the dimensional requirements of ANSI/ISO.
- b. The diameter of the fastener shall be shown in the contract.
- c. The minimum thread length is shown in Table 1071.01.

Table 1071.01

Thread Length	
Length of Fastener	Minimum Length of Thread
2 inches (50 mm) and under	Entire Length
Over 2 inches (50 mm)	1 3/4 inches (44 mm)

4. a. Nuts shall be square, hex, or hex machine nuts meeting the requirements of ASTM A 563M, Property Class 5.

b. Threads shall be ANSI metric coarse.

5. Plain washers shall be Type A meeting the requirements of ANSI 18.22M and have the dimensions shown in Table 1071.02.

English

Table 1071.02

Washer Dimensions			
Washer	Inside Diameter (inches)	Outside Diameter (inches)	Thickness (inches)
3/16	0.245 to 0.265	0.557 to 0.577	0.036 to 0.065
1/4	0.307 to 0.327	0.727 to 0.749	0.051 to 0.080
5/16	0.370 to 0.390	0.868 to 0.905	0.064 to 0.104
3/8	0.433 to 0.453	0.993 to 1.030	0.064 to 0.104

Metric

Table 1071.02M

Washer Dimensions			
Bolt	Inside Diameter (millimeters)	Outside Diameter (millimeters)	Thickness (millimeters)
M5	6.22 to 6.73	14.15 to 14.66	0.91 to 1.65
M6	7.80 to 8.31	18.47 to 19.02	1.30 to 2.03
M8	9.40 to 9.91	22.05 to 22.99	1.63 to 2.64
M10	11.0 to 11.51	25.22 to 26.16	1.63 to 2.64

6. a. Lock washers shall be regular helical spring steel of a compatible size for the required fastener.

b. Lock washers shall meet the dimensional requirements of ANSI B18.21.1.

c. Lock washers shall have a Rockwell Hardness of C45 to C51.

7. The machine screws, nuts, and washers shall have a zinc or cadmium coating with a minimum thickness of 0.31 mils (8 μm), with a Type III treatment conforming to ASTM B 633 Class Fe/Zn 8 or ASTM B 766 Class 8, respectively.

8. Fasteners for delineators shall be at least 3/16 inch (5 mm) diameter pan or round head machine screws (length as shown in the contract) conforming to the requirements of ASTM F 568.

1071.03 -- Acceptance Requirements

1. Galvanized or painted enamel steel posts and zinc or cadmium plated fasteners will be accepted based on the requirements of this Specification and the requirements in the Department's *Materials Sampling Guide*.

SECTION 1072 -- REFLECTORS

1072.01 -- Description

1. Authorized reflectors are described in this Section.

1072.02 -- Material Characteristics

1. The reflector shall consist of a round retroreflecting lens permanently bonded and hermetically sealed to its back.

2. The back may be either acrylic plastic or metal foil.

- a. The foil back reflectors must have a minimum of 0.018 inch (0.46 mm) thick aluminum housing.

- b. The acrylic plastic back reflectors do not require an aluminum housing.

3. The reflector shall have a mounting hole in the center with a diameter of not less than 3/16 inch (5 mm).

4. The reflector shall have a visible reflective area of not less than 6.5 square inches (4200 mm²) when mounted.

5. The lens shall consist of a smooth front surface free from projections or indentations other than the central mounting hole and manufacturer's identification.

6. The rear surface shall be a prismatic configuration such that it will cause total internal reflection of light.

7. The prism arrangement in the lens shall be such that the lens will have a segmented appearance with at least 2 and not more than 6 segments in each unit.

8. The unit shall be permanently sealed against dust, water, and water vapor.

9. Fasteners for delineators shall be at least 3/16 inch (5 mm) diameter pan or round head machine screws (length shown in the contract) conforming to the requirements of ASTM F 568.

1072.03 -- Specific Intensity

1. The reflectors shall meet specific intensity requirements shown in Table 1072.01.

Table 1072.01

Reflector Requirements					
Observation Angle, (degrees)	Entrance Angle, (degrees)	Minimum Specific Intensity (Candlepower per foot-candle) (Candela per lux)			
		White	Yellow	Red	Blue
0.1	0	120 (11.1)	72 (6.7)	30 (2.8)	12 (1.1)
0.1	20	48 (4.5)	29 (2.7)	12 (1.1)	4.8 (0.4)
0.33	0	20 (1.9)	12 (1.1)	5 (0.5)	2.0 (0.2)
0.33	20	8 (0.7)	5 (0.5)	2 (0.2)	0.8 (0.08)

2. Failure to meet the minimum specific intensity requirements of more than two reflectors out of the 53 subjected to testing shall constitute failure of the lot.

1072.04 -- Color

1. The color of the reflectors shall be white, yellow, red, or blue by day and when viewed by reflected light at night.
2. The color of the reflectors shall not fade during exposure.
3. The initial color of the reflectors shall be determined by use of a colorimeter and the tristimulus method to obtain x and y chromaticity coordinates.
4. The lens color shall be according to requirements of the contract.

1072.05 -- Packaging and Delivery

1. The reflector shall be furnished as a completely assembled unit ready for mounting.
2. The reflector shall be packaged in such a manner as to insure their arrival at the destination in an undamaged condition.

1072.06 -- General

1. Round Center-Mount Reflex-Reflectors for Delineators shall conform to the material and design requirements of this Specification.
2. For acceptance purposes, a sample of 53 units from each lot will be tested for optical and durability tests.

1072.07 -- Tests

1. The reflectors will be tested according to Table 1072.02.

Table 1072.02

Test	Test Method
Specific Intensity	NDOT T257
Seal	NDOT M290
Heat Resistance	NDOT M290

1072.08 -- Acceptance Requirements

1. Acceptable reflectors are shown on the Department's Approved Products List.
2. Fasteners for delineators refer to Section 1071.

SECTION 1073 -- ROADWAY LIGHTING, SIGN LIGHTING, AND TRAFFIC SIGNALS

1073.01 -- Description

1. This Section describes material requirements for roadway lighting, sign lighting, and traffic signals.

1073.02 -- Material Characteristics

1. General Requirements:

a. All materials shall be new. Used or reconditioned equipment is not acceptable.

b. Materials scheduled for use on the project must be approved by the Engineer before they can be installed.

c. (1) The Contractor shall be prepared to furnish, upon request, a sample of any item or material that he/she proposes to furnish. Unless destructive testing is required, the sample will be returned.

(2) All costs related to the furnishing of samples, including all shipping and testing costs, shall be included in the contract bid price.

d. Review of shop drawings by the Engineer is for the purpose of checking for general conformance with the design concept of the project and for general compliance with the contract documents only. Any action taken by the Engineer on submittals and shop drawings will not relieve the Contractor of the responsibility to provide satisfactory materials and equipment meeting the requirements of the contract documents.

e. If errors in shop drawings are not detected by the Engineer, the Contractor is not relieved of his/her responsibility to comply with the contract documents; and the Engineer's review of the shop drawings shall never be construed to allow the Contractor to proceed in error.

f. At the time of each submittal, the Contractor shall, in writing, call the Engineer's attention to any deviations that the shop drawings or samples may have from the requirements of the contract documents.

2. Ground Rods:

a. Ground rods shall, with the exception of length and diameter, be in compliance with IMSA Specifications and be installed in accordance with the *National Electric Code*. Ground rods used in traffic signal installations shall extend through the foundation and at least 7 feet (2.1 m) into the ground with 5 inches (125 mm) extending above the foundation. Ground rods shall have a minimum diameter of 5/8 inch (13 mm). Ground rods shall be supplied with a ground rod clamp.

b. Ground rods used in roadway lighting installations shall comply with ANSI/UL 467 (ANSI C 33.8 and CSA) and IMSA Specifications and be installed in accordance with the *National Electric Code* and the contract.

c. Grounding Clamps and connectors shall be UL approved for the material being grounded and the grounding method being used.

3. Electrical Conduit and Duct Systems:

a. Metallic conduits of the various types shall conform to the applicable industry standards as follows:

(1) Galvanized rigid steel conduit (GRS) shall meet the requirements of the *NEC* Article 346 and Underwriters Laboratories UL-6.

(2) Intermediate metallic conduit (IMC) shall meet the requirements of the *NEC* Article 345 and UL-1242.

(3) Electrical metallic tubing (EMT) shall meet the requirements of the *NEC* Article 348 and UL-797.

b. Non-metallic conduits of the various types shall conform to the applicable industry standards as follows:

(1) Polyvinyl chloride (PVC) conduit shall be rigid PVC conduit, schedule 40 or 80, and shall meet the requirements of *NEC* Article 347, NEMA TC-2, and UL-651. Schedule 80 conduit shall be used where the conduit is exposed and may be subject to impact and abuse.

(2) Filament reinforced epoxy conduit (FRE) shall be specification grade and shall comply with Article 347.1 of the *NEC* and shall be UL listed.

(3) Polyethylene conduit (PE) shall be smooth wall duct of Type III, Grade 34, Class C, Category 5 High Density polyethylene (HDPE) in accordance with the latest edition of ASTM D 1248. The polyethylene conduit shall be manufactured in accordance with ASTM D 3035 and NEMA TC-7.

c. Cable in duct (CID) systems shall be factory assembled in smooth wall HDPE duct of the type specified above. Conductors shall be of the type, size, and number called for in the contract. All conductors shall be prelubricated before being inserted into the duct and the ends of the duct shall be sealed.

d. Fittings used with metallic conduit shall be of a compatible metal. Fittings and cement used with plastic conduit must be compatible with the conduit material.

e. Conduit sizes required are shown in the contract and shall be interpreted to mean the minimum "trade size" allowed for the application. The Contractor may, at his/her option and expense, substitute a larger size.

4. Breakaway Devices:

a. Breakaway devices shall conform to all current AASHTO requirements for energy absorption and structural design.

b. Breakaway devices shall be furnished complete with the necessary hardware to provide a complete installation.

c. Galvanizing requirements for steel breakaway devices shall be in accordance with ASTM A 123.

5. Conventional Light Poles [50 Feet or less (15.2 m) Mounting Height]:

a. Light poles, anchor bolts, and all accessory hardware shall be designed in accordance with the current *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. The shaft shall be a single section and shall have only one longitudinal, automatically and electrically welded joint. Shafts for poles of 45 foot (13.7 m) or 50 foot (15.2 m) mounting height may be two-piece if approved by the Engineer.

(1) The pole and mast arm assemblies shall be galvanized in accordance with ASTM A 123 or A 153, as applicable. All burrs, flash, and sharp edges inside the pole and mast arm assemblies shall be removed.

b. All poles shall have an identification number stamped into the top of the base plate or into a durable metal tag which is securely attached to the pole shaft. Letter height shall be 1/2 inch (13 mm). The identification number shall contain the pole length, the mast arm type and size, date of manufacture, and manufacturer's name.

c. Foundation Anchor Bolts

(1) Connecting bolts for use with power-installed foundations shall be carriage bolts supplied by the foundation manufacturer.

(2) The bolts shall be galvanized.

(3) All other anchor bolts are detailed in the contract.

d. Each pole shall be furnished complete with an approved grounding nut or lug. The grounding nut or lug shall be welded inside the shaft opposite the hand hole and accessible through the hand hole.

e. The Contractor shall furnish a certificate of compliance from the manufacturer stating that the poles and associated materials comply with the structural, wind loading, and galvanizing requirements as required.

6. High Mast Lighting Towers (Poles Over 50 Feet (15.2 m) in Mounting Height):

a. High mast towers, anchor bolts, and accessory hardware shall be designed in accordance with the current *AASHTO Standard Specifications for Structural Supports For Highway Signs, Luminaires and Traffic Signals*. The tower and light ring supports, brackets and locking mechanism shall be designed to support 12 fixtures. The light ring shall be designed to hold the number of fixtures shown in the contract for each particular tower.

(1) The high mast tower design drawings and computations must be signed and stamped by a registered Professional Engineer, licensed in Nebraska. The Contractor shall submit 2 sets of computations 30 days prior to installation.

(2) Acceptance by the Department of the high mast tower designs will be based upon this seal and signature. By applying the seal and signature to the design drawings and calculations, the Engineer affirms that the high mast towers are of proper design and materials to meet the structural requirements of the contract.

b. Unless stated otherwise in the contract, each new high mast tower shall be furnished complete with base plate, hand hole with cover, anchor bolts with nuts and washers, and lowering system with internal motor. All items must be compatible and work together to provide a reliable and efficient lighting unit. All new towers shall be galvanized.

c. (1) The tower shall be of sectional construction, either round or multi-sided polygon in cross section, and shall be fabricated of high strength, low alloy steel.

(i) Each individual tower section shall contain no more than 2 longitudinal welds and no transverse or circumferential splices, either mechanical or welded.

(ii) Towers shall be constructed with the fewest sections practicable. Towers shall consist of no more than 3 sections with the bottom section greater than or equal in length to the other sections.

(iii) Each tower section shall be galvanized after fabrication.

(iv) Each section shall be uniformly tapered and shall be joined by slip fit connections. The minimum overlap of the slip fit connections shall be 1 1/2 times the outside diameter of the male section.

(2) The tower shaft shall have a single access door providing access to the winch, cable, cable drums, and electrical components. The door opening shall have rounded corners and be reinforced to maintain the original strength of the tower. The door shall be mounted with a stainless steel loose joint butt hinge and a padlock hasp for securing. The hinge shall be heavy duty and of sufficient strength to support the weight of the hand hole door. The door shall be gasketed in a manner which will prevent the entry of water into the tower. The door shall be held closed with stainless steel cover hold downs, deep slot stainless steel screws or hex head stainless steel bolts. The hand hole shall be sized and so arranged to permit removal of the lowering mechanism without excessive dismantling of the equipment.

(3) The bottom tower section shall be furnished complete with two grounding nuts (lugs) welded inside at points 90 degrees and 270 degrees from the hand hole and readily accessible through the hand hole.

(4) The bottom tower section shall be provided with an integrally welded base plate using steel that meets or exceeds the specifications of the adjacent tower section.

(i) The bottom tower section shaft wall thickness shall be a minimum of 0.375 inches for towers less than 120 feet and 0.4375 inches for towers over 120 feet.

(ii) The tower base plate thickness shall be a minimum of the anchor bolt diameter plus 1/4 inch.

(iii) The tower base plate shall have drilled anchor bolt holes located outside the bottom tower section. A minimum distance of 3 1/2 inches is required between the outside of the lower tower shaft and the anchor bolt circle.

(iv) The clear distance between the bottom of the access door or reinforcement flange and the top of the tower base plate shall be no closer than 18 inches.

(v) The surface around each hole (both top and bottom) shall be milled flat and smooth to receive the anchor bolt nut and washer. The plate shall be attached to the shaft with 100% penetration circumferential welds.

(vi) The base plate shall be designed to be supported solely by nuts.

(5) The top of the tower shall be designed to support the head assembly of the lowering system. Drawings shall be provided with the tower which show assembly sequence, lift point and recommended erection procedure. Tower and lowering system shall be compatible. No field welding will be allowed in the assembly of the tower shaft or in attaching the head assembly to the top of the tower.

(6) All sections of the shaft shall be match marked to facilitate assembly and to ensure that each shaft is assembled with the proper tapered sections.

d. (1) The tower Contractor shall provide all required anchor bolts. Each anchor bolt shall be provided with seven (7) heavy hex nuts and two hardened steel flat washers.

(2) The minimum foundation anchorage design acceptable will be one detailing six 2 inch (50 mm) diameter anchor bolts of AASHTO M 314, Grade 55 Steel. The Contractor's actual design may require a greater number of anchor bolts, anchor bolts of larger diameter, or both. In all cases, all anchor bolts must meet AASHTO M 314, Grade 55 requirements.

(3) The Contractor shall furnish an extra anchor bolt (including one nut and one washer) from each heat of steel used on the project (or multiple projects) to the Department for destructive testing.

(4) Anchor bolts shall be straight rods threaded a minimum of 18 inches on the top end and a minimum of 6 inches on the bottom end. The threads of all anchor bolts must be rolled in accordance with standard industry practice. The use of cut threads will not be permitted. Galvanizing of the anchor bolts, heavy hex nuts, and flat washers will not be allowed. Prior to shipment, the top 12 inches (305 mm) of the anchor bolt together with its heavy hex nuts and hardened flat washers shall be cleaned and painted with zinc rich paint to a minimum dry film thickness of 4 mils (0.1 mm). The type of zinc rich paint and its method of application shall be approved by the Nebraska Department of Transportation, Materials and Research Division.

(5) The heavy hex nuts for the anchor bolts shall meet the requirements of ASTM A-563, Grade C3 or DH3.

(6) The plain hardened steel washers shall conform to the requirements of ASTM F 436 Type 3 or ASTM F 436M Type 3. If Type 3 plain hardened steel washers are not available for the specified bolt diameter, mechanically deposited zinc coated hardened steel washers conforming to the requirements of ASTM F 436 or ASTM F 436M shall be used. Only flat washers shall be used. Lock washers will not be allowed.

(7) The manufacturer of the anchor bolts and heavy hex nuts shall furnish certifications, Buy America Certification, and test reports covering the steel used in each application. The test reports shall show the following:

- (i) Chemical analysis of the steel used.
- (ii) Yield strength in pounds per square inch (MPa).
- (iii) Tensile strength in pounds per square inch (MPa).
- (iv) Percent elongation in 2 inches (50 mm) of material.
- (v) Percent reduction in area.

(8) The Contractor shall furnish and install steel anchor bolt containment and alignment templates as detailed in the contract.

(i) Anchor bolts shall be caged and retained with steel templates, conforming to the requirements of ASTM A 36/A 36M, and nuts to prevent their movements while the concrete footing is being poured.

(ii) Welding on anchor bolts will not be permitted.

(iii) The anchor bolt cage shall be centered in the concrete foundation.

(iv) Once the concrete has set, no adjustments or realignments shall be made to the anchor bolts. Field straightening of anchor bolts will not be allowed. The anchor bolts shall be truly vertical with no more than 1/8 inch deviation in 12 inches of length permitted.

(v) Anchor bolt projection above the base plate shall allow for the thickness of a hardened flat washer, and for the capture of two heavy hex nuts plus 1/2 inch, while allowing no more than two anchor bolt diameters between the top of the concrete foundation and the bottom of the base plate.

e. High Mast Lowering System

(1) (i) High mast lowering systems (head assembly, luminaire ring assembly, terminal block, cable drums, winch assembly, support cables, power cable and electrical components) acceptable for use on state projects will be listed on the Department's Approved Products List. Only a two-drum bottom tethered lowering system or a single-drum top latching system will be accepted. All towers on the same contract must be equipped with the same system.

(ii) The High Mast lowering system shall be a luminaire hoisting and lowering device consisting of galvanized or stainless steel head assembly, galvanized or stainless steel luminaire ring, winch drums and winch assembly, Internal Power Unit, luminaire ring hoist cables (if applicable), winch cables, power cable, circuit breakers, lightning rod and arrestors, power connections to the power unit assembly and a luminaire ring guide system to protect the tower and luminaire ring assembly during raising and lowering operations.

(iii) Luminaire ring hoist cables shall be a minimum 3/16 inch (4.8 mm) stainless steel aircraft cable of the non-twisting type with the three cable system having a safety factor of 5. The hoist cables shall be manufactured to meet the requirements of MIL-W834 20C.

(iv) The winch cable shall be a 1/4 inch (6.3 mm) stainless steel anti-rotational aircraft cable with a safety factor of 3. The winch cables shall be manufactured to meet the requirements of MIL-W834 20C.

(v) All electrical components of the lowering assembly shall be U.L. approved.

(vi) The lowering assembly shall be a system which has been in use for at least five years and proven itself to be a reliable and functional unit. All changes or design modifications to the system during this five-year period shall be noted by the manufacturer.

(vii) Any of the design changes considered by the lighting engineer to be critical to the proper operation of the lowering system, and which, in his opinion, have not been in use long enough to establish an acceptable service record, will be sufficient cause for rejection of the entire system.

(2) The lowering system shall comply with the current AASHTO *Standard Specifications for Structural Supports For Highway Signs, Luminaires and Traffic Signals*. The tower and light ring supports, brackets and locking mechanism shall be designed to support 12 fixtures. The light ring shall be designed to hold the number of fixtures shown in the contract for each particular tower.

(3) (i) The masthead assembly shall contain steel sheaves for the support of the hoisting cables and a roller assembly or a large diameter deep groove pulley on which the power cable will ride.

(ii) All sheaves shall be precisely sized and formed to fit the cables which they will carry. The cross-section of the groove shall have a radius of 0.005" to 0.009" (0.13 mm to 0.23 mm) greater than half the nominal cable diameter and a minimum radius of 6 inches (150 mm), as specified by the Wire Rope Technical Board. All sheaves shall have permanently lubricated bearings or oil impregnated bronze bushings mounted on stainless steel shafts.

(iii) Hoist Cable sheaves that are not completely enclosed and captured shall have retainers or keepers to prevent the cables from disengaging the sheaves under slack conditions. The power cable sheave, if provided, shall be a completely enclosed, 14 inch (350 mm) minimum operative diameter, deep groove cable pulley with a close-fitting cover which captures the power cable within the pulley.

(iv) The power cable roller assembly, if provided, shall consist of multiple rollers placed between two vertical side plates. The roller assembly shall be of such design as to support the power cord in a 7 inch (175 mm) minimum bending radius. Keeper bars shall be positioned along the assembly to keep the cord in its track during raising and lowering of the light ring.

(v) The masthead assembly shall include a galvanized steel or aluminum cover that will effectively protect the mechanism from the elements.

(4) (i) The luminaire ring assembly shall be fabricated of galvanized or stainless steel and shall contain the required number of 2 inch

(50 mm) diameter luminaire mounting arms. A weather tight junction box containing a pre-wired 600 volt terminal block shall be mounted to the ring. The junction box shall be provided with a twist-lock type receptacle capable of receiving the plug of the pigtail lead when testing the luminaries in the lowered position. Pre-wiring shall consist of Type "ST" distribution cable with the insulation suitable for at least 105 degrees Celsius and properly sized to power each luminaire. The terminal block shall contain a sufficient number of terminals to allow connecting all luminaries plus an approved lightning arrester. The power cord shall be Type "G" or "type SEOOW" with five #8 133-strand copper conductors. Strain relief shall be provided at both ends of the power cable by using properly sized cable clamps. The use of Kellem-type grips alone will not be allowed. The power cable shall be MSHA approved.

(ii) All power cord connections shall be made using weather tight, twist-lock type plugs, connector bodies and receptacles. Connector bodies shall be as small as possible in physical size to prevent hang up inside the tower.

(iii) Two 240 volt, 30 amp double pole circuit breakers shall be furnished in the base of each tower. Two 240 volt circuits will be run to each tower. Connect half the luminaries to each circuit in a manner that will provide an alternate feed to the luminaries.

(5) The latch barrels, for a top latching system, shall be cast, high strength, and copper-free aluminum. Latching shall be accomplished by the alternate raising and lowering of the luminaire ring assembly using the winch and hoisting assembly. There shall be no moving latch parts or springs attached to the head frame assembly. The latch mechanism shall not be impaired by the formation of ice and shall not require adjustment after the original installation. Indicator flags shall be used to show if the luminaire support ring is in a latched or unlatched position.

(6) (i) The winch assembly shall consist of worm gear speed reducer with either one or two output shafts with cable drum attached. The winch shall be securely anchored and capable of supporting five (5) times the maximum lifted load. The winch shall include an integral drag brake to prevent unwinding, slipping or free-spooling of the winch cable. The drums shall be provided with keepers to ensure that the cable will properly wrap onto the drum. The winch, when powered by the Internal Power Unit, shall raise the luminaire ring at a minimum rate of 12 ft/min.

(ii) Single drum units will require the use of a transition device (clevis assembly) to properly attach the winch cable to the hoisting cables. The clevis shall not allow either the winch cable or any of the hoist cables to independently rotate. No bearings of any type will be allowed in the clevis. The clevis shall be beveled or tapered on the bottom of the plate to ensure that the transition device will not hang up on the inside of the tower.

(7) (i) Means shall be provided to accurately position, stabilize and hold the luminaire ring in place when in the raised position.

(ii) The luminaire ring shall be held in its raised position by either a top-latching or bottom tethered system. If a top-latching system is supplied, each latch must be capable of supporting three (3) times the weight of the luminaire ring with its full complement of luminaires attached.

Rotation of the luminaire ring to achieve positive latching with this system will not be allowed.

(iii) With the bottom tethered system, compression springs shall keep the luminaire ring assembly securely in place against the masthead while the load of the luminaire ring assembly is transferred from the winch assembly to chain or turnbuckle tension latches at the bottom of the tower.

(iv) Latching or unlatching with either system shall impart no more than one "G" acceleration in any direction on the luminaires and lamps.

(8) An Internal Power Unit shall be supplied with each lowering system supplied under this contract. The power unit shall be a heavy duty, reversing gear, single-phase motor, rated 1.8 peak HP or greater. The motor shall be operated by a push-button or lever control mounted at the end of a 20 ft. (min.) Type "SO" power cord.

(9) The pigtail lead used to power the lowered light ring and internal motor when servicing shall be a minimum of 12 ft. in length. The female pigtail end shall be supplied with a weather-tight rubber cap. The cap shall protect the pigtail end when not in use and stored in the tower base. The rubber cap shall be loosely attached to the pigtail lead with a cord or other restraint to prevent its becoming lost.

(10) Centering Arms or a rubber bumper ring shall be mounted to the inside of the luminaire ring to protect the tower, luminaire ring and luminaires from damage during raising and lowering. If Centering Arms are employed, they must be interconnected or of a design that precludes any possibility of the tower shaft slipping behind the arms and causing a "hang-up."

(11)(i) The manufacturer shall supply all drawings, installation instructions, maintenance manuals and technical information required for the proper installation and maintenance of a complete operating assembly.

(ii) The entire assembly shall meet all applicable local, county, state and national codes.

(12) The manufacturer shall guarantee all equipment from failure due to defects in material or workmanship for two (2) full years from date of shipment and shall warrant to repair or replace any equipment that fails within that time. In addition, the manufacturer shall provide a "Pass-Through Warranty" for use by the Electrical Contractor or Utility assigned by the State as maintaining authority ("Pass-Through Warranty" means that the manufacturer, manufacturer's representative and distributor shall accept defective warranted material directly from the State's appointed maintainer, on behalf of the State without State personnel having to coordinate the return).

7. Roadway Lighting Luminaires: (Conventional and High Mast):

a. Roadway lighting luminaires and lamps acceptable for use on State projects will be shown in the contract.

b. Luminaire type, wattage, and ballast ratings shall be as shown in the contract.

- c. Luminaires shall be supplied with lamps.
- d. Luminaires must meet the design parameters shown in the contract.

8. Lighting Control Center :

a. The lighting control center and components shall conform to the requirements shown in the contract.

9. Photoelectric Control:

a. Photoelectric controls shall conform to the requirements shown in the contract.

10. Roadway and Sign Lighting Structures:

a. All roadway and sign lighting structures requiring galvanizing shall be galvanized in compliance with ASTM A 123 after fabrication and welding has been completed.

b. All hardware shall be galvanized in compliance with ASTM A 153.

11. Sign Lighting Luminaires:

a. Sign lighting luminaires and lamps acceptable for use on State projects will be listed on the Department's Approved Products List.

b. Luminaire, ballast, lamp dimensions, and ratings shall be as described in the contract.

c. The luminaire shall be furnished completely assembled and ready for mounting, connecting, and lamp installation.

d. Luminaires shall be U.L. labeled and listed as "Suitable for Wet Locations."

12. Electrical Items: All electrical items for roadway and sign lighting, such as wire, circuit breakers, relays, conduit, cable, mounting hardware, wood poles, pipe clamps, and related electrical material, shall conform to the appropriate *National Electric Code* requirements.

13. Traffic Signal Cable:

a. The traffic signal cable shall be as shown in the contract and shall comply in all respects with the IMSA specification as follows:

Specification Reference	Use
19-1 or 20-1	General Use
19-3 or 20-3	Aerial Cable
19-5 or 20-5	Direct Burial Cable

b. (1) Acceptable alternatives to the above cable may be furnished providing the specific cable has been approved in writing by the office of the Department Traffic Engineer before its installation.

(2) IMSA conductor color coding shall be used and will be provided by the use of base colored insulation.

(3) This coloring shall penetrate the full thickness of all the conductor insulation.

(4) "Color" coding by the use of words or numerals printed on the insulation will not be accepted.

14. Electrical Wire and Cable:

a. Conductors and cables used for the electrical service shall conform to the applicable portions of Articles 230, 310, and 338 of the *National Electrical Code (NEC)* as well as to the requirements of the contract, and shall bear the U-L label.

b. The word "wire," when used in conjunction with roadway lighting, sign lighting, and traffic signals, shall be taken to mean a single electrical conductor, either bare or insulated.

c. The word "cable," when used in conjunction with roadway lighting, sign lighting, and traffic signals, shall be taken to mean single electrical conductors, insulated from each other but laid up together by being twisted around a central core.

d. The word "conductor," when used in conjunction with roadway lighting, sign lighting, and traffic signals, shall be taken to mean either a single conductor (wire) or assembly of individual conductors (cable) capable of transmitting electricity.

15. Aerial Cable:

Aerial cable (ACSR) shall meet or exceed the applicable sections of the following specifications:

a. ASTM B-232 Aluminum Conductors, Concentric-Lay-Stranded, Coated Steel Reinforced (ACSR)

b. ANSI/CEA S-76-474

16. Detector Lead-in Cable:

The detector lead-in cable shall be polyethylene insulated, polyethylene jacketed cable conforming to the latest edition of IMSA Specification No. 50-2.

17. Loop Detector Wire:

The loop detector wire shall be stranded, insulated wire rated at 600 volts for use in an inductance loop detector or as a lead-in wire. The wire shall comply with IMSA Specification 51-5.

18. Traffic Signals:

a. Traffic signals shall be designed in die cast aluminum or polycarbonate sections. All sections shall be interchangeable and fit so they can be combined in a tier.

b. The mounting device, lens indications, and other modifications shall be as shown in the contract.

c. The reflector shall be parabolic in design.

d. Other parts of the optical system, including the lens lamp socket, reflector, and reflector holder, shall be designed as a whole system so as to eliminate the return of outside light rays which enter the unit.

e. All parts of the vehicle signals shall be in compliance with the ITE Standard "Vehicle Traffic Control Signal Heads" Part 1 and Part 2, and

all parts of the pedestrian signals shall be in compliance with the ITE Standard "Pedestrian Traffic Control Signal Indications".

f. (1) The body, doors, visors, and backplates of the signals and all mounting accessories shall be colored flat black.

(2) Die cast aluminum sections shall be given 1 prime coat of metal primer and 2 coats of high quality flat black enamel.

(3) Dipping will not be allowed for any part of the enameling process

(4) The color shall be completely impregnated in polycarbonate material, and scratches shall not expose uncolored material.

g. Visors shall be attached with attaching screws and designed in a manner such that the visor may be easily installed or removed from the signal head.

h. A terminal block shall be mounted in the back of the second section of the signal head. The terminal block for a standard 3-section face shall be a 4-position, 8-terminal, barrier-type strip.

i. Hardware hinges shall be enclosed and have solid non-corrosive metallic hinge pins. Doors shall be secured against gaskets with wing nut clamps.

j. All signals at each intersection shall be from one manufacturer unless otherwise approved by the Engineer.

19. Vehicle Signals:

a. All lenses for incandescent signal lamps shall be prismatic and long range. The lenses shall have a nominal diameter of 8 inch (200 mm) or 12 inch (300 mm) as indicated in the contract. All lenses shall be made of glass meeting the light transitivity and chromaticity standards established by ITE Standard "Vehicle Traffic Control Signal Heads", Part 1 and Part 2.

b. Each signal lens, with the exception of lenses for optically programmed sections, shall have a visor of a type normally described as a tunnel visor which encloses 75% of the lens circumference for the entire length of the visor.

c. Cutaway type visors shall be provided for each lens of optically programmed sections.

d. Vehicle signal heads shall be equipped with a one-piece, vacuum formed backplate. The backplate shall provide a black field border, 5 inches (125 mm) wide, around the assembly. Backplates are not required on single section heads, on 3 or 4 way heads, or on pole mounted heads.

e. Vacuum formed backplates are not required for signal heads with T51A, T51B, T52A, and T52B signal faces.

f. All vehicle signal indications, except optically programmed signal heads, shall be of the LED type, unless noted otherwise in the contract.

g. All LED signals shall be limited to those on the Department's Approved Products List.

20. Pedestrian Signals:

a. Pedestrian signals shall be a single section housing with a 12" (300 mm) high rectangular lens, with sun visor and mounting hardware.

b. The lens shall be made of vandal-resistant, polycarbonate or acrylic plastic.

c. The "DON'T WALK" symbol shall be displayed on the left side of the lens, and the "WALK" symbol on the right side of the lens.

d. The "DON'T WALK" symbol shall be orange and the "WALK" symbol shall be white. The background or field around the symbols shall be black. The "WALK" and "DON'T WALK" symbols shall conform to the MUTCD.

e. All pedestrian indications shall be of the LED type, unless noted otherwise in the contract.

f. All LED signals shall be limited to those on the Department's Approved Products List.

21. Optically Programmed Traffic Signal:

Optically programmed traffic signals shall be limited to those on the Department's Approved Products List.

22. Traffic Signal Lamps:

The traffic signal lamps shall be clear and operate at 120 volts with an 8000 hour minimum rated life. All lamps shall have brass bases. All lamps shall be 150 watt for the 12 inch (300 mm) signal sections and 116 watt for the 8 inch (200 mm) signal sections. All lamps for pedestrian signal heads shall be 116 watt.

23. Traffic Signal Controllers and Cabinets:

a. Traffic Signal Controllers shall be either solid state pre-timed, NEMA vehicle actuated, or Type 170/2070 as indicated in the contract.

b. Solid state pre-timed controllers shall comply with all applicable sections of NEMA specification TS-1, including environmental and design standards. The controllers shall fulfill all functional requirements of electro-mechanical pre-timed controllers with the following additional features:

- (1) 4 cycles.
- (2) 3 offsets per cycle.
- (3) 3 splits per cycle.
- (4) 24 intervals per split.
- (5) 24 signal circuits, minimum.
- (6) 4 signal plans.
- (7) 3 preemption sequences.
- (8) 2 detector inputs minimum.

c. All interval timing shall be operator settable from the front panel of the unit. A conflict monitor shall be provided, either internal to the timer unit or shelf mounted. The controller cabinet shall be furnished with the number of load switches required to provide the sequence shown in the

contract, but shall be capable of expansion to 24 signal circuits by the insertion of additional load switches.

d. Type 170 traffic signal controllers shall comply with FHWA Publication IP-78-16 except for the system memory module. The system memory module shall be a model 412B2 with one 256k, 200 ns, Nonvolatile SRAM.

e. Type 2070 traffic signal controllers shall comply with the State of California Department of Transportation, Transportation Electrical Equipment Specifications (TEES) dated November 19, 1999 and all addendum publications to present date. The 2070 shall include one each of the following modules:

- (1) Model 2070-1B One Board CPU with removable
data key and OS-9 operating
system loaded
- (2) Model 2070-2A Field I/O for 170 Cabinet
- (3) Model 2070-3B Front Panel-Display B (8x40)
- (4) Model 2070-4 Power Supply
- (5) Model 2070-7A Serial Communications

This configuration is often referred to as a 2070L.

f. Cabinets for Type 170/2070 traffic signal controllers shall comply with FHWA Publication IP-78-16 with the following exceptions:

- (1) The standard gas tube arrestor shall not be used in the cabinet.
- (2) A 120 VAC, 60 amp Radio Interference Suppressor (RIS) shall be furnished between the service terminal block and the main circuit breaker. The RIS shall provide 50 decibel minimum attenuation over a frequency range of 200 kHz to 75 MHz. Two 130 VRMS MOV, having a transient energy dissipation of a minimum of 37 ft-lb (50j), shall be furnished between the load terminal and ground and between the neutral terminal and ground.
- (3) The Power Distribution Assembly shall be a PDA-2.
- (4) The AC Power to the controller receptacle, to the 24 Volt Power Supply, to the I/O files, and to the conflict monitor unit, shall be protected with an EDCO SHA1210 Series Parallel Protection Device, or approved equal. The device shall be located in the PDA-2 assembly.
- (5) Enclosure shall be unpainted aluminum.
- (6) Flash programming plugs shall be furnished for all vehicle phases.
- (7) Door locks shall be number two Corbin locks.
- (8) The conflict monitor unit shall be a Model 210, with one second delay on the Watchdog Timer, and a start-up timer compatible with 2070 controller boot-up.
- (9) The cabinets shall be furnished with a full complement of Flash Relays and Model 240 Flashers.
- (10) The cabinets shall have a ventilation fan baffle.

g. NEMA vehicle actuated controllers shall comply with NEMA Standards Publication TS-1 with the following exceptions: Controllers shall be furnished in 4-phase and 8-phase chassis only. If the controller is phase modular, the unit shall be furnished with a full complement of phase modules. Conflict monitors for 4-phase controllers shall be 6 channel. Monitors for 8-phase controllers shall be 12 channel. Cabinets shall be wired for the maximum number of phases plus 2 overlap phases, but shall be furnished with only those load switches required to provide the sequence shown in the contract.

h. The controller and all auxiliary equipment shall be housed in a weatherproof cabinet. The cabinet shall be of sufficient size to encase all control equipment and shall conform to the contract and the following requirements:

(1) The cabinet size shall be as stated in the contract. The manufacturer shall insure that not more than 60% of the internal cabinet volume is occupied by the required traffic control equipment.

(2) The cabinet shall be fabricated of high-grade aluminum alloy, sheet aluminum alloy, or rust-resistant copper bearing sheet steel.

(3) Cabinets shall be primed and finished with 2 coats of resin base paint. The finishing coats of paint shall be aluminum or silver in color unless otherwise specified. Brushed aluminum cabinets need not be painted.

(4) The cabinet shall contain a minimum of 2 metal shelves securely fastened to the side walls. The height and position of the shelves shall be easily changed or removed and replaced.

(5) The cabinet shall employ a roof design that extends over the main door.

(6) The main door of the cabinet shall substantially cover the full area of the front of the cabinet. This door shall be right hand hinged and allow complete access to the cabinet interior. A weatherproof and dustproof seal shall be provided between the door and cabinet using neoprene sponge or other approved gasket material.

(7) A door stop shall be provided for base mounted cabinets, which securely holds the door at open positions of 90 and 135 degrees.

(8) The door hinge pins shall be made of stainless steel.

(9) A hinged auxiliary door of weatherproof design shall be provided on the front of the main door and shall be secured with a standard police lock furnished with 2 keys. The door shall house the switches described in the electrical design portion of this cabinet specification.

(10) All cabinets shall be secured using a Corbin No. 2 lock, or approved equal, and shall be provided with 2 keys.

(11) Pad mounted cabinets shall be provided with a 3-point door latch mechanism with a handle in addition to the Corbin No. 2 lock, or approved equal. This handle shall be designed to accept a padlock.

i. (1) A thermostatically controlled, ducted fan unit with a minimum rating of 100 ft³/min (2.83 m³/min) in free air shall be installed in the cabinet to provide forced air ventilation through the cabinet. The fan unit shall be mounted to the inside top of the cabinet and shall be easily removed

and replaced without having to dismantle any part of the cabinet or exhaust duct system.

(2) The fan shall intake air through filtered vents located near the bottom of the cabinet or cabinet door and exhausts it through a screened duct located near the top of the cabinet. Fiberglass type dry filters shall be used to cover the cabinet's air intakes. These filters shall be easily removed and replaced and be of standard dimensions commercially available.

j. A heavy-duty clear plastic envelope, securely attached to the inside wall of the cabinet or cabinet door, shall be provided for stowing the cabinet electrical prints. Minimum dimensions shall be 7 inches (175 mm) wide x 7/16 inch (11 mm) deep.

k. The cabinets shall be furnished with all of the hardware necessary for assembly and installation. The hardware shall include anchor bolts, anchor bolt template, pole mounting attachments, and all nuts, bolts, and washers necessary to assemble and install the cabinet as specified in the contract.

l. (1) The controller and all auxiliary equipment housed within the cabinet shall be designed to operate from 117 VAC 60 Hertz, single-phase, alternating current supply. Distribution of the 117 VAC throughout the cabinet shall not occur until the AC power has first passed through the power protection devices specified herein.

(2) The power protection devices shall include the main AC power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment housed within the cabinet. The protection devices shall be mounted to a panel that is securely fastened to an interior wall of the cabinet.

(3) The AC power field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 117 VAC operations with a minimum rating of 50 amperes. It shall be equipped with a solder less connector suitable for terminating 6 gauge [0.184 inch (4.67 mm)] in diameter AWG wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

(4) Radio interference suppressors (RIS), adequate in number to handle the power requirements for the cabinet, shall be wired in series with and after the main AC power circuit breaker. The RIS shall be designed to minimize interference in all broadcast, transmission, and aircraft frequency bands.

m. As a minimum requirement, the lightning and voltage surge protectors shall be a combination of gas-type thyristors rated for 350 volts operation and metal oxide varistors rated for 150 volts. The combination shall be wired in advance of the main circuit breaker and shall provide a direct path to ground. Additional protection shall be provided on all loop detector input terminals.

n. (1) All cabinet wiring shall be neatly trained throughout the cabinet and attached to the interior panels using non-conductive clamps or tie-wraps. Bundles of cables shall be laced or tied every 4 inches (100 mm) or enclosed in a sheathing material. The cabinet wiring shall not interfere

with the entrance, training, or connection of the incoming or outgoing field conductors.

(2) Except where terminated by direct soldering, all wires shall be provided with terminal lugs for attachment to terminal blocks using screws. All wires shall be identified and labeled in accordance with the cabinet wiring prints.

(3) All wire insulation shall have a minimum rating of 600 volts.

o. The outgoing signal indication conductors shall be of the same polarity as the line (+) side of the AC field service to the cabinet. The incoming signal indication conductors shall be common and of the same polarity as the neutral (-) side of the AC field service. The neutral (-) side of the AC field shall be connected to the cabinet in an approved manner, usually to the copper ground bus. The cabinet shall, in turn, be connected to an earth ground through a ground rod.

p. The flashing operating switch shall control the power and flash transfer relays. It shall be labeled "AUTO-FLASH". In the "AUTO" position, normal controller operation prevails. When placed in the "FLASH" position, AC power is transferred from the load switches to the solid state flasher which, in turn, flashes the signal indications as specified. The vehicle detectors shall remain operational, but the AC power to the controller is interrupted.

q. The signal indication switch shall control AC power for the signal indications and shall not affect normal controller cycling. This switch shall be either a multipole toggle switch bussed together to obtain the required load rating or a circuit breaker. The minimum rating for the switch shall be 30 amperes and shall be labeled "SIGNALS-ON-OFF".

r. On the inside of the main door and accessible only when the main door is open shall be mounted a maintenance panel containing the test switches defined herein:

(1) The controller test switch shall allow the controller to be turned on for test purposes when the "AUTO-FLASH" switch on the Police Panel has been placed in the "FLASH" position. The switch shall be labeled "CONTROLLER", "TEST", "NORMAL".

(2) Detector test switches shall be used to manually place calls into the controller during actuated operation. These switches, one for each vehicle and pedestrian phase, shall be in parallel with the vehicle detector relay closure and pedestrian pushbutton circuits.

(3) A 3-wire ground fault type receptacle shall be provided and be easily accessible. This receptacle and the incandescent lamp shall be separately fused from and wired in advance of the main AC power circuit breaker.

(4) This assembly shall contain electromechanical relays used to transfer AC power and operation from the controller and load switches to the solid state flasher. This transfer relay assembly shall be controlled by either the "AUTO-FLASH" mode switch located on the Police Panel or the conflict monitor. The flasher shall remain operational with the controller removed from the cabinet.

(5) The cabinet shall be wired to flash amber for the main street and red for the cross streets. The red-yellow-flash indications shall be easily changed.

(6) The plug-in transfer relays shall be rated at a minimum of 20 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.

s. The cabinet shall be furnished with an incandescent lamp mounted near the top of the cabinet interior. This lamp shall be controlled by either a manual switch mounted on the maintenance panel or by the main door using a pushbutton, refrigerator-type switch.

t. The cabinet fan (solid state controller only) shall be separately fused and wired after the main AC power circuit breaker.

u. (1) Molded composition barrier type terminal blocks shall be used for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be one-piece construction with a minimum of 12 terminals. Each terminal shall have a threaded contact plate with a binderhead screw. The terminal blocks shall have minimum rating of 600 volts.

(2) All terminals shall be identified and labeled in accordance with the cabinet wiring diagram.

(3) The terminal block facilities shall be arranged in functional groupings and mounted to either panels or brackets fastened to the interior walls of the cabinet. Each terminal block shall be retained using either machine or self-tapping screws and shall be easily removed and replaced.

v. Outgoing signal conductor terminals shall be provided for the vehicle and pedestrian signal circuits for each phase. The terminal blocks shall be of the barrier type using 6 gauge [0.184 inch (4.67 mm)] in diameter or larger binderhead screws. These terminal blocks shall be located near the bottom of the cabinet, a minimum of 6 inches (150 mm) above the bottom surface for base mounted cabinets and 2 inches (50 mm) for pole mounted cabinets. A minimum number of 2 additional terminal blocks shall be provided for future expanded operation.

w. Controller input/output circuit terminals shall be provided and connected for all of the controller input and output circuits including those circuits which are not to be used on the project. The terminal blocks shall utilize 6 gauge [0.184 inch (4.67 mm)] in diameter or larger binderhead screws.

x. (1) A special panel shall be provided with terminal blocks for terminating all circuitry associated with vehicle detectors and pedestrian pushbuttons. These circuits shall be wired to their respective termination points within the cabinet and shall be operational. The terminal blocks shall use binderhead screws.

(2) Terminals shall be provided for each vehicle detector including AC neutral, relay common, relay closure, and the loops or probes from the field. Solid state lightning protection devices shall be provided for each loop input from the field. A minimum number of 2 additional terminal blocks shall be provided for future expanded detection.

(3) Terminals shall be provided for each pedestrian pushbutton circuit from the field.

y. Unfused terminals shall be provided for the neutral side of the AC field service and all common conductors within the cabinet assembly. This terminal strip shall be made of copper and use 6 gauge [0.184 inch (4.67 mm)] in diameter or larger screws. The ground bus shall be located on the panel with the main AC power circuit breaker and provide a minimum of 18 terminals.

z. The cabinet shall be wired for the maximum operation of the control unit including overlap and pedestrian phases. It shall only be necessary to add plug-in cabinet accessories (i.e., load switches, flash transfer relays, etc.) to obtain future operation.

aa. All load switches shall conform to the triple-signal solid state type load switch as specified in the NEMA Standard Publication No. TS-1. Dual-signal type load switches shall not be allowed.

24. Vehicle Detector Amplifier:

a. Integrated circuits and/or discrete semiconductor devices and resistors, capacitors, transformers, etc. shall be used throughout the detector amplifier instead of vacuum or gaseous tubes and electromechanical devices except for the indicator lights and detector amplifier output relay. Logic design shall be such as to insure maximum noise immunity.

b. All solid state components shall be amply derated with respect to heat dissipating capacity and rated voltage. Shortening of component life or shift in values shall not occur at maximum operating temperature and voltage. The design life under continuous duty operation shall not be less than 5 years.

c. (1) All solid state components shall be individually replaceable and shall be readily available from any industrial electronics supply house.

(2) The solid state components used in the design of the amplifier shall be mounted on printed circuit (PC) boards. The PC boards shall be fabricated from glass-epoxy laminate, NEMA grade G-10, with a minimum thickness of 1/16 inch (1.5 mm). Intercomponent circuit traces shall be copper track, with a minimum weight of 2 oz/ft² (605 g/m²) and shall be of adequate cross-sectional area to carry the designed current. All holes in the PC board utilizing intercomponent circuit traces on 2 sides shall be plated through.

(3) All solid state components mounted and soldered to the PC board shall be easily removed and replaced without causing damage to the board or tracks.

(4) All solid state components contained on the PC board shall either have their circuit reference symbol clearly marked on the board or be easily identifiable by referring to pictorial assembly drawings.

(5) The vehicle detector amplifier defined in these Specifications shall maintain normal operation over all combinations of temperature and voltage ranging from 105 to 136 VAC and -30°F to +165°F (-34°C to +74°C) ambient. The use of auxiliary heating and cooling devices

which would reduce the operational temperature range in order to achieve satisfactory performance shall not be allowed.

(6) The amplifier shall have a light for each detection channel to indicate vehicle detection. All indicator lights shall have a minimum design life of 20,000 hours at rated voltage and shall be easily replaceable. All indicator lights, when illuminated, shall be visible in bright sunlight.

(7) All tuning and/or sensitivity adjustment shall be made from the front of the enclosure without the use of tools. The connector and the tuning and detection indicators shall be mounted on the front of the enclosure.

(8) Service personnel shall have complete access to any part of the detector amplifier assembly for test and/or maintenance without affecting the warranty.

25. Loop, Vehicle Detector Amplifiers:

a. Loop, vehicle detector, amplifiers shall be of Type 170 or NEMA shelf mounted type as required by the controller with which it will be used.

b. Type 170 loop amplifiers shall be model 222 and shall comply in all respects with FHWA publication IP-78-16.

c. NEMA Type loop amplifiers shall conform to the following requirements:

(1) Sensitivity shall be selective for a minimum of 3 positions in regular increments.

(2) All electrical connections and adjustments shall be made on the front panel without the use of special tools. Connection shall be made using an MS 3102 A18-1P connector.

(3) No burn-in or warm up time shall be required before the detector amplifier is fully operational.

(4) The loop detector amplifier shall operate properly despite resistive leakage or total grounding of the loop.

(5) Loop detector amplifiers with more than one detection channel shall have lightning protection on each channel separately with complete immunity to crosstalk between channels. Each detection channel shall be electrically connected through a separate MS 3102 A18-1P connector. Mode of operation and sensitivity adjustments shall be independent between channels. Multiple channel detection amplifiers shall also comply with all other conditions of these Specifications.

(6) The loop detector amplifier shall provide a minimum of 2 modes of operation. The pulse or presence mode shall be switch selective on the front panel.

(7) The loop detector amplifier shall produce an output pulse of 100 milliseconds duration for each vehicle entering the detection zone. Any vehicle stopped on the loop for 2 seconds or more shall be automatically tuned into the resonant circuit so that any unused portion of the loop may detect passing vehicles.

(8) The unit shall provide a detection output for as long as the vehicle remains in the detection area or for at least 10 minutes after which it shall be incorporated in the background inductance so that any unused portion of the loop may detect passing vehicles.

(9) The loop detection amplifier shall employ a digital self-tuning system which is activated automatically with each application of power. That is, it shall self-tune during the process of connecting the mating connector and immediately following any power failure. The unit shall automatically return to the correct tuning level after a vehicle which has been incorporated into the background inductance moves away. Automatic and continuous fine tuning shall be featured to correct for the environmental drift of the loop impedance.

(10) The output relay shall be a failsafe relay (SPDT) with a contact rating of at least one ampere at 117 VAC. If specifically stated, the output shall be failsafe solid state switch, zener protected for 40VDC at 0.25 amp.

(11) Each vehicle detector amplifier shall be enclosed in a sheet aluminum case with a durable protective finish. This enclosure shall be easily removed allowing convenient access to the solid state circuitry. All electrical connections to the device shall be made using type MS multipin threaded shell connectors. The mating MS plug receptacle shall be attached to one end of a connecting cable at least 30 inches (750 mm) long.

26. Magnetic Vehicle Detector Amplifiers, Type 170:

a. Magnetic vehicle detector amplifiers shall be either a Type 170 card rack mounted or NEMA shelf mounted as required by the type of controller with which they are to be used.

b. Type 170 magnetic detector amplifiers shall be model 232 and shall comply with FHWA publication IP-78-16.

c. Magnetic amplifiers for use with NEMA controllers shall conform to the following requirements:

(1) Detection is achieved by monitoring the earth's magnetic field. The earth's magnetic field is momentarily disturbed where a vehicle passes within close proximity of the detector. This disturbance will induce a signal voltage in the coil which is applied to the amplifier input.

(2) The unit shall be designed to provide amplification of the signals produced by all vehicles ranging in size from a motorcycle to a tractor-trailer traveling at speeds of 5 MPH (8 km/h) or greater over the magnetic detector.

(3) The unit shall be designed to operate satisfactorily with the magnetic detector supplied.

(4) The amplifier shall be provided with an indicator light that is visible from the front of the case and will light momentarily to indicate an actuation. It shall be provided with a knob on the front of the case for adjusting the degree of amplification of the electrical energy from the detector. On the front of the unit adjacent to the adjustment dial and MS connector, there shall be mounted 2 test jacks labeled J101 and J102 for the purpose of checking the proper adjustment of the sensitivity knob.

(5) The registration of overlapping impulses from 2 detector relay units shall be ensured by the use of normally open and normally closed contacts provided on the output relay. Any contact that opens or closes in response to vehicle actuations shall be capable of making, breaking, and carrying 3 amperes at 120 Volts AC.

(6) The amplifier circuits shall be designed using semiconductor devices and shall operate with maximum stability and reliability under conditions of line voltage fluctuation up to 5%. Circuits employing printed circuits shall be of the highest quality with extra-heavy [2 oz/ft² (605 g/m²) or better] copper.

(7) The amplifier shall be designed for operation at 120 volts, 60 cycle, single phase. Maximum power consumption shall not exceed 5 watts and shall be suitably enclosed in a durable, protective case. It shall be supplied for plug connection.

(8) All circuits shall be designed to provide stable operation within an ambient temperature range of -30°F to +180°F (-34°C to +82°C).

(9) (i) The unit shall be housed in a durably finished fabricated sheet aluminum case.

(ii) Removal of the unit from its case shall require the use of simple tools. The removal of 2 screws shall allow access to the printed circuit panel and components.

(iii) Electrical connections of both the incoming and outgoing circuits shall be made by means of an 8 terminal MS type plug. The unit shall be replaceable with a similar unit without the necessity of disconnecting or reconnecting individual wires leading from the unit. The type MS plug shall be a protected male plug and shall be rigidly fixed to the front of the unit.

(iv) The mating MS plug receptacle shall be attached to one end of the connecting cable and be at least 2 feet (600 mm) long. The other end of the connecting cable shall have tagged leads, each of which shall be fitted with a spade type lug for easy attachment to the terminal blocks.

27. Vehicle Detector-Magnetic, Type TD-3:

a. This Specification defines the minimum detailed requirements applicable to the magnetic vehicle detector. The detector will operate on the principal that all vehicles create their own magnetic fields as they move through the earth's magnetic field. This causes an induced voltage in the coil of the detector. The voltage is amplified by a device and actuates a relay to operate the controller.

b. Operational Features:

(1) The magnetic detector shall be designed for installation in or near the roadway, capable of being actuated by the magnetic or electrical disturbance caused by the passage of a vehicle.

(2) The operation of the detector shall not be affected by parked cars or other stationary metallic objects in or upon the roadway.

(3) The detector, when used with the proper amplifying device, shall be capable of actuation by any vehicle passing the detector at the distance and speeds indicated below:

(i) At a speed of 12 MPH to 80 MPH (20 km/h to 130 km/h)--within 15 feet (4.6 m) of the detector.

(ii) At a speed of 7 MPH to 80 MPH (12 km/h to 130 km/h)--within 10 feet (3 m) of the detector.

(iii) At a speed of 3 MPH to 80 MPH (5 km/h to 130 km/h)--within 5 feet (1.5 m) of the detector.

c. Mechanical Requirements:

(1) The detector shall have sufficient mechanical strength to withstand normal handling and the transmitted shock of vehicular loads when installed in accordance with the manufacturer's instructions.

(2) The detector shall have a moisture-proof housing designed for underground operation. The detector's operation shall not be affected by temperature, humidity, or soil conditions.

(3) The detector shall be provided with means for making a waterproof connection to the cable or closed conduit system and shall be provided with insulated leads at least 50 feet (15 m) long.

(4) The detector shall be designed for use with one or more types of devices for amplifying, rectifying, or otherwise intensifying the electrical energy produced by the detector.

28. Pedestrian Pushbuttons:

a. Pedestrian pushbuttons shall be of the type and style specifically intended for the application shown in the contract. They shall be housed in a durable casting and be weather tight. The button and mechanism shall be of sufficient size and rugged design to withstand some abuse and discourage vandalism. The internal switching device shall be closed by physical contact with the button.

b. Signs shall be provided for mounting directly above the pedestrian pushbuttons indicating which pedestrian signal is associated with that particular button. These signs shall be of the size, type, and style specifically intended for that purpose and shall be provided by the manufacturer of the pedestrian pushbuttons. Each sign shall include an arrow to indicate the direction of the crossing to which the button applies.

29. Hardware:

a. All ferrous bolts, nuts, clamps, miscellaneous hardware, and fittings shall be galvanized according to ASTM A 153.

b. All other material or fittings necessary to complete the work shall be approved by the Engineer.

c. Saw cuts and holes made in the roadway for installation of vehicle detectors shall be sealed with a sealant that is on the Department's Approved Products List.

d. Chemical and physical properties of sealants are similar, but the potting and hardening time varies with temperature and composition of the particular mix. The Contractor shall assume responsibility for the type of

sealant used on a particular project under the prevailing environmental conditions.

e. Approval of other sealants will be determined from the manufacturer's technical information and actual samples taken and tested by the Department before installation.

30. Traffic Signal Poles:

a. This Specification shall be intended as the minimum requirements for furnishing mast arm and span wire signal poles of various sizes with and without lighting. Each signal pole supplied for installation shall conform to the contract and these Specifications.

b. (1) Each pole shaft, luminaire extension, luminaire mast arm, and signal mast arm shall be formed of proper steel to a tapered shaft and shall have only one longitudinal automatic electric weld. Each steel shaft shall be treated after forming and welding to flatten the weld.

(2) Each pole shaft, luminaire extension, signal arm, and luminaire arm shall be furnished with all miscellaneous hardware necessary to complete the signal pole assembly. Miscellaneous hardware shall include pole caps, hand hole covers, anchor bolt covers, anchor bolts, and all bolts, nuts, and washers necessary to complete the signal pole assembly and installation.

(3) A one-piece steel anchor base of adequate strength, shape, and size shall be secured to the lower end of the shaft by 2 continuous electric arc welds. The base shall telescope the shaft. One weld shall be on the inside of the base at the end of the shaft, while the other weld shall be on the outside at the top of the base.

(4) A grounding nut for accommodating a 6 gauge [0.184 inch (4.67 mm)] diameter bare copper wire shall be provided on the inside of the shaft 8 inches (200 mm) above the bottom weld joining the shaft to the anchor base. The grounding nut shall be mounted directly opposite the hand hole opening and shall not be allowed on the hand hole frame.

(5) When specifically required by the contract, a transformer base shall be provided. In such case, the hand hole in the pole shaft is not required and the grounding nut shall be located in the transformer base.

c. Anchor Bolts:

(1) Anchor bolts shall be supplied by the pole manufacturer. The manufacturer shall certify that the bolts are of adequate strength to resist the loading required in these Specifications and the Nebraska Signal Pole Standard.

(2) All anchor "J" bolts shall comply with the "Traffic Signal Pole Details" Standard Plan and be 1.65 inch (42 mm) diameter by 4.5 feet (1.37 m) long with a 6 inch (150 mm) hook. Each anchor bolt shall be threaded and galvanized to a length that will insure that all parts of the bolt exposed after installation are galvanized. Threads shall be rolled. Each anchor bolt shall be furnished with 2 hexagon nuts and 2 flat washers.

d. A removable pole top shall be furnished with pole shafts and luminaire extensions complete with a positioning cap screw.

e. A plate shall be welded interior to the top of each pole shaft for mounting a luminaire extension. The bolt circle shall be 5.5 inches (140 mm) in diameter. 4 holes shall be drilled and tapped to accommodate 1 inch (25 mm) bolts. A 3 inch (75 mm) diameter hole shall be provided in the middle of the plate for passage of electrical cable.

f. Signal mast arm and luminaire arms shall be furnished with a clamp-on mounting device suitable for attaching the arm to its respective shaft at the height specified. The clamp-on mount shall be structurally sound and neat in appearance. The signal arm mount shall provide a minimum 2% rise and a maximum 4% rise for each loaded signal arm or shall be adjustable in the field.

g. Hand holes:

(1) All hand holes shall be reinforced to maintain full strength of the steel shaft. Hand holes shall have a minimum opening of 4 inches x 6 inches (100 mm x 150 mm). Hand hole covers of a weatherproof design shall be supplied by the pole manufacturer.

(2) Mounting of the grounding nut on the hand hole frame shall not be allowed.

(3) The bottom of the hand hole opening shall be at least 3 inches (75 mm) above the top of the base.

h. Signal arms, luminaire arms, luminaire extensions, and pole shafts shall be supplied with 1 inch (25 mm) I.D. rubber grommets as shown on the pole standard plan. Signal arms shall also be supplied with 1 inch (25 mm) I.D. rubber grommets for the number of signals specified in the loading chart in the contract. Cable inlet holes shall be drilled in the field by the Contractor.

i. (1) Each pole shaft, luminaire extension, luminaire arm, and signal arm shall be galvanized to comply with ASTM A 123.

(2) All miscellaneous hardware shall be galvanized in accordance with ASTM A 153.

j. Loads:

(1) The pole shall be designed to support the signal load shown in the contract plus one additional signal head per span and shall withstand wind velocities up to 100 mph (160 km/h). The design weight of the signal head shall be 75 pounds (34 kg) with a surface area of 7 square feet (0.65 m²).

(2) The poles shall be designed to support the required signal and luminaire load, mast arms with 10 pounds of ice per linear foot (15 kg of ice per linear meter), and signal and lighting cables while withstanding winds with velocities up to 100 MPH (160 km/h).

(3) The pole shaft and signal mast arm shall be designed to support either a 2 or 3 signal head load as indicated in the contract with 12 feet (3.65 m) of separation.

k. The manufacturer shall state the necessary amount of pole-rake necessary for the pole to set plumb under the required signal and lighting load in the contract.

l. A certificate of compliance verifying the adequacy of the signal poles and their conformity to these Specifications shall be submitted to the Department Traffic Engineer. The certificate shall state that the pole and anchor bolts shall not fail under the loading requirements of these Specifications.

31. Pedestal Traffic Signal Pole:

a. Pedestal traffic signal poles shall consist of a threaded aluminum or steel shaft and an appropriate threaded base, together with anchor bolts to provide the mounting height and accept the traffic signal hardware as shown in the contract.

b. The pedestal pole assembly shall have the characteristic of yielding under impact when struck by a motor vehicle to cause a minimum deceleration effect upon the vehicle so as to reduce vehicle damage and personal injury potential. This yielding characteristic shall be provided by a breakaway base constructed of cast aluminum which shall be of such design that adequate static strength is maintained to support the pole, traffic signal, and mounting hardware along with ice and wind loadings.

c. The base shall be approximately 18 inches (450 mm) high and not more than 17 inches (425 mm) in diameter at the bottom.

d. The base shall have an opening on the side of not less than 40 square inches (25,800 mm²) which is covered by a door secured with a stainless steel screw.

e. There shall be a grounding nut located inside the base directly across from the opening and sized to accommodate a 6 gauge [0.184 inch (4.67 mm)] diameter bare copper conductor.

f. If the Contractor elects to furnish and install aluminum pedestal poles, they shall be fabricated from spun seamless tubing conforming to ASTM B 210M, Aluminum Alloy 6063-T6.

g. If the Contractor elects to furnish and install steel pedestal poles, they shall be fabricated in accordance with the applicable requirements of Paragraphs 5. and 6. of this Subsection.

32. Wood Poles:

a. Poles shall be Southern Yellow Pine or Douglas Fir of the Coast Region. Poles shall conform to American Standard 05.1 and shall be the length and class shown in the contract.

b. The preservative treatment shall be by the Empty-cell (Rueping) or Full-cell (Bethell) Process, whichever applies, and shall conform to the requirements specified in Standard C4 of the American Wood-Preservers' Association, with the exception that creosote is excluded.

c. Southern Yellow Pine poles [up to 45 feet (13.7 m)] shall be treated with not less than 0.38 pound (6.0 kg) of pentachlorophenol or 0.60 pound (9.6 kg) of ammoniacal copper arsenate (ACA), or chromated copper arsenate (CCA) per cubic foot (meter) of timber.

d. Southern Yellow Pine poles [45 feet (13.7 m) and larger] shall be treated with not less than 0.45 pound (7.2 kg) of pentachlorophenol or 0.60 pound (9.6 kg) of ammoniacal copper arsenate (ACA) or chromated copper arsenate (CCA) per cubic foot (meter) of timber.

e. Douglas Fir poles shall be treated with not less than 0.60 pound (9.6 kg) of pentachlorophenol, ammoniacal copper arsenate (ACA), or chromated copper arsenate (CCA) per cubic foot (meter) of timber.

f. The pentachlorophenol, ammoniacal copper arsenate, and chromated copper arsenate shall meet the requirements of Section 1076.

g. Poles to be treated with ammoniacal copper arsenate or chromated copper arsenate shall be dried to the fiber saturation point required to put the timber into satisfactory condition to accept the preservative and attain the required preservative retention and penetration. After treatment, the poles shall be re-dried and have a moisture content of not more than 30% at the time of shipment to the job site.

h. Each pole shall be marked in accordance with requirements of American Standard 05.1. The marking on the face of the pole shall be located approximately 10 feet (3 m) above the butt of the pole.

i. Poles shall be carefully selected for straightness.

j. Poles in line shall not have sweeps and short crooks exceeding 50% of the maximum sweeps and short crooks allowed in the American Standard and shall present a neat appearance after installation.

k. The number of poles containing the maximum sweeps and short crooks allowed in the American Standard shall be kept to a minimum. These poles shall be installed in locations where they will not detract from the general appearance of the line of poles.

l. Poles that are to be given a full-length preservation treatment shall be roofed, gained, and bored before treatment.

m. Gains shall be cut on the face (concave side) or side of greatest curvature in poles having reverse or double sweep between the ground line and the top of the pole, and the gained surfaces shall be in approximately parallel planes.

n. Poles stored for any reason more than 2 weeks shall be stacked on creosoted or decay-resisting skids of such dimensions and so arranged as to support the poles without producing noticeable distortion in any of them.

o. Poles shall be stored to allow free circulation of air, and the bottom poles of a pile shall be at least 1 foot (300 mm) above the ground level or any vegetation.

p. No decayed or decaying wood shall be allowed to remain underneath stored poles.

q. Treated poles shall not be dragged along the ground.

r. Pole tongs, cant hooks, and other pointed tools capable of producing indentations more than 1 inch (25 mm) in depth shall not be used in handling the poles.

s. No tools shall be applied to the groundline section of any pole. The groundline section is that portion between 1 foot (300 mm) above and 2 feet (600 mm) below the groundline.

t. The basis of acceptance of wood poles shall be as described in Section 1075.

33. Anchors for Guy Wires:

- a. Anchors for guy wires shall have a 8 inch (200 mm) minimum diameter and shall be a type appropriate for the soil conditions.
- b. Anchor rods shall be 5/8 inch (16 mm) galvanized steel rods 8 feet (2.4 m) in length with a thimble eye end.
- c. Guy guards shall be half-round galvanized metal guards 8 feet (2.4 m) in length.
- d. Bonding clamps shall be galvanized clamps providing a continuous column of metal wedged solidly between the anchor rod and the guy strand. Bonding clamp expansion shall be accomplished by tightening a set screw.

34. Span and Tie Wire:

Span wire and tie wire shall conform to the requirements of Section 1062.

35. Coaxial Cable:

- a. Coaxial cable shall be 75 ohm RG 59/U Type or RG 11/U Type.
- b. The conductor shall be solid or stranded copper. Minimum conductor size shall be 22 AWG for installations where the distance between the controller cabinet and the video camera is less than 200 feet (60 m); 20 AWG for distances less than 2000 feet (610 m); and 14 AWG for distances less than 3000 feet (910 m).
- c. The insulation shall be polyethylene.
- d. The shield shall be braided bare copper.
- e. The jacket shall be black polyethylene or black polyvinylchloride.
- f. The finished outside diameter of the cable shall not exceed 0.405 inch (10 mm).
- g. The contractor shall furnish and install a BNC connector on each end of the cable.

36. Optical Detector Cable

- a. Optical Detector Cable shall meet the requirements of IPCEA-S-61-402/NEMA WC 5, Section 7.4, 600 volt control cable, 75 degrees Celsius, Type B.
- b. The cable shall contain 3 conductors, each of which shall be #20 AWG (7x28) stranded, tinned copper with 25 mil (630 μ m) minimum average thickness low-density polyethylene insulation. Insulation shall be color-coded: 1-yellow, 1-blue, 1-orange.
- c. The shield shall be aluminized polyester film with a nominal 20% overlap. A #20AWG (7x28) stranded, tinned, bare drain wire shall be placed between the insulated conductors and the shield and in contact with the conductive surface of the shield.
- d. The jacket shall be black PVC with minimum ratings of 600 volts and 175°F (80°C) and a minimum thickness of 45 mils (1100 μ m). The jacket shall be marked as required by IPCEA/NEMA.

- e. The finished outside diameter of the cable shall not exceed 0.35 inch (9 mm).
- f. The capacitance as measured between any conductor and the other conductors and the shield shall not exceed 40 pico farads per foot at 1000 Hz.

1073.03 -- Acceptance Requirements

- 1. All items described in this Section are accepted as described or as indicated in the Department's *Materials Sampling Guide*.

SECTION 1074 -- GABIONS AND REVET MATTRESSES

1074.01 -- Description

1. Gabions and revet mattresses are generally used for erosion and earth control.

1074.02 -- Material Characteristics

1. Wire coatings shall be as described in the contract.

2. The size of the stone for gabions shall be 4 inches to 8 inches (100 mm to 200 mm) in diameter. The size of the stone for revet mattresses shall be 3 inches to 6 inches (75 mm to 150 mm) in diameter. The maximum length of stone shall not exceed 16 inches (400 mm). The maximum weight for any one stone shall not exceed 6.0 pounds (2.7 kg).

3. Approved stone is defined as that meeting the requirements of Paragraphs 1., 3., and 4. of Subsection 905.02.

1074.03 -- Acceptance Requirements

1. Acceptable gabions and revet mattresses are shown on the Department's Approved Products List.

SECTION 1075 -- TIMBER AND LUMBER

1075.01 -- Description

1. Timber and lumber shall consist of treated and untreated wood of the kinds, qualities, grades, and sizes shown in the contract.

2. Kinds of Wood -- Unless otherwise provided, all treated or untreated timber and lumber shall be cut from live sound Douglas Fir trees from the Coast Region or Southern Yellow Pine.

3. General Requirements -- All timber and lumber, treated or untreated, shall be of the grade called for in the contract documents or these Specifications.

4. Definitions of Terms -- The terms used in these Specifications shall be interpreted in accordance with ASTM D 9, supplemented by the following:

a. Full Sawn Timber Lumber -- When timber and lumber are specified as "nominal" or "full sawn", it shall mean that the material may be sawn oversize to the tolerances shown below, but may not be undersize at the time of manufacture. Time of manufacture is defined as "timber in the green condition as cut and received from the lumber mill".

(1) For 2 inches (50 mm) thickness timber and lumber, 1/4 inch (6 mm) oversize.

(2) For 3 inch to 7 inch (75 mm to 175 mm) thickness timber and lumber, 3/8 inch (9 mm) oversize.

(3) For 8 inch (200 mm) or more thickness timber and lumber, 1/2 inch (12.5 mm) oversize.

(4) For 4 inch to 7 inch (100 mm to 175 mm) wide timber and lumber, 3/8 inch (9 mm) oversize.

(5) For 8 inch (200 mm) or more wide timber and lumber, 1/2 inch (12.5 mm) oversize.

b. Stress Grades -- Timber and lumber grades having assigned working stress and modulus of elasticity values in accordance with accepted basic principles of strength grading.

c. Trim -- Trimming of timber and lumber is the act of cross cutting a piece to a given length.

(1) Double end trimmed (DET) timber and lumber is trimmed reasonably square by a saw on both ends.

(2) Precision end trimmed (PET) timber and lumber is trimmed square and smooth on both ends to uniform lengths with a manufacturing tolerance of 1/16 inch (1.5 mm) over or under in length in 20% of the pieces.

(3) Square end trimmed timber and lumber is trimmed square allowing slight manufacturing tolerance of 1/64 inch (0.5 mm) for each nominal 2 inches (50 mm) of thickness or width.

5. Nomenclature of domestic hardwoods and softwoods shall be in accordance with ASTM D 1165.

1075.02 -- Material Characteristics

1. General Requirements:

a. All timber and lumber required to meet a specific stress grade shall be graded as provided in ASTM D 245 according to rules approved by the American Lumber Standards Committee for the species involved.

b. Unless otherwise specified in the contract documents, all timber and lumber shall be rough (unsurfaced) and full sawn at the time of manufacture. Tolerances allowed for "full sawn timber and lumber" shall be as specified in Subsection 1075.01, Paragraph 4.a. The dimensions of surfaced lumber shall be in accordance with the industry standards approved by the Board of Review of the American Lumber Standards Committee (ALSC) for surfaced lumber of the species furnished.

c. Each piece of timber and lumber shall be well manufactured and unless otherwise specified, all ends shall be cut square to a tolerance of 1/64 inch (0.5 mm) for each nominal 2 inches (50 mm) of width or thickness. Unless otherwise specified, each piece shall be furnished to the length specified $\pm 3.0\%$.

d. All timber and lumber to be used without preservation treatment shall contain not less than 85% heartwood when measured around the girth of any piece 5 inches (125 mm) or more in least dimension or on each wide face for lumber 4 inches (100 mm) or less in greatest dimension. Each measurement is taken at a point where the least amount of heartwood occurs.

e. For all timber and lumber that is to be pressure treated, there shall be no heartwood requirements; and the amount of sapwood shall not be limited.

f. All timber and lumber shall be square edged.

2. Treatment of Timber and Lumber:

a. The creosote, pentachlorophenol and copper naphthenate preservative treatment for timber and lumber shall be by the Empty-cell (Rueping) Process; and, where allowed, the ammoniacal copper arsenate (ACA), chromated copper arsenate (CCA), and ammoniacal copper zinc arsenate (ACZA) preservative treatment for timber and lumber shall be by the Full-cell (Bethel) Process. Treatment shall conform to the requirements as specified in T1-Use Category System: User Specification for Treated Wood of the American Wood-Preservers' Association Standards and AASHTO M 133. Preservatives shall meet the requirements of Section 1076.

b. Preservative Treatment. The preservative treatment and minimum retentions for timber and lumber shall conform to the requirements as specified in U1-Use Category System: User Specification for Treated Wood of the American Wood Preservers' Association Standards as amended herein. Timber and lumber to be treated with ammoniacal copper arsenate or ammoniacal copper zinc arsenate shall be dried to the fiber saturation point required to put the timber into satisfactory condition to accept the preservative and attain the required preservative retention and penetration. After treatment, with the exception of offset blocks and posts for

guardrail terminal systems, the material shall be redried and have a moisture content of not more than 30% at the time of shipment to the job site.

c. In order to assure dimensional stability after treatment, the material should be redried to a moisture content of not more than 30% at the time of shipment. If properly redried to this moisture content, the material may be undersize from the "nominal or full sawn dimensions" by a maximum of 3/8 inch (9 mm) on each face. However, at the option of the producer or treater, material need not be redried after treatment, provided that the material is "full sawn" in accordance with Subsection 1075.01, Paragraph 4.a.

d. Timber to be given preservative treatment shall be cut and framed before treatment insofar as is practicable. No unnecessary cutting, framing or boring of treated timber and lumber will be allowed after treatment; and all places where the surface of treated timber and lumber is broken by cutting, boring, or any other cause shall be coated thoroughly with 3 applications of the same type of preservative with which the material was originally treated (RE: AWPA M4).

e. All Douglas Fir timber and lumber that is to be treated and whose least dimension is 3 inches (75 mm) or over shall be incised on all 4 sides in a suitable power driven machine. When indicated in the contract, timber and lumber whose dimension is 2 to 3 inches (50 to 75 mm) shall also be incised, but on its side faces only. The incisions shall be reasonably clear cut; and their spacing, pattern, and depth shall be such as to provide a uniform penetration of the preservative to the required depth without damage and with the least loss in strength of the material being treated.

1075.03 -- Fence Post and Brace Requirements

1. All wood posts used in fencing, including those used for braces, shall be round.

2. Wood posts and braces shall be cut from sound and solid trees and shall contain no unsound knots.

3. Sound knots will be allowed, provided the width of the knot does not exceed 1/3 the diameter of the piece at the point where it occurs or a maximum of 2 1/2 inches (63 mm).

4. Posts shall be free from decayed wood, rot, "red heart", ring shake, season checks more than 1/4 inch (6 mm) wide, and splits in the end.

5. When measured over the outer 2 inches (50 mm) of a radial line from the pith, Douglas fir posts shall not show less than 5 annual rings per inch (25 mm) and pine posts shall show not less than 4 annual rings per inch (25 mm) and not less than 30% of summer wood.

6. Posts shall not show spiral grain exceeding 1/4 turn in 10 feet (3 m). Groups of knots or any combination of defects which impair the strength more than the maximum size knot will not be allowed.

7. Round wood fence posts shall be free from bends in more than one plane and free from short or reverse bends. A straight line from the center of the tip to the center of the butt shall not deviate from the center of the post by more than 2% of the length of the post.

8. All round wood posts shall be peeled for their full length (all bark and inner skin removed). They shall be free from the glazed surface left by

dried sap. All knots or projections shall be shaved smooth and flush with the surrounding surface of the surrounding wood.

9. Both ends of each post shall be sawed perpendicular to the vertical axis of the post to a tolerance of 1/4 inch in 4 inches (6 mm in 100 mm). The Contractor may point the ends of driven posts before treatment.

10. Round wood fence posts that are to be pressure treated shall be of any of the following species:

Jack Pine	Red or Norway Pine
Lodgepole Pine	Southern Yellow Pine
Ponderosa Pine	Douglas Fir
Western Larch	

11. Untreated round fence posts when specified, shall be white or burr oak, black locust, osage orange, or red cedar.

12. Dimensions:

a. Round wood fence posts shall be of the dimensions shown in the contract.

b. The size of a post will be specified by its top diameter in even inches (millimeters).

c. Posts will be accepted only when the top diameter equals, or exceeds by not more than 7/8 inch (22 mm), the specified diameter; except that posts of specified diameter of 7 inches (175 mm) and larger may exceed the specified diameter by not more than 1 3/4 inches (44 mm).

d. This diameter, after peeling, shall be determined with a circumference-diameter tape or by dividing the circumference measurement in inches (millimeters) by 3.14.

e. Posts will be furnished in the length specified plus or minus 2.0%.

13. The preservative treatment shall conform to Paragraph 2. of Subsection 1075.02 (Paragraph 2.c. excluded).

14. Acceptance of fence posts and braces shall be as described in Paragraph 2. of Subsection 1075.07.

1075.04 -- Round Guardrail Posts and Offset Blocks

1. a. General. All round guardrail posts shall conform to the American National Standards Institute Specifications and Dimensions for Wood Poles ANSI 05.1., except as modified herein.

b. Round guardrail posts and offset blocks shall be cut from sound live timber, preferably during the winter season. They shall contain no unsound knots. Sound knots shall be allowed, provided they are not in clusters, and provided the diameter of the knot does not exceed 33% the diameter of the post at the point where it occurs. Any defect or combination of defects which will impair the strength of the post more than the maximum allowable knot will not be allowed. All posts must be free from injurious ring shakes, rot, twists, falling or wind shakes, bird pecks, damage caused by insects entering the body of the posts or any defect which will detract from the appearance of the post.

- c. All round guardrail posts shall be dense. All wood offset blocks shall be Grade No. 2 or better as certified by the producer or treater.
- d. Posts shall be free from short or reverse bends and shall be straight such that a line from the center of the butt to the center of the tip will not deviate more than 1 inch (25 mm) from the center of the post. The Contractor may furnish turned posts. The turned posts need not taper, but all others shall taper from butt to tip.
- e. All bark shall be removed, and all knots shall be smoothly dressed close to the body of the posts.
- f. The tops and butts of all posts shall be sawed perpendicular to the vertical axis of the post to a tolerance of 1/4 inch in 4 inches (6 mm in 100 mm). Posts to be used in safety beam guard rail post installations shall also be notched, or the offset blocks shall be routed before treatment in accordance with the contract.
- g. The preservative treatment shall conform to Paragraph 2. of Subsection 1075.02 (Paragraph 2.c. excluded). No treatment with creosote is allowed.

2. Species: Unless otherwise specified, round wood guardrail posts and offset blocks shall be either Douglas Fir of the Coast Region or Southern Yellow Pine, except that the use of offset blocks composed primarily of wood fibers and recycled plastic may be used in safety beam guardrail systems. These wood polymer composite offset blocks shall conform to the dimensions shown in the contract and be successfully crash tested according to NCHRP 350.

3. Dimensions:

a. Round timber posts for safety beam guardrail shall conform to the dimensions shown in Table 1075.01. Offset blocks shall conform to the shape and dimensions shown in the contract documents.

Table 1075.01

	Length	Bottom Diameter Min.	Top Diameter
Treated, Unseasoned or Green (>30% moisture)	6 feet Nom. (1.82 m Nom.)	8 inches (203 mm)	8 to 9 inches (203 to 228 mm)
Treated Dried (<30% moisture)	5 feet 10 inches (1.78 m)	7 3/4 inches (197 mm)	7 3/4 inches (197 mm)

- b. The diameter of the posts shall be determined by means of a circumference-diameter tape or by dividing the circumference measurement in inches (millimeters) by 3.14, and no actual or caliper diameter shall vary from the diameter as determined with the circumference-diameter tape by 1/2 inch (12.5 mm).
- c. Acceptance of round guardrail posts shall be as described in Paragraph 1. of Subsection 1075.07.

1075.05 -- Sawn Wood Guardrail Posts and Offset Blocks for Safety Beam Guardrail and Guardrail Terminal Systems

1. Safety Beam Guardrail:

a. Sawn wood guardrail posts and offset blocks shall conform to the shape and dimensions specified in the contract documents and in accordance with the requirements of Subsection 1075.02, Paragraph 2.c. At the time of shipment, posts and blocks shall be of the length specified, $\pm 3.0\%$. Posts and blocks shall be double-end trimmed with the mounting bolt hole in each being drilled 1/16 inch (1.5 mm) oversize and within 1/2 inch (12.5 mm) of the specified location on either side of the post or block.

b. Species. Unless otherwise specified, sawn wood guardrail posts shall be either Douglas Fir (Coast Region), or Southern Yellow Pine. Wood offset blocks shall be either Douglas Fir (Coast Region), Southern Yellow Pine (major or minor species), or Ponderosa Pine.

c. Sawn wood guard rail posts shall be capable of a minimum working stress of 1600 psi (11 MPa) on the extreme fibers when subjected to bending and be either of the following grades:

(1) Douglas Fir: Select Structural (graded as beams and stringers)

(2) Southern Yellow Pine: Dense Structural 65

d. Wood offset blocks shall be Grade No. 2 or better, as certified by the producer or treater. Offset blocks composed primarily of wood fibers and recycled plastic may be used in safety beam guardrail systems. These wood polymer composite offset blocks shall conform to the dimensions shown in the contract and be successfully crash tested according to NCHRP 350.

e. The preservative treatment shall conform to Paragraph 2. of Subsection 1075.02 with the exception that creosote is excluded.

f. Acceptance of sawn wood guard rail posts shall be as described in Paragraph 1. of Subsection 1075.07.

2. Guardrail Terminal Systems:

a. Sawn wood guardrail posts and offset blocks for guardrail terminal systems shall conform to the shape and dimensions specified in the contract documents or be as shown on the approved manufacturer's design plans. Posts and blocks shall be double end trimmed with the mounting bolt hole in each being drilled 1/16 inch (1.5 mm) oversize and within 1/2 inch (12.5 mm) of the specified location on either side of the post or block.

b. Unless otherwise specified by design, sawn wood, guardrail posts shall be either Douglas Fir (Coast Region) or Southern Yellow Pine. Wood offset blocks shall be either Douglas Fir (Coast Region) or Southern Yellow Pine (either major or minor species).

c. Sawn wood guardrail posts and offset blocks shall be in accordance with the manufacturer's design requirements.

d. Unless otherwise specified by manufacturer's design, offset blocks composed primarily of wood fibers and recycled plastic may be used in guardrail terminal systems. These wood polymer composite offset blocks

shall conform to the dimensions shown in the contract and be successfully crash tested according to NCHRP 350.

e. The preservative treatment shall conform to Subsection 1075.02, Paragraph 2. (Paragraph 2.c. excluded). Use of creosote for treatment is not allowed.

f. Acceptance of sawn wood guardrail posts and offset blocks shall be as described in Paragraph 2. of Subsection 1075.07.

1075.06 -- Sign Post Requirements

1. Sawn wood sign posts shall conform to the dimensions specified in the contract documents. Sawn wood sign posts shall be full length, double end trimmed, free of heart centers, surfaced 4 sides (S4S) to American Lumber Standard Sizes, and incised on all 4 sides.

2. Sawn wood sign posts shall be Douglas Fir of the Coast Region.

3. Sawn wood sign posts shall be capable of a minimum working stress on the extreme fibers when subjected to bending as shown in the contract and be of the grades shown in Table 1075.02.

Table 1075.02

Sawn Wood Grades			
Size	Grade	Description	Des. Value (Min. F-b)
4 inch x 4 inch & 4 inch x 6 inch	Douglas FirSelect Structural	Structural Light Framing	1500 psi
4 inch x 4 inch & 4 inch x 6 inch)	Southern Yellow Pine No. 1 Dense No. 1 Dense	Structural Light Framing, Structural Joists and Planks	4x4 1650 psi 4x6 1500 psi

4. The preservative treatment shall conform to Paragraph 2. of Subsection 1075.02 (Paragraph 2.c. excluded). Use of creosote for treatment is not allowed. Posts must be redried after treatment to a moisture content not to exceed 30%.

5. Acceptance of sawn wood sign posts shall be as described in Paragraph 2. of Subsection 1075.07.

1075.07 -- Acceptance of Timber and Lumber

1. Acceptance of timber and lumber by a certified agency.

a. Material will be inspected for grade, dimension, and treatment by an agency certified by the American Lumber Standards Committee Board of Review (ALSC). Guardrail offset blocks do not need to be inspected for grade and dimension.

b. ALSC grade inspection certificates shall show the kind, quality, grade, and dimensions of the material furnished.

c. ALSC treatment inspection certificates shall show the following:

- (1) The actual preservative retention determined by assay.

(2) Depth of preservative penetration.

(3) Analysis of the preservative used.

(4) Moisture content (when applicable) of material treated with chromated copper arsenate, ammoniacal copper arsenate, or ammoniacal copper zinc arsenate before shipment.

d. Marking:

(1) Both ends of each piece of material (with the exception of guardrail offset blocks) accepted as conforming to these Specifications shall be permanently branded or permanently stamped with indent printing using a marking hammer showing the identity of the inspector who performed the work. One end shall be branded or stamped after determining compliance of the material in the green condition (before treatment). The other end shall be branded or stamped after determining its compliance after treatment. No piece shall be loaded for shipment which does not show both end marks in legible form.

(2) Additionally, the treating plant must provide a permanent mark (by branding) on any top face (hole end) on each post to identify the species, grade, date, type of treatment, retention, and the treating plant identification logo.

e. The Contractor shall furnish the Department's Materials and Research Division with 4 copies each of ALSC grade and treatment inspection certificates at no additional cost to the Department.

f. Unless otherwise specified, and in addition to these certificates, each piece of timber and lumber cut to "use size" at the mill and required to meet a specific stress grade shall be stamped at the mill to show the grade, mill and species.

g. Caution should be exercised in making final inspection of treated material before shipment to be sure that conditions subsequent to treatment have not caused excessive splitting, checking, warping, or any distortion which may cause the material to fail to meet these Specifications.

h. These inspections and certificates in no way relieve the Contractor from furnishing required specification material. The Department reserves the right to inspect and test each shipment when received and to reject material not meeting specifications.

2. Acceptance of timber and lumber on the basis of certificate(s) of compliance from producer and/or treater are as follows:

a. The producers' and/or treaters' certificate of compliance shall list all the material supplied and shall state that the material listed complies in kind, quality, grade, and dimension to the requirements of the specifications. No independent inspection agency performing work for the producer and/or treater shall relieve the producer and/or treater from furnishing required specification material.

b. Treatment inspection certificates shall show the following:

(1) The actual preservative retention determined by assay.

(2) Depth of preservative penetration.

(3) Analysis of the preservative used.

(4) Moisture content (when applicable) of material treated with chromated copper arsenate, ammoniacal copper zinc arsenate, or ammoniacal copper arsenate before shipment.

c. Should the production and treatment of the material occur at the same plant, a single certificate showing all of the above information will be acceptable.

d. All certificates must originate from the producer and/or treater and be dated and signed by an authorized company representative.

e. The Contractor shall furnish the Department's Materials and Research Division with 4 copies each of grade and treatment inspection certificates at no additional cost to the Department.

f. Caution should be exercised in making final inspection of treated material before shipment to be sure that conditions subsequent to treatment have not caused excessive splitting, checking, warping, or any distortion which may cause the material to fail to meet these Specifications.

g. These inspections and certificates in no way relieve the Contractor from furnishing acceptable material. The Department reserves the right to inspect and test each shipment when received and to reject material not meeting specifications.

SECTION 1076 -- WOOD PRESERVATIVES

1076.01 -- Description

1. Creosote to be used as a wood preservative shall be a distillate derived entirely from tar produced by the carbonization of bituminous coal.

2. Pentachlorophenol solution in petroleum for use as a wood preservative shall consist of 5% pure pentachlorophenol in a suitable petroleum solvent.

3. Waterborne preservatives that are approved for specific applications defined in this Section are:

a. ACA-Ammoniacal copper arsenate waterborne preservative.

b. CCA-Chromated copper arsenate waterborne preservative.

c. ACZA-Ammonical copper zinc arsenate waterborne preservative.

4. Copper naphthenate solution in petroleum for use as a wood preservative shall consist of 1% copper metal by weight in a suitable petroleum solvent.

1076.02 -- Material Characteristics

1. Creosote, pentachlorophenol, ammoniacal copper arsenate, chromated copper arsenate, copper naphthenate, and ammoniacal copper zinc arsenate shall conform to the requirements of AASHTO M 133.

1076.03 -- Acceptance Requirements

1. Creosote shall be sampled and tested in accordance with AASHTO T 60.

2. Pentachlorophenol shall be analyzed in accordance with ASTM D 1274.

3. Ammoniacal copper arsenate shall be analyzed in accordance with ASTM D 1326.

4. Chromated copper arsenate shall be analyzed in accordance with ASTM D 1628.

5. Ammoniacal copper zinc arsenate shall be analyzed in accordance with AWPA A2.

6. Copper naphthenate shall be analyzed in accordance with AWPA A5.

SECTION 1077 -- PAINTS AND PROTECTIVE COATINGS

1077.01 -- Description

1. The paint color shall be as specified in the contract.

1077.02 -- Material Characteristics

1. All paints except the 2-component top coats and primers shall be furnished mixed and ready to use. When applied by approved methods, they shall show good covering and leveling qualities without running, sagging, streaking, or pigment floating.

2. Mixed paints, pastes, and paint components shall be of a smooth and uniform consistency and show no evidence of caking, thickening, livering, hardening, or other deleterious properties. They shall be free from skins and other foreign material. All mixed paints and paint components shall be capable of being broken up with a paddle and mixed to a smooth, uniform consistency. They shall not curdle, gel, or show any other objectionable properties.

3. When it is specified that the paint shall be tinted, the tinting material shall be thoroughly and uniformly incorporated with the paint to form a uniform and even shade.

4. All paints shall be air-drying and shall dry to a smooth finish, free from grit, seeds, or other surface imperfections. They shall not show undue change in sunlight or show appreciable discoloration with age. The dry-film shall show satisfactory adhesion to the metal surface and satisfactory intercoat and system adhesion.

5. All paints shall be packed for shipment in strong substantial containers. Two-component top coat and primer components shall be packaged separately or in double-compartment containers. The lids of the containers shall be of such design that they will exclude air and withstand considerable handling without becoming dislodged. Each container shall be plainly labeled. The label shall show the name of the manufacturer, the type of material, the date of manufacture, and instructions for use.

6. The Department reserves the right to sample all shipments of paint and to withhold acceptance of the paint until an analysis shows the paint meets the specified requirements. Paint material or paint systems that do not meet the specified requirements shall be rejected.

7. The paints and paint material shall be tested as necessary.

1077.03 -- Acceptance Requirements

1. The paint materials and paint systems authorized for use shall be on the Department's Approved Products List.

SECTION 1078 -- RECYCLED ASPHALT SHINGLES FOR USE IN ASPHALTIC CONCRETE

1078.01 -- Description

1. Recycled Asphalt Shingles (RAS) may be used in Asphaltic Concrete. The maximum allowable (by weight) will be 10% on shoulders and 5% on mainline.

1078.02 -- Material Characteristics

1. All RAS shall consist of organic felt shingles or fiberglass shingles, obtained from a shingle manufacturing facility or tear offs. Scrap shingles shall not contain any objectionable materials (less than 1.5% by weight), including but not limited to: road tar, metal, glass, wood, plastic, brick, rubber, fabric, or any other material having similar characteristics. The RAS shall not contain harmful quantities of asbestos in accordance with guidelines provided by the Environmental Protection Agency and shall conform to all state and local regulations.

2. All RAS material shall be sized so that 100% (by weight) of the material passes through a 1/2 sieve, and at least 95% shall pass through a 3/8 inch sieve.

3. Before mix design approval, the following shall be submitted, along with materials and paper work for the mix design.

a. Certification by the processor of the shingle scrap, as to the shingle scraps content and source. Certification forms are available from the Department.

b. A 5 lb. sample of the shingle scrap material for review.

1078.03 -- Construction Requirements

1. RAS shall be stockpiled separate, from other salvaged material. Blending of scrap material in a stockpile with other salvage material is prohibited.

2. Scrap shingles shall be introduced into the hot mix asphalt, at the asphalt mixing plant, at the same point where Recycled Asphalt Pavement (RAP) is introduced.

3. Asphaltic Concrete containing RAS, regardless of RAP content, shall have a minimum of 55% virgin PG Binder for tear off shingles, and a minimum of 40% virgin PG Binder when using manufacturer waste shingles.

1078.04 -- Basis of Payment

1. The RAS material will be eligible for the RAP Incentive at a rate of 50% as specified elsewhere in the specifications.

RECYCLED ASPHALT SHINGLES (RAS) CERTIFICATION SHEET

Project _____

Processor of Shingle Scrap: _____

Name _____

Address _____

Contact _____

Phone _____

We the undersigned, certify that the shingle scrap to be used on this project, was supplied directly from the processor listed below. We also certify that the material supplied consisted of only organic and/or fiberglass shingles and contains no harmful quantity of asbestos or other hazardous material in accordance with Environmental Protection Agency and all state and local regulations.

Name of Contractor Shingle Scrap was Supplied to

Address

Authorized Representative of Processor of Shingle Material Date

SECTION 1079 -- SLAG CEMENT FOR USE IN CONCRETE AND MORTARS

1079.01 -- Description

1. Slag Cement shall meet the requirements of ASTM C 989, Grade 100 or 120.

1079.02 -- Material Characteristics

1. All slag cement will be acceptance tested by the Department. This includes production plant samples and field samples.

1079.03 -- Procedures

1. Slag cement shall be protected, stored, handled, and sampled in the same manner as specified for Portland cement in Sections 1002 and 1004 and the Department's Materials Sampling Guide.

2. Each shipment of slag cement sent to the project or ready mix plant shall be accompanied with a Certificate of Compliance from the supplier or manufacturing plant. The certificate must include the following information:

- a. Name of the supplier or manufacture.
- b. Source of the slag cement.
- c. Consignee and destination of the shipment.
- d. Project number to be used on, if available, and date shipped.
- e. Railroad car number or truck identification number.
- f. Weight of the shipment.
- g. Certified test number representing the material being shipped.
- h. An unrepeated order number or other identification number so that each shipment is separately identified.

3. The following signed certification statement, or similar wording, must also be included on the form:

"This is to certify that this shipment of slag cement meets the specification requirements of the Nebraska Department of Transportation for slag cement, Grade 100 or 120".

Signed _____

For _____

(Supplier)

4. Two copies of the Certificate or Compliance shall be sent with the shipment to the ready mix plant or project. The concrete producer will retain one copy of the Certificate of Compliance for their records and one will be collected by the Engineer if necessary.

5. Slag cement may be used as soon as it is received; provided it is accompanied by the proper Certificate of Compliance and the results of previous tests indicate a satisfactory product.

1079.04 -- Acceptance Requirements

1. a. Approved slag cement will be on the Department's Approved Products List.

b. Slag cement may be added to the Department's Approved Products List if it is in conformance with the Department's Acceptance Policy for slag cement.

2. a. Should any sample indicate noncompliance with the specifications, use of material from that source based on certification only may be withheld. It will be necessary that the slag cement be held in special silos or bins at the plant or some facility under control of the company furnishing the slag cement until such time that test results show compliance.

b. When it can be shown that continuing production from that plant has a high assurance of meeting specifications, material acceptance may once again be based on certification only.

3. a. If tests made on field samples taken by the Department fail to meet any of the specification requirements, all shipments from the supplier will be held until tests have been completed by the Department and approval for use is issued.

b. This procedure will be continued until it can reasonably be assured that the slag cement from the supplier will again continue to meet contract requirements.

SECTION 1080 -- WARM MIX ASPHALT

1080.01 -- Description

1. The Contractor has the option to use Warm Mix Asphalt (WMA) meeting the following requirements.

1080.02 -- Material Requirements

1. Warm Mix Asphalt (WMA)

a. Warm Mix Asphalt mixtures shall follow the requirements of Superpave Asphaltic Concrete and all other applicable sections with the following exceptions:

(1) The Contractor shall request the use of a WMA additive in writing when submitting the Job Mix Formula. The requested additive shall be an approved Level I or II production product or combination thereof. The manufacturer's recommended additive rates, specifications, and all other pertinent information shall be included in the requests. All requests must be approved by the Engineer prior to their use.

1080.03 -- Construction Methods

1. Level I Production

a. Level I WMA additives are as follows: water injection devices.

b. Hydrated Lime at 1.25% by weight of virgin aggregate is required for all mixtures.

c. The allowable drop in temperature shall be a maximum of 40°F below the producer's recommended production temperature for Hot Mix Asphalt (HMA), or less as required during production to achieve proper laydown and compaction properties. Plant production temperatures shall not drop below 230°F.

2. Level II Production

a. Approved Level II WMA additives are listed on the Department's Approved Products List.

b. For amine based WMA additives, 25% of the additive must be considered an amine based anti-stripping agent, unless Poly-Phosphoric Acid (PPA) is used. If PPA is used in the binder, the WMA shall be a non-amine based WMA, specifically for use and compatible with binders containing PPA. WMA additives and anti-strips shall be terminal blended by the binder supplier. For all other warm mix technologies hydrated lime shall be added at a minimum rate of 1.25% by weight of virgin aggregate, including the weight of limestone. Hydrated Lime shall not be used on Level II WMA mixtures when the WMA additive is an Amine based additive or when the Amine WMA additives are used in combination with Level I water injection. The minimum rate for amine based WMA additives shall be 0.7%. The dosage rate of anti-strip shall not exceed manufacturer's recommendations.

c. The drop in temperature shall be a maximum of 90°F from the producer's recommended production temperature for HMA. Plant production temperatures shall not drop below 215°F.

3. Other WMA additives shall not be used unless otherwise approved by the Engineer.

4. WMA additives may be used in combination by approval of the Engineer.
5. Asphalt mixes shall be tested for TSR on the first lot of production and then on randomly selected lots thereafter.
6. Field samples shall be heated and compacted using the following table unless otherwise approved by the Engineer.

Mix Type	% RAP	Compaction Temp °F
SPS	0-25	270 ± 5
	26-65	280 ± 5
SPR	0-35	280 ± 5
	36-55	290 ± 5
SPH	0-35	300 ± 5
SLX	20-35	280 ± 5
SRM	35-65	290 ± 5

7. The Engineer may suspend or eliminate the use of WMA on a project if any of the following conditions occur: rutting, segregation, surface voids, tearing, irregular surface, low density, raveling, stripping, or if pavement does not meet any other design criteria.

1080.04 -- Method of Measurement and Basis of Payment

1. Warm Mix Asphalt (WMA) additives will be measured and paid for directly by the unit of each for the item "Hydrated Lime/Warm Mix Asphalt" for each ton of hot mix asphalt produced.

SECTION 1081 -- ASPHALT DENSITY GAUGE

1081.01 -- Description

1. An Asphalt Density Gauge may be used for Quality Control when determining the in-place density of asphaltic concrete.

1081.02 -- Material Requirements

1. The device must be approved by the Engineer.

1081.03 -- Testing Method

1. The Contractor shall establish the method of testing in the preconstruction conference. All testing shall be in accordance with AASHTO T-343 and as directed in this provision.

2. The first 3 (three) density locations of the project shall be cored in accordance with AASHTO T166 to calibrate the asphalt density gauge. Prior to coring, the Contractor shall calibrate the device at each core location.

3. Calibration: A correction factor shall be established for the first 3 (three) cores by calculating the difference between the average density measurement of the asphalt density gauge and the roadway core density. All readings taken with the gauge shall have the correction factor set at zero. The necessary corrections will be adjusted in the Department Superpave Software. The correction factor shall be verified with another core for every 15 density readings that are to be recorded.

4. Density Reading Procedure: Place the asphalt density gauge on the asphalt mat over the area to be tested. Record the density reading, and repeat this process for a total of 5 (five) readings, as detailed in Figure 1. An average of the 5 (five) readings will be used as the density reading for each location. For densities taken less than 6 (six) inches from the edge of the lift, density readings shall be taken as shown in Figure 2. The span between density reading locations in each direction shall be no greater than 12".

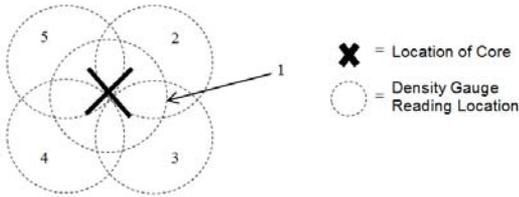


Figure 1: Asphalt density gauge reading pattern

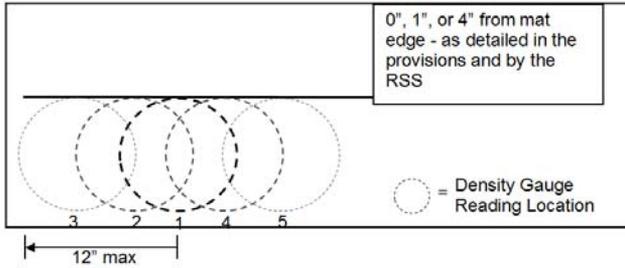


Figure 2: Asphalt density gauge reading pattern less than 6 (six) inches from mat

5. If any density measured by the asphalt density gauge is below 90%, a density core shall be cut at that location and used for density measurement for that subplot. Density readings below 90% shall not be used to calculate a correction factor. All disputed values determined using the asphalt density gauge will be resolved using AASHTO T 166.

SECTION 1082 -- ASPHALT CONCRETE LONGITUDINAL JOINT DENSITY TESTING

1082.01 -- Description

1. One sample for determination of joint density will be taken randomly from each lot. This joint density sample stands independent of the required standard density per subplot used for determining the average of 5 (five) density pay factor.

1082.02 -- Equipment

1. Testing shall be conducted in accordance with the AASHTO T 166, NDOT T 587, or an approved Asphalt Density Gauge. The Contractor shall insure that the proper adjustment bias and/or correction factors are used and accessible to Department personnel, along with all other inputs when NDOT T 587 or the Asphalt Density Gauge is selected. All correlation factors and test results shall be generated and reported on the Department Superpave Software.

1082.03 -- Testing

1. The Contractor shall establish the method of testing in the reconstruction conference.

2. One sample for determination of joint density will be taken randomly from each lot, as determined by the Engineer. The location of the edge density samples are identified by the Random Sampling Schedule.

3. The joint density core shall be cut 1 (one) inch away (laterally) from the identified edge of the top of the mat.

4. The Contractor shall cut cores the first day of work following placement of the mixture. The core samples shall be a minimum of a 3 (three) inch (75mm) diameter.

5. The Department will observe the Contractor taking, transporting, and testing the cores (as applicable). The Department will take immediate custody of the cores at the completion of the testing. All disputed values determined using NDOT T 587 or the Asphalt Density Gauge will be resolved using AASHTO T166.

6. The Contractor shall determine the density of samples by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice). The individual QC test value of the Maximum Mix Specific Gravity (Rice), determined by AASHTO T 209, will be used to calculate the density of each corresponding core.

7. Exceptions to the sampling and testing of joint density core samples for the determination of density are as follows:

a. When the nominal layer thickness is 1 (one) inch (25 mm) or less, the sampling and testing of density for this layer will be waived.

b. When the average thickness for the standard lot is 1 (one) inch (25 mm) or less, the testing of joint density samples for this lot will be waived.

If requested by the Contractor, a re-test for the original joint density test, taken no later than the working day following the receipt of the test result, will be allowed. Locations of re-tests will be provided by the Engineer from the Random Sampling Schedule. The density obtained by the re-test shall be used to establish the density pay factor for the lot.

1082.04 -- Method of Measurement

1. All work related to the Asphaltic Concrete Longitudinal Joint Density Sample will not be measured and paid for but will be subsidiary to the associated asphaltic concrete.

1082.05 -- Basis of Payment

1. The pay factor shall be computed according to the following table:

Joint Density Test Lot Pay Factor			
Joint Density	SPS	SPR	SPH
93.0 or greater	102%	102%	102%
92.0 to 92.9	100%	102%	102%
91.0 to 91.9	98%	100%	102%
90.0 to 90.9	98%	98%	100%
89.0 to 89.9	98%	98%	98%
88.9 or Less	98%	98%	98%

2. The pay factor will be incorporated in the production specs calculation in the Superpave Software. Any incentive or disincentive will be added or subtracted to the pay factor after any other applicable production tolerances pay factors have been incorporated. The pay factor will apply to the entire lot.

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