Standard Specifications for Highway Construction

2007 EDITION

TABLE OF CONTENTS

SUMMARY OF TABLE OF CONTENTS

STANDARD SPECIFICATIONS

DIVISION 100 -- GENERAL REQUIREMENTS AND COVENANTS

SECTION 101 -- GENERAL INFORMATION, DEFINITIONS, AND TERMS

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

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 Plans, 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.
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	Nebraska Department of Roads.
NEC	National Electrical Code.
NEMA	National Electrical Manufacturers Association.
SAE	Society of Automotive Engineers.
SSPC	Steel Structures Painting Council.
UL	Underwriters Laboratories.
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
m^3/s	Cubic Meters per Second
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
m2	Square Meter
Sta	Station
StaM	Station (Metric)
St.	Steel
T	Ton
V	Volt
W	Watt
yd^3/s	Cubic Yards Per Second
yd^2 or SY	Square Yards

101.03 -- Definitions

101.0301 -- Access Connection

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

101.0302 – Addendum

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

101.0303 – Advertisement

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

101.0304 -- Arterial Highway

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

101.0305 -- Auxiliary Lane

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

101.0306 -- Award

The decision of the Department to accept the bid of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract therefore and bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

101.0307 -- Backslope

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

101.0308 -- Balance Factor

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

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

101.0310 -- Bidder

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

The source of approved material required for the construction of embankments, or other portions of earthwork requirements, from locations shown in the Plans or approved by the Engineer.

101.0312 -- Bridge

A structure, including supports, erected over a depression or any obstruction, as a water course, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the centerline of a roadway of more than 20 feet (6.0 m) between undercopings of abutments or extreme ends of openings for multiple boxes.

101.0313 -- Bridge Length

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

101.0314 -- Calendar Day

Every day shown on the calendar, including Sundays and holidays, beginning and ending at midnight.

101.0315 -- Change Order

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

101.0316 -- Channel

A natural or artificial waterway.

101.0317 -- Commission

The Nebraska State Highway Commission.

101.0318 -- Contract:

1. The written agreement executed between the Department and/or any other political subdivision 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 “Notice to Contractors”, proposal form, bid, contract form and contract bond, Standard Specifications, supplemental specifications, special provisions, general and detailed plans, 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

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

101.0320 -- Contract Item

An item of work specifically described and for which a price, either unit 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

The prequalified individual or legal entity contracting with the Department

and/or any other political subdivision for the construction, reconstruction, improvement, maintenance, and/or repair of roads, bridges, and their appurtenances.

101.0322 -- Contract Period

The period from the specified date of commencing work to the date that the specified number of working days or calendar days, as the case may be, has elapsed, both dates inclusive, or from the specified date of commencing work to the specified date for completion, both dates inclusive, as specified in the contract.

101.0323 -- Contract Time or Completion Date

The number of working or calendar days specified in the proposal form as the time allowed for the completion of the work contemplated in the Contract, including authorized time extensions. When a calendar date of completion is shown in the proposal form, in lieu of a number of working or calendar days, the work contemplated shall be completed by that date.

101.0324 -- Control of Access

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.

1. **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.

2. **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.

101.0325 -- County

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.

101.0326 -- Culvert

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

101.0327 -- Current Controlling Operation

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

101.0328 -- Department

The Nebraska Department of Roads.

101.0329 -- Detour

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

A highway with separated roadways for traffic in opposite directions.

101.0331 -- Earthwork Measured in Embankment

The calculated volume of the embankment shown in the Plans where balance factors do not apply.

101.0332 -- Easement (Right-of-Way)

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

101.0333 -- Embankment

A raised soil structure.

101.0334 -- Employee

A person working on a Department project for the Contractor.

101.0335 -- Engineer

The Director, acting directly or through a representative duly authorized by the Director, such representative acting within the scope of the particular duties assigned to him/her or of the authority given to him/her.

101.0336 -- Equipment

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

101.0337 -- Expressway

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

101.0338 -- Extra Work

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

101.0339 -- Federal Agencies and Officers

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

101.0340 -- Final Acceptance

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

101.0341 -- Foreslope

The surface sloping downward and away from shoulder line.

101.0342 -- Freeway

An expressway with full control of access.

101.0343 -- Frontage Street or Frontage Road

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

101.0344 -- Grade Separation

A crossing of two highways at different elevations.

101.0345 -- Highway

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

101.0346 -- Holidays

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.

101.0347 -- Inspector

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

101.0348 -- Laboratory

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

101.0349 -- Letting

The public opening and reading of bids received from prequalified bidders for work advertised by the Department.

101.0350 -- Materials

Any substance specified for use in the construction of the project. All materials shall be new unless otherwise stated in the Plans or Special Provisions.

101.0351 -- Median

The portion of a divided highway separating the traveled ways.

101.0352 -- Median Lane

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

101.0353 -- Mitigation Site

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

101.0354 -- Notice to Contractors

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

101.0355 -- Notice to Proceed

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

101.0356 – Pavement Structure

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.

101.0357 -- Plans

The official Plans, profiles, typical cross sections, general cross sections, summary of soil and materials survey information, aerial photo maps, earthwork computations, design data, and supplemental 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.

101.0358 -- Point of Delivery

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

101.0359 -- Profile Grade

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.

101.0360 -- Project

The construction to be performed under the contract.

101.0361 – Project Manager

The Engineer'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 estimate utilized to compensate the Contractor for the performance of the work.

101.0362 -- Proposal Form

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.

101.0363 -- Proposal Guaranty Bid Bond (Bid Bond)

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.

101.0364 -- Quality Assurance

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

101.0365 -- Quality Control

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

101.0366 -- Ramp

A connecting roadway between two intersecting highways at an interchange.

101.0367 -- Right-of-Way

Real property used for transportation purposes.

101.0368 -- Road

A public way for the purposes of vehicular travel, including the entire area within the right-of-way. A road designated as part of the State Highway System may be called a highway, while a road in an urban area may be called a street.

101.0369 -- Roadbed

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.

101.0370 -- Roadside

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

101.0371 -- Roadside Development

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.

101.0372 -- Roadway

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

101.0373 -- Roadway Width

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

101.0374 – Rules and Regulations

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

101.0375 -- Schedule of Items

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

101.0376 -- Setback Line

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.

101.0377 -- Shoofly

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.

101.0378 -- Shoulders

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.

101.0379 -- Soil

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

101.0380 -- Special Provisions

Additions and revisions to the Nebraska Standard Specifications for Highway Construction and Supplemental Specifications To The Standard Specifications for Highway Construction.

101.0381 -- Specifications

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.

101.0382 -- Speed-Change Lane

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

101.0383 -- State

The State of Nebraska acting through its authorized representatives.

101.0384 -- Station

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.

101.0385 -- Street

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.

101.0386 -- Subcontractor

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

101.0387 -- Subgrade

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

101.0388 -- Subsidiary

Work and material requirements that are not measured for payment and for which no direct payment is made. The bidder must include the cost of performing these requirements in another item that is identified in the Plans or Specifications.

101.0389 -- 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.

101.0390 -- Superintendent

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

101.0391 -- Superstructure

The entire structure above the substructure.

101.0392 -- Supplemental Agreements

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

101.0393 -- Supplemental Specifications

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.

101.0394 -- Surety

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.

101.0395 – Tentative Final Acceptance

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.

101.0396 -- Traffic Lane

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

101.0397 -- Traveled Way

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

101.0398 -- Unbalanced Bid, Materially

A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department. May cause a bid to be disqualified.

101.0399 -- Unbalanced Bid, Mathematically

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.

101.0400 -- Value Engineering Proposal

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

101.0401 -- 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.

101.0402 -- Wetlands

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. (Wetlands generally include swamps, marshes, bogs, and similar areas.)

101.0403 – Work

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.

101.0404 -- Working Day

1. A working day is any calendar 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 percent of the hours in his/her normal schedule with more than 80 percent 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, 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, and Nebraska holidays will not be counted as working days.

101.0405 -- Working Drawings

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, including a schedule of submittal dates for working drawings where specified, which the Contractor must submit to the Engineer.

101.0406 -- Work Order

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, co-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 shall not be required for contracts for repair and maintenance where the estimate of the Engineer for such repair and maintenance is less than twenty-five hundred 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 ten 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 fifteen 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 ten 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 ten 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 will be permitted when the net amount of the "Letter of Credit" does not exceed five hundred thousand dollars. 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.

102.02 -- Qualification

1. 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.

2. 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.

3. 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.

4. The Department may determine that a bidder is qualified to bid on any one or combination of the following groups of work:

Group Number	Work Class
1	Grading
2	Aggregates
3	Concrete Pavement
4	Culverts
5	Landscaping
6	Bridges
7	Guard Rail
7b	Fence
8	Specialty
8a	Building Construction
8b	Electrical
8c	Signing
8d	Painting
8e	Demolition
9	Bituminous
10	General (All Classes)

5. Any bidder who desires a change in the class or classes of work for which he/she is qualified to bid must submit a request in writing for such change at least ten days before the letting at which he/she desires to bid with the new classification.

102.03 -- Drug-Free Workplace

The State of Nebraska requires all bidders on all construction, maintenance, or improvement contracts let by the Department to file 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 permit conditions.
i. The addenda.

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.

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

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, on forms provided by the Department, a complete report of all work then under contract, including subcontracts, 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 twenty-five percent of a bidder's current qualification and award the contract or contracts in a total amount which does not exceed by more than twenty-five percent the current qualification established by the Department.

102.07 -- Affirmative Action

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.

102.08 -- 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 two or more bids in a total amount exceeding their current qualification by more than 25 percent shall submit the same, subject to the limitations of their current qualification, plus a tolerance of 25 percent. 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.

3. 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.

4. 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.

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

6. A proposal form for any contract for which prequalification of bidders is required may be issued, at the discretion of the Department, to two 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.

102.09 -- Interpretation of Quantities in the Schedule of Items

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.

102.10 -- Preparation of Bids

1. The bidder shall use the Department authorized Electronic Bidding System Software when submitting a bid.

2. The bid shall be submitted in the envelopes provided by the Department, or submitted by using a Department authorized online bidding exchange, or as directed by the Department.

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 diskette or any 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 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 clearly legible or it shall be rejected.

8. Signatures.

a. Written signatures must be in ink on the line provided in the form. Printed names below the line provided or located in other areas of the form will not be considered. All corrections and other entries not made by the EBS software must be in ink or typed.

b. Bids submitted over the internet must be signed using electronic signatures as provided by the Department-authorized internet service provider.

c. Failure of the bidder to properly sign the bid shall make the bid incomplete, and the bid will be rejected.

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 is left blank and the quantity of the item is one and an amount is shown in the "Bid Amount" column, then the amount in the "Bid Amount" column will be considered the unit price.

c. If the bidder enters an amount in the "Unit Price" column when "Lump" is shown in that column, 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 column provided for that purpose and the total amount for each group and combination of groups, as indicated in the schedule of items, necessary for a complete bid for the work on which the bidder wishes to bid.

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 "Bid Amount" 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. If the "Unit Price" and "Bid Amount" columns are left blank, the bid will be considered incomplete and rejected except when alternate or single groups are bid and a bid is not being submitted for those items which were left blank.

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

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.

102.11 -- 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 rejected.

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 102.15).

j. Other forms, as required by the Department.

k. An envelope with separate pockets for the bid and bid bond respectively when required by the Department.

l. Bid Signature Page. Written bid signature pages must be signed and notarized. Electronic signatures must have authorized digital signatures. Each bidder, in signing the bid signature page by or on behalf of the person, firm, association, or corporation submitting the bid, certifies that:

(1) 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.

(2) All equipment has been assessed for the current year.

(3) The company is operating under a Drug-Free Workplace Policy, a copy of which is on file with the Department.

(4) A contract bond for the contract amount will be furnished.

(5) Reports have been filed regarding Equal Opportunity participation (Federally funded projects only).

(6) Disadvantaged Business Enterprises (DBE) goals on designated Federally funded projects will be achieved or “good faith” documentation provided.

m. Failure to submit a bid signature page as part of the bid will make the bid nonresponsive. False statements in any of the certifications will constitute perjury.

102.12 -- Bid Submission

1. Bids must comply with all plans, special provisions, addenda, the Specifications (as defined in Subsection 101.0380), 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 hour set forth for the opening and must be, by that time, delivered to the place indicated in the "Notice to Contractors." At the Department's discretion there are two options to submit bids. The bidder can deliver to the Contracts Office a bid (as defined in Subsection 102.11) in the Department provided envelopes or authorized bidders can submit the bid electronically over the Internet.

a. OPTION 1 - The bid and Bid Bond shall be placed in separate sealed envelopes, attached to each other, and furnished by the Department. If an "Annual Bid Bond" is applicable the bidder shall indicate this in writing on the Bid Bond envelope. 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 on-line bidding service.

3. The Department retains the discretion to accept as responsive a non-electronic bid.

102.13 -- 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 class or classes of work mentioned.

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

102.14 -- Irregular Bids

1. Any tie, statement, qualification, or limitation made by the bidder in violation of, or not permitted by, Subsection 102.13 will cause the bid to be considered void.

2. Bids may be rejected if they show any alterations of forms, additions not called for, conditional bids, alternate bids, incomplete bids, erasures, or irregularities of any kind. Each bidder shall make an honest attempt to show correct extensions and totals in his/her bid. If, in the opinion of the Engineer, such an attempt is not made, such bids may be rejected.

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

102.15 -- Proposal Guaranty Bid Bond (Bid Bond)

1. Each bid shall be bonded with a bid bond made payable to the Department in an amount equal to at least five (5) percent 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 not to be opened and read. 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. There are two options to submit the proposal guaranty bid bond. 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.

a. OPTION 1 - (Project Specific Paper Bid Bond). The bid bond shall be executed on the Department of Roads' Bid Bond Form, copies of which may be obtained from the Department. The bid bond shall be delivered to the Department with the bid.

b. OPTION 2 - (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 would cover all projects on which the bidder bids for a 12-month period shown in the bond. The bidder must indicate in the bid submittal to the Department that their "annual bid bond" applies to the submitted bid. Theannual bid bond shall be executed on the Department of Roads' Bid Bond Form, copies of which may be obtained from the Department.

102.16 -- Withdrawal of Bids

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

2. To withdraw a bid, the bidder shall provide written notice (letter, telegram, or FAX) to the Department's Contracting Office prior to the time established for the bid opening. The notice shall be signed by a person authorized to bid.

3. An agent authorized by the bidder in writing (letter, telegram or FAX) may resubmit withdrawn bids.

4. The Department will not accept bids after the bid opening time specified in the "Notice to Contractors."

102.17 -- Public Opening of Bids

1. Except when specifically authorized in writing by the Department and except as authorized in Subsection 102.16, bids will be opened and read publicly at the time and place indicated in the "Notice to Contractors." Bids and bid bonds not filed with the Department as authorized in Subsections 102.12 and 102.15 will not be opened and read. 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. The group totals and unit prices for individual bids may be read at the sole discretion of the Department.

102.18 -- Disqualification of Bidders and Debarment Policy and Procedures

1. Disqualification

Any one or more of the following causes shall be considered as sufficient for the disqualification of a bidder and the rejection of his/her bid or bids:

a. 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.

b. Evidence of Collusion Among Bidders. Any or all bids will be rejected if there is reason for believing that collusion exists among the bidders or if the bidder has been found unacceptable to bid due to collusion prior to award of the contract. Following conclusive evidence of collusion among bidders, participating bidders in such collusion will receive no recognition as bidders for any future work of the Department until such participants are reinstated as qualified bidders.

c. Bids in which the prices are obviously unbalanced.

d. Bids which are materially unbalanced. A bid is unbalanced if lump sum prices or unit bid prices do not reflect reasonable actual costs and there is a reasonable doubt that the lowest ultimate cost under the contract will be achieved.

e. 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.

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

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 ten 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 fourteen 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 ten 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 fourteen 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 102.18, 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 anytime 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.

3. The Director, at his/her discretion, may hold a hearing, no later than fifteen 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 twelve 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 thirty 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.

l. 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. By signing and submitting a bid, the bidder is providing the certification set out below.

b. The inability of a person to provide the certification required below 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 (102.18), 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 102.18 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.

j. 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 three-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.j.(3) of Subsection 102.18 of this Specification.

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

k. Where the bidder is unable to certify to any of the statements in the certification, an explanation shall be attached to his/her bid.

SECTION 103 – AWARD AND EXECUTION OF THE CONTRACT

103.01 -- Contract Award

The award of the contract will be made in Lincoln, Nebraska, by the Director to the lowest responsible bidder whose bid complies with all the requirements prescribed. 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; but, in any case, the award shall be made within thirty days after the opening of the bids. 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. The successful bidder will be notified by letter, mailed to the address shown on his/her bid, that his/her bid has been accepted and that he/she has been awarded the contract.

103.02 -- Consideration of Bids

1. Following the bid opening, the Department will compare the responsive bids. Unless otherwise defined in the bid, the comparison will be based on the summation of the quantities and the unit bid prices shown in the bid schedule. The comparison will be available to the public after one working day.

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. The Department may consider both tied and untied bids to determine the lowest responsible bidder when entire projects have been tied at the option of the bidder. When untied bids are not received on all tied projects, 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. The right is reserved to require from any or all bidders on any project, including the apparent low bidder, prior to award of the Contract, all documents and information used in the preparation of their bids. Failure to furnish the documents and information shall result in a period of disqualification that is determined by the Director.

103.03 -- Cancellation of Award

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

103.04 -- Requirements with Respect to Contract Bond

The bidder to whom the Contract is awarded shall furnish within thirty 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.

103.05 -- Execution of Contract

The Contract shall be signed by the successful bidder and returned, together with a satisfactory bond, within thirty days from the date of award. The Department will not execute a contract until satisfactory bonds, certificate of insurance, and other required documents have been received. No bid shall be considered binding upon the Department until the execution of the Contract.

103.06 -- Failure to Execute Contract

1. A contract is not executed if the bidder:

a. Fails to file an acceptable contract bond within 30 days from the date of award.

b. Fails to complete and submit all required forms and documents within 14 days after the opening of bids.

c. Gives written notice expressing intent not to execute the Contract.

2. When a contract is not properly executed, 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).

b. Proceed with the execution of the Contract after the 30-day period when all required documents have been correctly submitted and adjust the bidder's prequalification downward as specified in Paragraph 2. of Subsection 102.02.

c. Award to the lowest, succeeding, responsive bidder and recover the differences from the defaulting bidder.

103.07 -- Special Arrangements

The right is reserved, unless otherwise stated in the proposal form, to consider bids and award separate contracts for each group of items as shown in the proposal form. All awards under the Standard Specifications are subject to the approval of the Department before becoming effective as contracts.

103.08 -- Material Guaranty

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

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

104.02 -- Alteration of Plans or Character of Work

1. Differing site conditions:

a. (1) The Contractor shall notify the Department in writing of the specific differing conditions before they are disturbed, before any additional work is performed, and as soon as the condition is discovered.

(2) This includes subsurface or latent physical conditions which differ materially from those indicated in the contract.

(3) It also includes unknown physical conditions of an unusual nature and differing materially from those ordinarily encountered and generally recognized as inherent in the work provided in the contract.

b. Before the site is disturbed or the affected work is performed, the Engineer shall be given an opportunity to investigate.

c. Upon written notification, the Engineer will investigate the differing conditions. If the Engineer determines that they do materially differ and will result in an increase or decrease in the cost or time required for the performance of any work under the contract, a cost (excluding loss of anticipated profits) or time allowance adjustment will be made. The Engineer will make a written determination, and the contract will be modified in writing if a change is warranted.

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

2. a. (1) The Engineer may change the quantities or requirements as needed to satisfactorily complete the project at any time during the contract.

(2) These changes will be provided to the Contractor in writing.

(3) These changes in quantities or requirements do not invalidate the contract nor release the contract surety.

(4) If the change requires additional time to complete the contract, adjustments to the contract time will be made according to Subsection 108.02.

b. Except for significant changes in the character of work, the work will be paid for at the contract unit prices.

c. For significant changes in the character of work, contract adjustments may be made according to Subsections 104.04 or 109.05. A significant change in the character of the work is deemed to have occurred when:

(1) The additional work differs materially in kind or nature from the work included in the original proposed construction; or

(2) A major item of work, defined as an item whose total original contract cost exceeds 10 percent of its original group total amount, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of the original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed. Items of Work in Group 10 – General are excluded from the definition of "major item of work", and will not become the basis for negotiating a contract adjustment when quantities change. Also, 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.

(3) 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 and they agree on the actual quantity delivered and installed, then a change order is not required to justify the overrun or underrun.

d. 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.

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 percent 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 prescribed 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.

104.04 -- Extra Work

1. 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.

2. 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.

3. 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.

104.05 -- Maintenance of Detours and Shooflies

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. Temporary approaches and crossings constructed for public use shall be maintained in a safe condition 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 plans 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", the Contractor shall be responsible for their maintenance.

b. (1) The Contractor shall receive "Equipment Rental" payments as prescribed in Section 919 for authorized shoofly maintenance.

(2) The Contractor shall also receive payment for all materials used in authorized shoofly maintenance.

c. All shoofly maintenance shall be done as prescribed in the relevant Section of these *Specifications*.

d. If the Contractor fails to perform required shoofly 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.

104.06 -- Removal and Disposal of Unforeseen Structures and Obstructions

1. a. The Contractor shall remove unforeseen obstructing structures found in the roadway.

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 these *Specifications* or the special provisions, 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 m^3).

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 m^3). This exclusion does not apply to items visible on the ground surface at the time of contract letting.

4. The Contractor shall remove all discarded material, rubbish, and/or debris from the highway at no additional cost to the Department and dispose of it as provided in Subsection 203.02.

104.07 -- 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. This material shall not be cut without the approval of the Engineer. Extreme care shall be taken to avoid damage to the material.

104.08 -- Final Cleaning Up

1. As part of completion of the work and before acceptance and final payment, the Contractor shall remove all rubbish, excess materials, falsework, temporary structures, and equipment from the project site, borrow sites, and all ground occupied in connection with the work. All parts of the work shall be left in a neat and presentable condition. Waterways, including wetlands, shall be returned to their preconstruction condition.

2. The Contractor shall place, at no additional cost to the Department, waste material or strippings back into borrow and materials pits as directed by the Engineer.

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 plans and *Specifications*.

   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 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 orders of the Engineer.

   (4) Follow the plans and specifications.

   b. Work may also be suspended by the Engineer for:

   (1) Conditions considered unsuitable for prosecution of the work.

   (2) Any other reason deemed in the public interest.

   c. The Engineer shall notify the Contractor in writing of all suspensions.

105.02 -- Plans and Working Drawings

1. The plans will be supplemented by such Contractor provided working drawings 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 for any structure shall consist of such detailed plans 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 shall be subject to the Engineer's review.

3. No changes shall be made in any plan or drawing after it has been reviewed except by a written acknowledgement from the Engineer. It is expressly understood that the Engineer's review of the Contractor's working drawings will not relieve the Contractor of any responsibility.

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

5. The Contractor shall furnish shop plans on 22 x 36 inch (594 x 841 mm) sheets with 1/2 inch (15 mm) margins on all sides except the left side, which shall be 2 inches (50 mm). The margin lines shall measure 21 x 33 1/2 inches (564 x 766 mm). The marking shall be in accordance with the special plans or as may be required by the Engineer. All prints which are furnished to the Engineer shall be clear, distinct, neatly trimmed, and acceptable to the Engineer. The Contractor shall furnish the Engineer as many copies of working drawings as are required in each Division specifying submission of working drawings, or seven copies (8 copies if the submission is a precast structure or element) if the quantity is not specified.

6. a. The Engineer may require reproducible prints of all shop plans, which shall be furnished by the Contractor at no additional cost to the Department. The prints shall not be folded, but shall be mailed in tubes sized to accommodate the plans. No working drawings will be submitted to the Engineer unless they have been carefully checked by the Contractor. As evidence of this check, all sheets of one set and the first sheet of all remaining sets of shop drawings shall bear the Contractor's stamp of approval. Drawings showing gross errors will be returned for correction before review by the Engineer. The name of the shop or company furnishing the drawings shall be on the tracing.

b. Alternatively, the Contractor may authorize the company furnishing the shop plans or working drawings to send them directly to the Construction Division in Lincoln. The Contractor's authorization letter, which must accompany each plan submittal, shall clearly indicate that the Contractor is responsible for any errors on the shop plans. Shop drawings submitted under this procedure will be returned to the sender after being reviewed.

c. The project number, structure number, control number, and project location as it appears on the plans shall be shown on each sheet of all shop drawings.

7. The address for submitting shop plans and working drawings is:

Nebraska Department of Roads
1500 Highway 2
P.O. Box 94759
Lincoln, NE 68509-4759
Attn: Construction Division

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 plans 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 will be supplied with the number of approved plans and contract assemblies, including special provisions as prescribed in Section 111. One set shall be kept available on the worksite at all times.

2. The Contractor shall cooperate with the Engineer, Department 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 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 special provisions or as noted in the plans.

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 plans 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

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.

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 acceptance of the work, the Contractor shall remove or uncover for examination 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 work prove acceptable, the work of uncovering and covering, removing and replacing, or making good the parts removed shall be paid for as "extra work". Should the work prove unacceptable, 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 standards.

105.10 -- Removal of Unacceptable and Unauthorized Work

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

2. Unacceptable 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 beyond the lines or limits shown in the plans 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 unacceptable and unauthorized work and deduct the costs from the monies due the Contractor.

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 grading and finishing operations, 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).

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

5. No dragline, power shovel, or crane shall be operated with any part of the machine resting directly upon a pavement, bituminous or asphaltic concrete surface, base course, or structure.

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

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 pavement, bituminous or asphaltic concrete surface, or base course 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.

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

10. 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 permission from the Engineer granted for that particular bridge.

11. Unless otherwise approved, 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 be allowed to cross bridges only if the relationship between the gross weight on any single axle and the axle spacing conforms to the regulations promulgated by the Department.

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

When using land outside of the highway right-of-way for any purpose, the Contractor must have consent and shall leave such lands or other sites used in a neat and presentable condition.

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.

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 is also responsible for any damage that results during the performance of required maintenance or other operations when the Contractor fails to use common sense and standard maintenance practices (e.g., if a Contractor drives across a wet field to maintain a silt fence, then the Contractor shall correct the damaged finish grades and reseed the damaged area at no additional cost to the Department).

105.14 -- Final Inspection

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.

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 from commercial sources of supply.

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 the State's Standard License Agreement, and the well driller 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 capped in accordance with applicable laws and regulations.

106.02 -- Samples, Tests, and Cited Standards

1. All materials are subject to and will be inspected, tested, and accepted 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 or the Contractor as specified.

4. Upon request, copies of all test results will be furnished to the Contractor.

5. The frequencies and methods of sampling and testing materials, including those required for a definite purpose and not covered by these *Standard Specifications*, will be 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 according to the standard test methods of AASHTO and ASTM in effect on the date of advertisement for bids. If there is a difference in the test methods, the order of precedence will be as follows:

Precedent Order
- NDR *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, 1916 Race Street, Philadelphia, PA 19103.

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, 917 National Press Building, Washington, D.C. 20001.

c. (1) Federal Specification - *U.S. Government Federal Stock Catalogue*. The specification number refers to the most recent revision adopted by the General Services Administration. Revisions in effect on the bid advertising date will apply.

(2) Copies of separate specifications listed in the *Federal Stock Catalogue* may be obtained at the prices indicated from: Business Service Center, General Services Administration, Regional Office Building, Seventh and D Streets, Washington, D.C. 20005.

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 required by the Engineer, the Contractor shall arrange for an approved building for use by the inspector. This building shall be:

(1) Located conveniently near the plant.

(2) Independent of any building 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. The Contractor will 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. Any additional space that may be 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.

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

106.05 -- Unacceptable Materials

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

2. Materials not meeting the requirements of the *Specifications* 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 deduct the cost of removal and replacement from money due the Contractor.

106.06 -- State-Furnished Materials

1. When the contract provides that certain materials required to complete the work will be furnished by the State, they will be delivered or made available to the Contractor at the location(s) specified in the plans or special provisions.

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. Shortages will be replaced in kind or reimbursed by deductions from money due the Contractor.

b. The Contractor shall be responsible for all damages occurring to State-furnished materials while the materials are in his/her possession. Any demurrage or storage charges shall also be the responsibility of the

Contractor. The cost of damages, demurrage, or storage shall be deducted from money due the Contractor.

4. The Contractor shall include the cost of handling, 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 products 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 products (i.e., smelting, and any subsequent process which alters the steel 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 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 product may be imported. All manufacturing processes to produce steel products 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 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 and/or iron materials.

5. Notwithstanding this requirement, a minimum of foreign steel will be permitted if its value is less than one-tenth of one percent of the total contract cost or $2,500, whichever is greater.

6. 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 products 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, and protective equipment 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 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 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. Work must stop whenever the Contractor violates any governing Federal, State, or local environmental quality regulation. The Engineer will provide a written order confirming the work stoppage to the Contractor within two NDR work days. Work can resume once the Engineer determines the threat to the environment is corrected.

b. Dredged material shall not contain any unsuitable items (e.g., trash, debris, car bodies, etc.), and the material discharged must be free from toxic pollutants.

c. To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows

or cause the relocation of the waterway.

d. If the discharge 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. During the period of April 1 to July 15, the primary nesting season of migratory birds, an initial survey of nesting birds within the project area shall be conducted. Any presence of eggs or young shall be reported immediately to the U.S. Fish and Wildlife Services.

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.

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 Director-State 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.

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 filed with the Department.

2. However, whether or not such an agreement is made or filed, 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

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.

107.06 -- Sanitary Provisions

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 plans, special provisions, 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 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 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 the Engineer deems that 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. Unless otherwise specified in the *Traffic Control Plan* details, drop-offs adjacent to or contiguous with the traveled way shall be protected by a wedge of compacted stable material capable of carrying traffic (the wedge being 1 vertical to 4 horizontal or flatter). An edgeline warning stripe shall also be placed on the traffic side of the drop-off.

b. The Engineer shall authorize other methods, such as concrete barriers or safety drums, to protect drop-offs when conditions do not allow a wedge of compacted, stable material.

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.

d. Drop-offs up to 2 inches (50 mm), unless otherwise ordered by the Engineer, may remain exposed with appropriate warning signs alerting motorists to the condition.

8. When so provided in the typical cross sections, these *Specifications*, or the special provisions, 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, reflectorized drums, or object markers to locate and mark hazards within the project limits.

10. a. 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.

b. The cost of barricades used to protect corrugated metal pipe installations and storage areas is subsidiary to the pipe or other appropriate bid item.

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 plans 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

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 promptly notified when any such articles are uncovered, and the Contractor shall suspend operations in the area involved until such time that arrangements are made for their removal and preservation.

107.11 -- Right-of-Way

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

107.12 -- 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 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.

107.13 -- Liability Insurance

1. a. The Contractor shall carry public liability insurance to indemnify the public for injuries or death sustained by reason of carrying on the work. In addition, the Contractor must also carry worker's compensation insurance in accordance with Nebraska statutory requirements.

b. Before execution of the contract, the Contractor shall furnish a certificate or certificates satisfactory to the Engineer verifying that adequate

insurance is in force.

c. When "hazardous wastes" must be handled and/or moved, the Contractor shall submit proof that a pollution exclusion, as is common to most liability policies, will not void his/her coverage.

d. Unforeseen work involving hazardous waste requires appropriate liability insurance. The cost of this insurance will be handled as "extra work".

2. a. The General Liability coverage for bodily injury liability shall be not less than $1,000,000 for injuries, including accidental death, in any one occurrence, and subject to an aggregate limit of not less than $2,000,000.

b. The amount of property damage liability insurance shall be not less than $1,000,000.

c. The General Liability policy must include contractual insurance coverage.

d. The Business Automobile Insurance Policy, or equivalent policy, shall be not less than $1,000,000 for bodily injury and property damage per occurrence on all vehicles which will be used at any time in connection with the performance of the work on the project.

e. The Contractor may, at his/her option, provide the limits of liability as set out above by a combination of the above described policy forms and excess liability coverage.

f. Insurance, as herein required, shall be maintained in force until the Department releases the Contractor from all obligation under the contract.

3. If any of the work is sublet, similar insurance shall be provided by or in behalf of the Subcontractor or Subcontractors (at any tier) to cover their operations.

4. Certificates of insurance will not be accepted unless the insurer is licensed by the Nebraska Department of Insurance. Certificates of Insurance shall show the Nebraska Department of Roads as the Certificate Holder.

5. The Contractor shall provide and carry any additional insurance required by the special provisions.

107.14 -- Opening of Sections of the Project to Traffic

1. The Engineer may direct that all or part of the project be opened to traffic before final acceptance of the work. Opening such sections shall not constitute final acceptance of the work or a waiver of any contract provisions.

2. a. In the event that the opening 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.

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

(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 prescribed in the plans and specifications.

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

1. The accuracy of information furnished with respect to existing utilities is not guaranteed, and the Contractor must verify all such information.

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

3. The Contractor shall determine the actual locations of all existing underground utilities before starting any work that may cause damage to such utilities.

4. a. The Contractor must protect and keep operational all encountered utilities. Contractor damaged utilities shall be promptly repaired to the owner's satisfaction, and all restoration of damaged utilities shall be done at no additional cost to the Department.

b. The Contractor must properly request the utilities to locate their equipment. If the utilities fail to locate or are unable to furnish the Contractor adequate information to prevent damage to their equipment, the Department will not hold the Contractor responsible for the damage.

5. Where operations are adjacent to properties of railway, telegraph, telephone, power, or other utilities, work shall not begin until all arrangements necessary for their protection have been made and the Contractor has explained the arrangements to the Engineer.

6. a. The Contractor shall cooperate with any affected utility 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.

7. 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.

8. 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 can perform such work, the Contractor shall coordinate efforts with the utility to provide the utility adequate time to plan and complete its work.

9. 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.

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

107.17 -- 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.

107.18 -- 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 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) With the Engineer's consent, the Contractor may sublet up to 70 percent of the work.

(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 authorization by the Department shall subject both the Contractor and Subcontractor to the imposition of appropriate sanctions by the Department.

3. The Contractor's request to sublet work shall be made electronically to the NDR 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 physically included in any subcontract.

4. Second tier subcontracts will be allowed except for subcontracts or portions of subcontracts used to meet DBE goals. All requests for second tier subcontracting shall be submitted to and approved by the prime Contractor before they are forwarded to the NDR Construction Engineer for approval.

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 thereafter. 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. The Contractor may discuss a proposed subcontract with the Engineer before entering into a signed subcontract agreement, but final approval will not be granted until a formal request and proper certification has been received by the Department.

7. A copy of all executed subcontracts, written agreements, and/or lease agreements used to meet DBE goals shall be submitted to the NDR Construction Engineer with the subcontracting request. These copies must show labor cost, material prices, overhead, and profit.

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

9. a. The prime Contractor shall include a “Prompt Payment Clause” as a part of every subcontract for work and materials (including second tier subcontracts).

b. (1) The “Prompt Payment Clause” will require payment to all 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.

(2) 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 “Prompt Payment Clause” will stipulate the subcontractor’s obligation to return to the Contractor 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 prime Contractor within 20 calendar days of receiving notice of the adjusted quantities.

c. The prime Contractor 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 prime Contractor to carry out the requirements of the “Prompt Payment Clause” without just cause, including the timely return of retainage, is a material breach of this contract which may result in the Department withholding the amount of payment from the prime Contractor that should have been paid to the subcontractor, termination of this contract, or other such remedy as the Department deems necessary.

(2) Additionally, failure of the subcontractor to carry out the requirements of the “Prompt Payment Clause” by failing to return overpayments in a timely manner may result in the Department withholding subcontract approval for other work until the overpayments have been returned.

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 establish a starting date by issuing a written "Notice to Proceed", normally but not necessarily coinciding with the tentative starting date. The work and the

determination, count, and reporting of working days or calendar days shall commence on the “Notice to Proceed” date or on the actual starting date, whichever is earlier. The Contractor may, however, make a written request to the NDR Construction Engineer to begin work on a different date. (See Subsection 108.03).

c. If an earlier starting date is approved by the NDR 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 NDR 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.

d. If a later starting date is approved by the NDR 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 72 hours’ notice of the intent to start work prior to the revised starting date.

2. a. 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:

(1) delays in obtaining the necessary right-of-way;

(2) delays in obtaining the necessary environmental or other permits;

(3) delays in delivery of materials, except for critical defense materials; or

(4) delays due to any other conditions or restrictions stipulated in the contract.

b. 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.

c. 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:

(1) a suspension of the working day or calendar day count;

(2) an adjustment or extension of the contract time allowance; or

(3) additional compensation for any delays, inconvenience, or damages sustained by the Contractor due to interference from the conflicting appurtenances.

d. 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.

3. 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 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. 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.

d. 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.

4. Although the work is to be documented on the weekly report of working days, the Contractor will not be charged working days or calendar days when performing the following types of work:

a. Driving test piling, provided that 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.

b. Channel excavation work that facilitates bridge and culvert work, provided that the Contractor is not engaged in any other items of the contracted work except work performed under the conditions described in Paragraph 4. of this Subsection.

c. Clearing and grubbing work, 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.b. of this Subsection.

d. The production and stockpiling of aggregates prior to the actual beginning date, provided that other items of work included in the same contract time allowance, except those listed in Paragraph 4. of this Subsection, are not being performed on the project.

e. Any work which does not require an inspector, performed entirely outside the limits of the project before the actual beginning date, provided that other items of work included in the same contract time allowance, except those listed in Paragraph 4. of this Subsection, are not being performed on the project.

f. 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.

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

h. (1) Minor miscellaneous or finishing work, provided that all significant pay items (and work subsidiary to them, e.g. bridge painting) are complete and all other work has been completed to the extent that the work could be opened to traffic and the prosecution of the minor work would not interfere with the normal use of the highway by traffic.

(2) Working days or calendar days shall be charged during this period if the Engineer determines that the Contractor is not prosecuting the remaining work in a manner which is conducive to a timely completion of all work included in the contract.

(3) If the Contractor allows more than three working days to elapse without minor miscellaneous or finishing work being attempted or completed, then the Contractor will have failed to satisfactorily prosecute the remaining work. The Engineer shall be the sole judge of which work is deemed to qualify as minor miscellaneous or finishing work and whether sufficient minor work is being accomplished.

i. Clearing and grubbing work and the furnishing and placement of right-of-way markers in advance of the tentative or anticipated beginning date in order to facilitate relocation or rehabilitation of utilities, relocation of other facilities, or other construction work.

j. Pre-watering of excavation or borrow areas in advance of the tentative or anticipated beginning date.

k. Ground preparation for landscape planting work performed in advance of the tentative or anticipated beginning date, work during the establishment period for landscape plantings, and for the work of any subsequent replanting.

l. Installation of traffic control signs done in advance of the tentative or anticipated beginning date, provided the signs are properly covered until work begins.

m. Contractor-provided construction surveying and staking done before the tentative or anticipated beginning date.

5. Each week, the Engineer will furnish the Contractor a report of working days or calendar days charged. The Contractor then has 14 days after receipt of the Engineer's report to provide a written explanation of why he/she does not concur with the working days or calendar days as assessed.

6. a. If the Contractor finds that he/she will be unable to complete the work within the authorized number of working/calendar days, he/she may promptly make a written request to the Engineer 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 his/her 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 his/her control.

b. If the Engineer finds that the delay was caused by conditions beyond the Contractor's control, he/she 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 days 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. When the special provisions require work to be performed in cold weather, consideration in the determination of work days will not be given because of possible loss of efficiency due to prosecution of the work during cold weather.

8. 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.

9. A shortage of labor in counties near the project will not be considered justification for an extension in the specified time allowances. The Contractor shall investigate the anticipated availability of labor in the area during the contract period and give consideration in preparing the proposal to the necessity and cost of importing labor.

10. a. The Engineer may allow additional working days or calendar days when extra work not in the original contract or additional quantities of contract items are required.

b. Time extensions will be granted in proportion to the value of 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.

c. 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. a. 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" or the actual beginning date, if earlier. If circumstances prevent the Contractor from beginning work on the originally designated start date, the Contractor must request from the Department a new starting date, in writing, seven days before the originally designated contract start date.

b. This request must include the reason for the delay.

c. The start date will be postponed if the Engineer determines the circumstances identified by the Contractor are beyond his or her control, the postponement benefits the Department, or if the contract is amended to address the issue of the delay. In such cases, the Engineer will change the start date and notify the Contractor.

2. a. The Engineer reserves the right to designate where the work shall start. When the Contractor's operations are materially affected by changes to the plans or if he/she has failed to comply with the requirements of Subsection 108.07, the Engineer may request a revised progress schedule.

b. This revised progress schedule shall show how the Contractor proposes to prosecute the balance of the work.

c. The Contractor shall submit the progress schedule within seven days after receipt of the Engineer's request. The Contractor's progress schedule shall include any special provision requirements regarding the order of performance of the remaining work.

108.04 -- Limitation of Operations

1. 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.

2. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional section.

3. 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 plans, specifications, 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 all 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 plans, specifications, 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 corrective 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, by written order, for such periods as he/she may deem necessary due to unsuitable weather or any other 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. 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 and/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 prescribed 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 contact.

108.07 -- Contractor's Work Schedule

1. a. The Contractor shall complete all requirements on or before the expiration of the contract time allowance.

b. The Contractor shall develop and submit for approval a progress schedule. The schedule shall be presented and briefed to the Engineer at the Preconstruction Conference. This schedule and any supplemental schedule shall show:

(1) Completion of all work within the specified contract time.

(2) The proposed order of work for all bid items.

(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.

c. 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.

d. The Contractor shall furnish four copies of the schedule to the Engineer.

e. 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's original schedule is approved.

f. 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.

2. a. If the Contractor's progress falls behind his/her schedule, the Engineer may put the Contractor on notice and direct the Contractor to take whatever action is necessary to expedite completion of the work.

b. Additionally, the Engineer may request that the Contractor submit, within seven days, a revised progress schedule that demonstrates how and when the Contractor intends to complete the work. 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 fails to make satisfactory arrangements to adjust his/her performance and schedule within seven days, his/her 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.

3. When the Contractor desires to change the approved schedule, he/she must submit the proposed revised schedule to the Engineer for approval at least seven days before any significant deviation from the currently approved schedule.

108.08 -- Liquidated Damages

1. Liquidated damages are intended to compensate for expenses incurred by the Department due to the Contractor's failure to complete the work within the authorized number of working days or calendar days. 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 plans and specifications.

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. 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. 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 plans, 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.

(4) All measurements made by the Engineer shall be according to the English system of 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 m^2).

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 plans or ordered in writing by the Engineer.

d. When requested by the Contractor and approved by the Engineer, 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. Below are factors for conversion from dry weight measurement to volume measurement. The weight of any water in the aggregate shall be deducted before using the conversion factor.

To Convert Tons (Megagrams) of Material to Cubic Yards (Meters)	Divide By
Crushed Sand Gravel	1.20 Tn/CY (1.30 Mg/m^3)
Fine Aggregate for Concrete	1.30 Tn/CY (1.54 Mg/m^3)
Coarse Aggregate (Limestone) for Concrete	1.25 Tn/CY (1.48 Mg/m^3)
Sand-Gravel for Concrete; Surfacing Gravel or Crushed Rock	1.35 Tn/CY (1.60 Mg/m^3)
Crushed Rock for Base Course	1.25 Tn/CY (1.48 Mg/m^3)
Crushed Rock for Base Course Screenings	1.25 Tn/CY (1.48 Mg/m^3)
Mineral Filler and Soil Binder	0.85 Tn/CY (1.06 Mg/m^3)

e. 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.

f. 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.

2. If the proposal provides that payment is to be made on established quantities, final measurements will not be made unless 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

The Contractor shall accept the Department's compensation as full payment for:

1. Furnishing all materials, labor, tools, and equipment necessary to complete the work and for performing all work included in the contract.

2. 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.

3. For all risks of every description, except as noted, connected with the prosecution of the work.

4. For all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified.

5. For any use or infringement of patented, trademarked, or copyrighted items.

109.03 -- Responsibility for Payment

Payment for the contracted work will be made by the State of Nebraska from the State and Federal-aid highway funds. 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, 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 five percent of the total compensation for the extra work as compensation for the administrative costs.

6. a. For all labor, including the foreperson in direct charge of the extra work, the Contractor shall receive 120 percent 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 percent 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 percent 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 Dataquest, Inc.

b. When it is necessary for the Contractor to rent such equipment, the Contractor shall be allowed 115 percent 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 his/her 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 ten percent to cover overhead, handling, other costs, and profit.

109.07 -- Partial Payment

1. a. When his/her progress meets or exceeds his/her 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 $10,000, the Contractor will receive semi-monthly progress estimates in which the Department shall make the prescribed retentions, 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. The Department shall retain one percent, up to a maximum of $25,000, of the estimated amounts earned. The Department reserves the right to retain additional amounts 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. See Subsection 802.05 for payment schedule.

4. a. Upon presentation by the Contractor of receipted bills, 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.

b. The amount to be included in the payment will be determined by the Engineer, but in no case shall it exceed 100 percent of the value of the materials as shown by the receipted bills. 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 value of such materials, as determined by the Engineer, amounts to less than $2,000.00, 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 within 30 days.

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. The Contractor is responsible 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) Form FHWA-47, "Statement of Materials and Labor Used by Contractors On Highway Construction Involving Federal Funds" (federally funded projects on the National Highway System in which the contract is more than $1,000,000).

(4) Contractor's weekly payroll reports with form WH-348, "Statement of Compliance" (Federally funded projects only).

(5) 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. 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.

2. 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.

3. 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.

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

5. 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.

d. 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; and how the damage occurred, etc.).

e. 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 110 -- WAGES AND CONDITIONS OF EMPLOYMENT

110.01 -- Scope

1. The provisions pertaining to wages and conditions of employment shall apply to all work performed by the Contractor or Subcontractor.

2. 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.

3. A plant or facility is considered to serve a project "exclusively" if not more than ten percent of sales from the plant or facility are made to others.

110.02 -- Labor Laws Cited

1. The Contractor's attention is directed particularly to the provisions and requirements of the State Workers Compensation Law and to Statutes regulating the conditions of employment on public work.

2. In addition to the State law regulating the conditions of labor, certain additional regulations and restrictions may be imposed. In each of these cases, the restrictions will be set forth in the special provisions for the particular project involved.

3. The Contractor and any Subcontractor shall not require any laborer or mechanic to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to health and safety. The *Construction Safety and Health Standards* (Title 29, Code of Federal Regulations, Part 1926, formerly Part 1518, as revised from time to time) promulgated by the United States Secretary of Labor, in accordance with Section 107 of the *Contract Work Hours and Safety Standards Act* (83 Stat. 96), apply to all contracts.

110.03 -- Employment of Labor

1. No person under the age of 16 years and no one whose 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 operate against the employment of people with physical disabilities, otherwise employable, where such persons may be safely assigned to work which they can ably perform.

2. The Contractor shall not employ convict labor for any purpose within the limits of the project unless it is labor performed by convicts who are on parole, supervised release, or probation.

3. The Contractor or Subcontractor is prohibited from engaging in discriminatory employment practices described by the Nebraska Fair Employment Practices Law. Any breach of this law shall be regarded as a material breach of 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 NDR District Engineers.

b. Central Headquarters, Nebraska Department of Roads, Lincoln, Nebraska.

c. NDR website.

2. Prospective bidders may purchase plans and *Specifications* from the Department for the fee given in the call for bids. The fee shall accompany each request for plans or *Specifications*. Checks shall be payable to the State Treasurer, Nebraska Department of Roads.

3. Upon award of the contract, the Contractor will receive the following at no charge:

Plan Distribution	Maximum No. of Free Sets
Full-Size Plans (22 x 34 inches) (594 x 851 mm) (including Standard Plans)	1 set
Full-Size (22 x 34 inches) (594 x 851 mm) Cross-Sections	2 sets
1/2-Size Plans (11 x 17 inches) (297 x 420 mm) (including Standard Plans)	7 sets
Proposals	8 sets

4. Additional plans may be purchased by payment of the current reproduction fee.

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; and for all other work and operations which must be performed or costs incurred before beginning work at the project site.

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 ten percent 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 ten percent of the total group amount, the amount in excess of ten percent 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 of the permanent pavement marking work 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 percent 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 five percent of a group's originally contracted work, excluding Mobilization, the Department will pay 50 percent of that group's Mobilization amount.

c. Upon completion of ten percent of a group's originally contracted work, excluding Mobilization, the Department will pay 100 percent 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 preserving the standards of quality and professionalism called for by the specifications.

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 for resolving 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 SURVEYING

114.01 -- Description

1. Department and Contractor Responsibilities:

Each project will have the construction staking and surveying done by either the Contractor or the Department. When the pay item "Construction Staking and Surveying" is shown in the bid proposal Schedule of Items and in the plans, then the Contractor shall accomplish the requirements in Paragraph 3. of this Subsection. When the Department has the responsibility to accomplish the construction staking and surveying shown in Paragraph 2. of this Subsection, then the pay item "Construction Staking and Surveying" will **not** be shown in the plans 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 NDR survey 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 hours notice is required.

3. Contractor provided construction stakes, lines, and grades:

a. The plans and the bid proposal Schedule of Items will show the pay item "Construction Staking and Surveying" when the Contractor is responsible for survey 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) 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 and Surveying," the work shall be done under the direction of a registered Professional Engineer or registered Land Surveyor.

(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 percent 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 NDR project personnel 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 plans. 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 NDR *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 plans 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

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**	**Pay Unit**
Construction Staking and Surveying	Lump Sum (LS)

2. Payment is full compensation for all work prescribed in Subsection 114.01, Paragraph 3.

DIVISION 200 -- EARTHWORK

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 intends to use on this or another project.

3. Nonsalvageable materials are all materials for which the Department has no intended use and the Contractor has disposal responsibility.

4. The Contractor shall place right-of-way markers as one of the first orders of work.

5. The Contractor shall conduct the operations and maintain the work so that adequate drainage and erosion control are in place at all times.

6. Techniques will be employed to prevent petroleum products, chemicals, harmful materials, construction debris, excessive suspended solids, dredged material, and wet concrete from entering waterways.

7. 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.

8. Sources of soil materials may be designated and described in the plans and special provisions. The quality of material in such deposits 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 option area and may reject unacceptable portions of the deposit.

9. When waste or borrow locations are not designated in the plans or special provisions, the Contractor shall dispose of and/or provide material conforming to the contract requirements.

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 plans.

11. To use soils from sources other than those designated, the Contractor shall make a written request for the alternate sources. The request must state that at no additional cost to the Department, the Contractor will acquire the necessary right to take the materials, perform site exploration and development, and haul the material whatever distance is necessary.

12. If the Engineer directs the Contractor to change from a designated soil source to another not designated in the plans or described in the special provisions, the work of moving from one source to another, any additional stripping or hauling of the material, and any other additional costs occasioned by such change shall be considered "extra work".

13. Only authorized materials shall be permanently piled or buried within the right-of-way of any public road.

14. When pre-watering is required, proposed pre-watering methods will be explained by the Contractor at the preconstruction conference.

15. Surplus excavated material shall be disposed of in the toes of embankments or in waste areas provided by the Contractor in a manner satisfactory to the Engineer.

16. Necessary borrow material shall be obtained as indicated in the plans.

17. At the preconstruction conference, the Contractor shall submit for acceptance specific plans for accomplishing temporary erosion control, including that required for haul roads, plant sites, borrow pits, and disposal sites. A plan that contains only general statements indicating that erosion control will be accomplished "according to accepted standards" or "according to NDR standards" is not acceptable. No work shall start until the erosion control plans are accepted by the Engineer.

18. The use of a borrow site shall be restricted to one contract or one pay item until the appropriate payment measurements are taken. Intermediate cross section surveys are the Contractor's responsibility. The Department will do the initial and final cross section survey.

19. The Contractor shall furnish copies of the water distributor and supply tank calibrations to the Engineer.

20. All equipment shall be adequate for its intended use and shall be maintained in satisfactory working condition.

21. The Contractor shall be responsible for all equipment calibrations.

22. The Contractor shall protect all structures and roadway appurtenances like signs, guardrails, and curbs. If the Contractor damages item(s), the Contractor shall repair or replace the item(s) at no additional cost to the Department.

23. The finish grading operation shall be started any time there are 9 acres (3.6 hectares) of ground that could be finish graded.

SECTION 202 -- CLEARING AND GRUBBING

202.01 -- Description

1. This work shall be described as either "General Clearing and Grubbing" and/or "Large Tree Removal" in the plans and the bid proposal Schedule of Items.

2. a. Clearing and Grubbing is a lump sum bid item that includes:

(1) "Clearing" -- removing and disposing of all unwanted material from the surface, such as trees, vegetation, boulders, and trash.

(2) "Grubbing" -- removing and disposing of all unwanted material from underground, such as sod, boulders, stumps, roots, buried logs, or other debris.

b. The Contractor will be responsible for determining the number of trees less than 80 inches (2 meters) in circumference that are to be removed during the work of general clearing and grubbing.

3. Large tree removal does not include “General Clearing and Grubbing.”

4. a. “General Clearing and Grubbing” requires the Contractor to remove all living or dead vegetation, including trees, and trash from within the limits of construction and the lateral obstacle clearance zone, including borrow pits and channel changes unless designated to remain.

b. Live trees, hedges, shrubs, or grass designated to remain shall be protected as shown in the plans.

c. Work within the right-of-way and outside the limits of construction or lateral obstacle clearance zone shall be performed in a manner as to preclude injury or damage to live trees in excess of 3 inches (75 mm) in diameter.

d. Trash, dead trees and vegetation in the right-of-way limits and beyond the limits of construction shall be disposed of by the Contractor.

202.02 -- Construction Methods

1. The Contractor shall remove and dispose of unwanted material designated by the Engineer.

2. 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. An approved mechanical stump chipper may be used for this work.

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. The Contractor's clearing and grubbing responsibilities also include the following:

a. Removing large rocks and boulders and other unsightly matter within the limits of construction and the lateral obstacle clearance zone.

b. Filling holes; smoothing and contouring the ground.

c. Shaping the ends of cuts and fills to fit adjacent terrain and to enhance the area's appearance.

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 except those trees with a circumference exceeding 80 inches (2 m) at 40 inches (1 m) above ground level and stumps whose circumference at or near ground level is 80 inches (2 m) or more.

2. a. Trees whose circumference exceeds 80 inches (2 m) at 40 inches (1 m) above ground level and stumps whose circumference exceeds 80 inches (2 meters) at (or near) ground level are to be counted to establish the pay quantity.

b. "Large Tree Removal" does not include clearing and grubbing.

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. "General Clearing and Grubbing" includes all trees whose circumference is less than 80 inches (2 m) in diameter at 40 inches (1 m) above ground level and all stumps whose circumference is less than 80 inches (2 m) in diameter at (or near) ground level.

4. Payment is full compensation for all work prescribed in this Section.

SECTION 203 -- REMOVAL OF STRUCTURES AND OBSTRUCTIONS

203.01 -- Description

1. 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 plans.

2. Unless structures interfere with the work, they shall not be removed until the new structures replacing them are complete.

3. Environmental Requirements:

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 prescribed 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. a. "Preparation of Structure at Station _____" includes removing any part of the existing concrete or masonry structure (usually a box culvert) and using it in the new structure as indicated in the plans and the work prescribed in the plans 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 plans.

4. a. The Contractor shall remove all pavement identified for removal in the plans.

b. Ballast, gravel, bituminous material, or other surfacing or pavement 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. 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 m^2) 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 to the stream bed.

b. Bridges and culverts designated in the plans or special provisions 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. The Contractor shall remove all other structures from the right-of-way.

9. Concrete designated for use as riprap shall be broken into pieces not to exceed 330 lb. (150 kg) and promptly stockpiled or placed at designated locations. No dimension shall be more than 4 times the least dimension.

10. 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 bypass service shall be maintained during construction operations.

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. a. Retaining walls shall be removed as indicated in the plans.

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 piles to the elevations indicated in Table 203.01.

Table 203.01

Pile Cut Off Elevation	
Excavation or embankment areas	2 feet (600 mm) below finished grade
Dry stream beds	2 feet (600 mm) below natural ground
Running streams	at the stream bed
All other areas	at natural ground

14. 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.

b. "Traffic Signal System Removal" includes the following:

(1) Traffic signal heads.

(2) Poles, their mast arms, and foundations.

(3) Controllers.

(4) All associated and connecting wires, cables, pull boxes, and conduits.

c. "Lighting System Removal" includes the following:

(1) Luminaires.

(2) Poles, their mast arms, and foundations.

(3) Lighting control centers.

(4) All associated and connecting wires, cables, pull boxes, and conduits.

d. "Sign Lighting Removal" includes the following:

(1) Luminaires.

(2) Mast arms or structures.

(3) Associated wire, cable, pull boxes, and conduit.

e. Unless indicated otherwise, foundations, pull boxes, control centers, and all lighting, sign lighting, and traffic components indicated for removal in the plans 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.

f. The plans 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 plans.

g. After the removal has been completed, the Contractor shall backfill the excavation with approved soil and compact it to 95 percent of maximum density as determined by NDR T 99.

h. 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.

i. Salvaged Material Disposition:

(1) All components shall be delivered to the Department's storage area identified in the plans.

(2) The Contractor shall contact the NDR 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.

j. Electrical conduit and cable may be abandoned in place.

15. 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 NDR storage area indicated in the plans 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. (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. 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 plans and delivering both the posts and signs to the indicated NDR storage area.

c. (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 as directed by the Engineer.

17. a. The Contractor shall remove signs as indicated in the plans.

b. This work involves the removal of existing signs and luminaires on the overhead structures as indicated in the plans. 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 prescribed 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 density of not less than 95 percent of maximum density as determined by NDR 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. (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. Broken concrete and masonry rubble may be placed in the toe of slopes and berms at least one foot (300 mm) below finish grade, or around new piers and culverts, as stream bank anchor, or as directed by the Engineer.

d. Uncontaminated bituminous rubble may be placed in the toes of slopes and berms.

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. 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.

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. a. Measurements for curbs will be made along the front face of the curbs.

b. Measurements for combination curb and gutter will be made along the flow line of the gutters.

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 _____" is measured as a lump sum. This is the complete removal of a traffic signal at the indicated location and includes:

a. Traffic signal heads.

b. Poles, mast arms, and foundations.

c. Controllers.

d. All associated and connecting wires, cables, pull boxes, and conduits.

14. "Remove Lighting System at _____" is measured as a lump sum and includes the following:

a. Luminaires.

b. Poles, mast arms, and foundations.

c. Lighting control centers.

d. All associated and connecting wires, cables, pull boxes, and conduits.

15. "Remove Sign Lighting at _____" is measured as a lump sum and includes:

a. Luminaires.

b. Mast arms.

c. Associated wires, cables, pull boxes, and conduits.

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 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:

(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 plans indicate 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 included in appropriate bid items that caused the pipe to be removed. Excavation costs shall not be included in the "Remove Driveway Culvert Pipe" bid item.

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 proposal, 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 (m^2)]
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 (m^2)]
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 (m^2)]
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 (m^2)]
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 plans unless changes are authorized.

3. The State may sell and/or remove buildings prior to the start of construction. If buildings are sold and/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. Payment is full compensation for all work prescribed 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 m^2) 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 plans 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 plans. 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 on the plans 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 plans (such as sediment traps, silt fence, ditch checks, etc.).

6. Cover crop seeding shall consist of furnishing and applying the appropriate cover crop seed as prescribed in Section 812. Where slope protection is required, it shall be placed instead of cover crop seeding. The cover crop shall be seeded over the entire disturbed area of each portion of the project which has been finish graded, excluding the actual roadbed. The Engineer may designate other areas of the project to be cover crop seeded.

7. a. 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. When such measures fail to provide adequate protection from erosion, the Contractor shall provide temporary slope drains to carry excess runoff from the fills in the vicinity of streams, rivers, or other impoundments.

b. Temporary slope drains may be constructed of pipe, fiber mats, rubble, concrete or asphaltic concrete, plastic sheets, or other materials acceptable to the Engineer for erosion control.

204.04 -- Method of Measurement

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				
	Pay Items (See Notes 1, 2)			
	Measured Quantity		Established Quantity	
Work Description Code	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, dikes, intersections, approaches, and private entrances in conformity with the alignment, grades, and typical cross sections shown in the plans.
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 plans.
I	The excavation or embankment necessary for the relaying and/or installation of driveway culvert pipes.
J	Obtaining soils from off-site borrow pit, hauling soil to the location(s) designated in the plans, placing, compacting, and finish grading the soil to form the roadbed, embankments, and cuts shown in the plans.
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 plans 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 plan quantities represent the volumes of the embankments and excavations as plan drawings. The Contractor must estimate and add to the plan quantities allowance for settlement, shrinkage, consolidation, waste, and other conditions to determine the actual excavation volume.

205.02 -- Material Requirements

1. 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 which cannot be used in the embankment 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	**Near (10 Feet) [3 m]**	**Class II**	**Class III**
	General	**Structures**	**All Areas**	**All Areas**
Diameter of Rock	12 Inches (300 mm)	6 Inches (150 mm)	8 Inches (200 mm)	8 Inches (200 mm)

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. A frozen soil layer may remain in the embankment provided the proper density and moisture content exist in the layer before additional embankment is placed on the layer.

7. Borrow Site Approval:

a. When borrow is obtained from pits or waste excavation is placed at sites which are not shown in the plans, the Contractor shall submit details of his/her sites, including photocopies of either a USDA, Natural Resources Conservation Services (NRCS) aerial photograph or topographical map of the area, to the NDR Construction Division for approval.

b. It is anticipated that it may require 60 calendar days or more for the Department to obtain necessary Nebraska State Historical Society and the

Nebraska Game and Parks Commission approval. The Contractor will not be allowed to begin work at borrow sites until the necessary permits are obtained.

c. (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) Photocopies of an ASCS 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. (1) Material shall not be removed from borrow pits 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 pit so that cross sections may be taken.

(2) 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 pits shall be bladed and shaped to drain as shown in the plans or as directed by the Engineer.

205.03 -- Construction Methods

1. a. The Contractor shall excavate, build, and shape the roadbed, embankments, and cuts as shown in the plans.

b. 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. (1) 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.

(2) 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.

(3) 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.

(4) 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 pits, or channels, including inlet, outlet, and intercepting ditches, in embankment, subgrade, shoulders, and other locations as shown in the plans.

4. 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, a uniformly compacted face shall be left, 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 plans. The finished roadway shall be a continuous surface that matches the lines, grades, and cross sections shown in the plans.

5. 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 plans.

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 plans, 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 pit that is not shown in the plans unless approved by the Engineer.

b. Borrow obtained from pits shown in the plans shall be excavated to the cross sections and grades shown in the plans.

c. The Contractor shall remove the available topsoil at State-furnished borrow pits to a minimum depth of 6 inches and stockpile this material in approved areas.

d. Subgrade stabilization will be accomplished in accordance with Section 303 at no additional cost to the Department when it is required to stabilize Contractor-furnished granular material to support any subsequent construction.

(1) If the Contractor elects to furnish granular materials (less than 35 percent passing through a No. 200 sieve [75 µm]) as borrow, the Contractor shall, at no additional cost to the Department, provide cohesive material (35 percent or more passing through a No. 200 sieve [75 µm]) 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.

(2) 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.

(3) 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.

e. Borrow and waste areas will be restored as prescribed in Section 208.

7. 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. 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. a. When less than 3 feet (1 m) of embankment is to be constructed on any part of the existing bituminous surfacing, bituminous base, or aggregate base and no other provisions have been made, the surfacing and bases shall be removed 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. 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 shall be removed and paid for in accordance with Section 203.

11. a. 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 m^2) and leave them in place.

b. The Contractor may use jackhammers, drop hammers, or any other suitable means to break the pavement.

12. 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.

13. 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 plans.

b. (1) 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).

(2) 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.

(3) 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.

14. 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 plans.

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 14.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 14.c.(2) and 14.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 14.c.(1) or 14.c.(3) of this Subsection before the placement of any embankment material.

(3) **Class III:**

(i) Class III embankments shall be compacted to the density and moisture content shown in the plans. The maximum density and optimum moisture shall be determined in accordance with NDR T 99.

(ii) [1] 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.

[2] Each layer shall be leveled before compaction.

[3] In all cases, the hauling shall be distributed over the entire area to assist in compacting the material.

[4] 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 Density Requirements. Each successive horizontal layer of soil shall be compacted to the density requirements shown in the plans. 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 plans.

(iv) Compacting equipment and methods which will consistently produce the compaction specified in the plans 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 plans.

(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 14.c.(1) or 14.c.(3) of this Subsection prior to the placement of any embankment material.

c. Compacting Equipment:

(1) (i) Tamping (sheepsfoot) 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.

(ii) 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 weight, number of tires, weight per inch (mm) of tire width, and tire pressure shall be adequate to achieve the required compaction. The roller shall be designed for use in the compaction of earth fills.

(3) Alternate equipment which will produce as good or better compaction than the equipment specified above may be used with the Engineer's approval.

15. 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 the density specified in the plans.

16. All embankments and excavated areas shall be shaped and finished to produce the specified smooth surfaces and slopes. All old 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.

17. a. Unsuitably wet material which cannot be dried by discing in place shall be removed to the length, width, and depth directed by the Engineer and replaced with approved material.

b. Unsuitably wet soil in low areas where drainage is expected to be a problem shall be removed 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.

18. 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.

19. When the borrow soil for the project is dissimilar (Plastic Index difference of 10 units or more or if delamination is evident) from the soil on site, then the Contractor shall disc 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 disc shall be able to penetrate through 2 entire uncompacted lifts.

20. Engineer Directed Discing:

a. The plans 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. a. 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 and also overbreakage or slides not caused by Contractor error. Stockpiled materials will be measured in the stockpile.

b. "Excavation (Established Quantity)" is the plan quantity in cubic yards (cubic meters). "Excavation (Established Quantity)" is not field measured.

2. 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.

3. a. "Earthwork Measured in Embankment" is a plan quantity in cubic yards (cubic meters) computed by the method of average-end-areas from the cross sections shown in the plans.

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.

4. 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 of soil requirements.

5. "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 plans and the Contractor elects to use other sites, the Contractor shall be charged with all costs that are incidental to obtaining the sites shown in the plans. These charges shall be deducted from Department money due the Contractor.

3. Clearing and grubbing of borrow and waste sites shown in the plans shall be measured and paid for in accordance with Section 202. When borrow is obtained from sites which are not shown in the plans, 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 plans.

6. Removing and disposing of the bituminous surfacing and 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 plans 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. 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 plans.

(3) Are stockpiled to drain and dry before placement in the embankment.

10. a. When unsuitably wet soil is removed and replaced, the volume of wet soil removed shall be paid for at 2 times the quantity removed 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 shall 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 unsuitably wet 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 unsuitably wet 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 plans 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 prescribed 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 project's free haul distance and the plans do not indicate any waste or excess material. When these conditions exist, the removal and disposal shall be paid for as extra work.

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 10% 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 10% 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 .15. For the item of work "Earthwork Measured in Embankment," "F" shall be equal to .20.

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 .74. For the item of work "Earthwork Measured in Embankment," "F" shall be equal to 1.00.

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 – 1.10P(b), but not less than zero.

When the current price, P, is less than the base price, P(b).

D = P – .90P(b), 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 No. 2 Diesel Fuel (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 No. 2 Diesel Fuel (Oklahoma) published in the first issue of *"Platt's Oilgram Price Report"* for the month in which the progress estimate is generated.

17. Payment is full compensation for all work prescribed in this Section.

SECTION 206 -- ROADWAY GRADING

206.01 -- Description

"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 plans.

206.02 -- Material Requirements 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 plans.

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 indicated in the plans.

5. The Contractor shall perform the excavation, placement, sloping, and finishing of soils as prescribed in Section 205. The embankment shall be compacted to comply with the compaction requirements shown in the plans.

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 2 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**	**Pay Unit**
Roadway Grading	Station (Sta) [Sta M]

2. When borrow and waste sites are obtained by the Department and shown in the plans and the Contractor elects to use other sites, the Contractor shall be charged with all costs that are incidental to obtaining the sites shown in the plans. These charges shall be deducted from Department monies due the Contractor.

3. Clearing and grubbing of borrow and waste sites shown in the plans 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 plans, 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 prescribed in this Section.

SECTION 207 -- SALVAGING AND PLACING TOPSOIL

207.01 -- Description

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 plans 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. a. The Contractor shall clear and grub the topsoil areas before the topsoil is removed.

b. Soils below the designated topsoil layer shall not be incorporated into the salvaged topsoil.

2. Topsoil may be stockpiled at any location within the right-of-way which will not impair drainage when it is not placed directly on the designated areas.

3. a. 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 plans.

b. Areas to be covered shall be loosened by tilling, harrowing, or discing to a depth of at least 2 inches (50 mm).

c. Harrowing, discing, or both may be required to assist in breaking down clods or lumps to provide a uniform texture to the topsoil.

d. Heavier clay bearing loam topsoils used on sandy areas shall be harrowed or disced to mix the two soils.

4. Rocks, twigs, large clods which will not break down, and other foreign material shall be removed; and the entire surface shall be dressed to present a uniform appearance.

5. 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).

6. a. It shall be the Contractor's responsibility to determine the volume of topsoil required to complete the work.

b. 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

"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 prescribed 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.

2. Waste site restoration applies to all Department provided areas where waste 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 and/or all wastes are buried and finish graded.

2. The Contractor shall scarify the entire pit area, including slopes, to a minimum depth of 6 inches (150 mm).

3. The Contractor shall uniformly spread topsoil that was stockpiled at the start of excavation over the pit area. The entire area, including the stockpile areas, shall be seeded in accordance with Section 803 using the kinds and rates specified in the special provisions for borrow/waste pit restoration.

4. The Contractor shall adjust seeding time as outlined in Subsection 803.03 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.

6. Borrow and waste pits not shown in the plans that are provided by the Contractor from sources outside the right-of-way limits shall be restored by the Contractor in accordance with this Section except in the case where the landowner specifically requests or authorizes items of restoration work be deleted.

208.03 -- Method of Measurement

1. "Restore Borrow Pit" and "Restore Waste Site" will be surface measured, and the unit of payment will be the acre (hectare) of pit area actually used.

2. All temporary stockpile areas shall be considered subsidiary to the work of "Restore Borrow Pit" or "Restore Waste Site".

208.04 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Restore Borrow Pit	Acre (A) [Hectare (ha)]
Restore Waste Site	Acre (A) [Hectare (ha)]

2. The area of borrow pits and waste sites restored shall be the quantity shown in the plans unless changes are authorized.

3. In the event that the Contractor proposes to provide borrow or waste sites other than those shown in the plans, payment for "Restore Borrow Pits" and "Restore Waste Sites" shall not exceed the areas shown in the plans.

4. The restoration of borrow and waste sites furnished by the Contractor when sites are not shown in the plans shall not be paid for directly but shall be considered subsidiary to the items of work for which direct payment is made.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 209 -- OVERHAUL

209.01 -- Description

1. All excavated materials shall be hauled as shown in the plans 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 pits that are not shown in the plans or from pits substituted by the Contractor for the convenience of his/her operation.

3. When changes to the plans cause an increase in the haul distance, overhaul compensation will be allowed if all three following conditions are met:

a. The materials must be obtained from outside the balance shown in the plans, or from Borrow Pits not shown on the plans.

b. The haul distance is greater than the average haul distance (also known as the "free haul distance") for the affected balance.

c. The haul distance is greater than the minimum free haul distance of 1500 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).

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 in this Section.

(This page was intentionally left blank.)

DIVISION 300 -- SUBGRADE PREPARATION, FOUNDATION COURSES, BASE COURSES, SHOULDER CONSTRUCTION, AND GRAVEL SURFACING

SECTION 301 -- GENERAL REQUIREMENTS

301.01 -- General

1. Compaction requirements are shown in the plans or in the specifications.

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. 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 and/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 equipment used for mixing and proportioning the foundation course mixtures shall consist of twin pugmill mixers or equivalent equipment able to apply water uniformly. Also included shall be an approved feeder capable of uniformly proportioning the aggregate and soil binder.

3. 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.

4. a. Water distributors shall be equipped with spray bars.

b. The distributor equipment shall provide accurate and uniform distribution of water. The control valves shall close fully to prevent leakage.

c. The Engineer may approve alternate water distributing equipment.

d. Water will be measured through a meter or with calibrated tanks in gallons (kiloliters). The weight of the water can also be measured and converted to gallons (kiloliters).

5. The equipment used for profiling the subgrades, base courses, and foundation courses shall conform to the requirements of Subsection 302.03.

6. 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 a smooth, glossy surface or produces detrimental laminations within the compacted lifts will not be allowed.

7. Equipment used to deliver materials along the length of the roadbed shall place the material uniformly.

8. Equipment for weighing loaded trucks shall comply with requirements given in Subsection 503.03.

SECTION 302 -- SUBGRADE PREPARATION AND SHOULDER SUBGRADE PREPARATION

302.01 -- Description

1. The Contractor shall complete the following requirements under the "Subgrade Preparation" bid item:

a. (1) Furnish and place subgrade materials as shown in the plans.

(2) Bring the roadbed to the plan profile when the roadbed was graded under a separate contract, the grade is less than 0.20 foot (60 mm) low, and 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.

e. Scarify, mix, adjust the moisture content, shape, and compact the soils as necessary to conform to the plans and specifications.

2. In addition to the above requirements for "Subgrade Preparation", "Shoulder Subgrade Preparation" shall also include 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 plans.

302.02 -- Material Requirements

1. Soils shall meet the requirements prescribed in Subsection 205.02.

302.03 -- Construction Methods

1. Subgrade Preparation and Shoulder Subgrade Preparation:

a. The Contractor shall shape the subgrade to the typical cross sections shown in the plans. In the event the subgrade width is less than the width shown on the typical cross sections, the widening shall be accomplished by either:

(1) Lowering the grade.

(2) Placing additional embankment on the shoulder slopes.

b. Embankments will be constructed in accordance with Section 205.

c. 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.

d. After placing, shaping, and compacting the material, the slope shall be no steeper than 1 vertical to 3 horizontal.

e. (1) 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.

(2) The scarified material shall be completely mixed vertically and horizontally to insure a uniform material throughout the area to be surfaced.

(3) 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 plans.

f. 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.

g. Intersection and driveway preparation shall also include salvaging, stockpiling, and reapplying the salvaged aggregate beyond the surfaced area.

h. 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.

i. 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.

2. Subgrade and Shoulder Subgrade Profiling:

a. The Contractor shall profile all subgrades after they are properly compacted. Automated profiling equipment will not be required for intersections, driveways, or other irregular areas.

b. 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 prescribed 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) A motorgrader with automatic blade control may be used for profiling shoulders, medians, and the roadbed for flexible pavement, but not for the subgrade or base course for the traveled way or auxiliary lanes of rigid pavement. However, the Engineer may allow its use with rigid pavement after determining that satisfactory results are obtainable.

(4) 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.

(5) (i) When there is no overlay of the traveled way, the existing roadway surface may be used as a reference when profiling shoulders.

(ii) 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.

(6) 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. a. (1) When the unit for payment is the square yard (square meter), preparation of subgrade, intersections and driveways, and shoulder subgrade will not be measured directly.

(2) The quantity for payment will be the number of overlying square yards (square meters) of rigid or flexible pavement, including intersections and driveways.

(3) Deductions will be made for all areas not prepared.

b. When the unit of payment is the station, "Subgrade Preparation" and "Shoulder Subgrade Preparation" are measured as follows:

(1) Stations shall be measured horizontally along the project centerline between the beginning and ending points.

(2) Full length stations will be 100 feet (100 m).

(3) Deductions will be made for all areas not prepared.

(4) 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".

(5) 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.

c. 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.

d. 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".

2. 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 plans, then, except for areas greater than 300 SY (250 m^2), furnishing cohesive soil for subgrade stabilization will be considered subsidiary to subgrade preparation, shoulder subgrade preparation, and/or preparation of intersections and driveways.

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 prescribed 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 designated by the Engineer.

d. Step slopes, if necessary to provide an adequate embankment width and prevent soil erosion.

e. Dispose of surplus excavated or profiled material.

f. Scarify, adjust the moisture, shape, and compact soils as is necessary to conform to the plans.

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. a. When the grading is complete, the Engineer will determine the quantity of soil binder the Contractor shall provide to stabilize subgrade sand.

b. Soil binder shall be pulverized to the extent that at least 90 percent will pass a 1/2 inch (12.5 mm) sieve and at least 60 percent will pass a No. 10 (2.0 mm) sieve. The binder shall be pulverized before it is mixed with the other aggregates.

3. a. 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 not less than 100 percent of maximum density as determined by NDR T 99. Moisture may be added as necessary to obtain the required density.

b. After the Contractor attains the required density, the stabilized subgrade shall be profiled in accordance with the requirements of Subsection 302.03.

4. 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. a. 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.

b. The work of stabilizing subgrade outside the width shown in the typical cross section in the plans, 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 prescribed 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 plan'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. Only when the Department provides the material will the plans indicate where to obtain shoulder construction materials.

2. Soils shall meet the requirements prescribed 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. a. 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.

b. During shoulder construction, the embankments shall be adequately drained to prevent damage to the pavement structure.

3. Piles or windrows of shoulder materials shall not be placed along the traveled way more than 15 days ahead of their intended use. The windrow 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.

4. a. (1) The Contractor shall construct shoulders to the typical cross sections shown in the plans.

(2) 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.

(3) Shoulder construction shall match the existing width and fill slope or plan section widths, whichever is widest.

b. Earth Shoulders (Asphaltic Concrete Surfacing):

(1) (i) The latest the Contractor shall begin "Earth Shoulder Construction" is the fifth day of placement of the top layer of asphalt pavement. The Engineer may suspend the Contractor's asphalt placement operation if shoulder construction is not started within this time.

(ii) Should the Contractor discontinue asphaltic concrete placement, shoulder construction shall begin by the third calendar day after

the Contractor stopped asphalt placement and shall complete the shoulder work in the areas paved within 7 days.

(iii) Shoulder work will not be considered to have started until soils are placed, graded, and compacted for at least 1,500 feet (500 m).

(iv) 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)	5
More than 3.0 to 4.0 (4.8 to 6.4)	6
More than 4.0 to 5.0 (6.4 to 8.0)	7
More than 5.0 to 6.0 (8.0 to 9.7)	8
More than 6.0 to 7.0 (9.7 to 11.3)	9
More than 7.0 (11.3)	10

(2) (i) If shoulder construction has not been started by the end of the fifth day of placement of the top pavement lift, liquidated damages in the amount of $500 per calendar day will be assessed beginning on the sixth 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.

(ii) Failure to complete earth shoulders within the prescribed working day time limit shown in Paragraphs 4.b.(1)(ii) and 4.b.(1)(iv) 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.

(iii) The Engineer will exclude shoulder requirements for asphalt placed in urban areas, intersections and driveways, and minor isolated areas [less than 600 SY (500 m^2)] 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 4.b.(1)(i) of this Subsection.

(iv) 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. 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.

6. The Contractor shall correct any pavement damage that results from shoulder construction activities.

7. 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. a. Each shoulder will be measured separately in stations of 100 feet (100 m) without regard to width. 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. 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".

c. 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 prescribed in this Section.

SECTION 305 -- CRUSHED ROCK BASE COURSE

305.01 – Description

Crushed rock base course shall consist of furnishing, placing, shaping, and compacting a course of crushed rock to provide a firm and stable foundation for subsequent construction. This base course shall be constructed on a profiled subgrade in accordance with the requirements of these *Specifications* and in conformity with the lines, grades, quantity requirements, and the cross sections shown in the plans.

305.02 -- Material Requirements

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 exercise particular care in loading, hauling, and distributing the crushed rock to avoid segregation of the coarse and fine particles. Windrowing will not be required if the rock particle distribution is uniformly maintained.

2. a. The Contractor shall spread crushed rock screenings for the base course uniformly over the prepared subgrade and then moisten and compact them. 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.

b. 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.

c. The Contractor shall accomplish primary compaction by rolling with multiple-wheel, pneumatic-tired rollers and a tandem or three-wheel roller having a minimum weight of 10 tons (9000 kg). A minimum of three full coverages with the designated rollers will be required. Rolling shall be continued until further rolling does not increase the density of the material.

d. 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. Acceptance of the rock at the placement site will be based upon verification that the rock is of the proper size, gradation, and strength.

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 prescribed in this Section.

SECTION 306 -- GRANULAR FILL

306.01 -- Description

Granular fill consists of 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 plans.

306.02 -- Material Requirements

The granular material shall meet the requirements in Subsection 1033.02, Paragraphs 1., 2., 3., and Table 1033.02, Class B, unless specified otherwise in the plans or special provisions.

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 percent of maximum density as determined by NDR 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 prescribed 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 plans. The foundation course is built on an approved subgrade. This work includes:

   a. Placement and maintenance of the control lines.

   b. Placement of the foundation course.

   c. Compaction of the foundation course.

   d. Profiling the foundation course.

   e. Disposal of excess material after profiling is completed.

2. There are three types of foundation course:

   a. Aggregate

   b. Bituminous

   c. Crushed concrete

307.02 -- Material Requirements

1. Aggregate Foundation Course:

a. Aggregate foundation course shall consist of siliceous gravel and sand aggregate, soil binder, and water.

b. Aggregate shall conform to the quality requirements of Subsection 1033.02, Paragraphs 1., 2., and 9., and the gradation requirements of Table 1033.10.

c. (1) Soil binder material shall conform to Section 1034 except that:

(i) The gradation requirement does not apply.

(ii) The plasticity index limits shall be 5 to 25.

(2) Soil binder material shall be obtained according to borrow requirements of Sections 205 and 209.

d. At least 14 days before beginning foundation course production, the Contractor shall submit a proposed mix design along with a 80 pound (36 kg) aggregate sample and a 20 pound (9 kg) binder sample to the NDR Materials and Research Engineer for approval. The proposed mix design will:

(1) Result in an aggregate and soil binder mix that complies with the requirements of Table 1033.10.

(2) Propose single defined values for the percentage passing each sieve on the gradation shown in Table 1033.10.

(3) Include the average soil binder and aggregate gradations used to calculate the mix design.

e. The NDR Materials and Research Engineer will evaluate the soil sample characteristics and determine the specific moisture-density values for the proposed foundation course design.

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 shall be described in the special provisions or the plans.

b. All salvaged bituminous material must pass a 2 inch (50 mm) sieve just prior to its use.

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 crushed concrete shall be described in the special provisions or the plans.

b. The Contractor shall submit for approval a 75 pound (34 kg) sample of crushed concrete which the contractor proposes to use in the work. This sample shall be delivered to the Project Manager or to the Materials and Research Division, Central Laboratory at least 14 days prior to placement of the foundation course.

c. The required density of the crushed concrete foundation course shall be shown in the plans.

d. The crushed concrete gradation shall be determined as prescribed in NDR T 27 (washed test). The gradation requirement for the crushed concrete foundation course is shown in Table 1033.11

e. Moisture content shall be no higher than necessary to facilitate compaction to required density.

307.03 -- Construction Methods

1. Aggregate Foundation Course.

a. (1) The Contractor shall place and profile the foundation course as shown in the plans.

(2) (i) The foundation course material shall be mixed and moistened in a twin pugmill mixer.

(ii) The foundation course material shall be mixed at a moisture content between optimum and 3 percentage points below optimum.

(3) Before foundation course placement, the subgrade shall be sprinkled lightly with water.

(4) (i) The foundation course material shall be hauled to the road, spread in a uniform layer, and compacted to at least 100 percent of the maximum density as determined by NDR T 99.

(ii) Material placement shall be in sufficient quantity to allow compaction and profiling of the entire surface of a section.

(iii) Uncontaminated material recovered in profiling one section may be uniformly spread on an adjacent unprofiled section.

b. Control of Foundation Course Mixtures:

(1) The gradation of the siliceous gravel and sand aggregate shall be such that, in combination with soil binder, a resultant mixture complying with the requirements shown in Section 1033, Table 1033.10 will be produced.

(2) The foundation course shall have a resistance to displacement that is satisfactory to the Engineer.

c. Obtaining Material for Foundation Course:

This work shall be performed in accordance with the borrow requirements in Sections 205 and 208.

d. Profiling:

(1) The profiling shall be done with the same type of equipment used for the profiling of the subgrade (see Subsection 302.03). The uncontaminated material recovered in profiling to grade shall be spread uniformly on the surface of the subgrade in the subsequent section.

(2) After compaction, the foundation course shall be trimmed such that the thickness of the crushed concrete foundation course will not vary from the plan thickness by more than 1/2 inch (13 mm).

(3) Sections of foundation course deficient in thickness by more than 1/2 inch (13 mm) shall be corrected at no additional cost to the Department. The Engineer will determine the boundaries of the area to be corrected.

2. Bituminous Foundation Course:

a. The Contractor shall load, haul, 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 trimming of the entire surface after compaction.

b. (1) The Contractor shall roll the bituminous foundation course until no further compaction can be obtained and all roller marks are eliminated.

(2) The Department will establish a rolling pattern for the project and set a density range.

(3) The Contractor shall monitor the rolling pattern with a nuclear density gauge, testing and recording the density every 1/2 mile (0.8 km). The Contractor shall perform additional testing of separately placed irregular areas at the direction of the Engineer.

(4) The Contractor shall take immediate action to correct the foundation course density if any density measurements are outside of the specified range.

(5) The Contractor shall supply the Engineer with a copy of the results of the nuclear density tests at the end of each day.

c. (1) After the foundation course has been compacted and before the surface is trimmed, the thickness shall be measured.

(2) If the thickness of the compacted material is insufficient to permit trimming, the deficiency may be corrected by the placement and compaction of additional material, provided an adequate bond can be established between the compacted surface and the new material. A tack coat may be required.

(3) The trimming operation may be accomplished by milling, if necessary.

(4) During the trimming operation, the control of grade and cross slope shall be through sensors actuated by a taut reference line, erected and maintained by the Contractor, true to line and grade, in order to assure vertical control during the trimming operation.

(5) The accuracy of the preparation of the subgrade and the trimming of the bituminous foundation course will be such that the thickness will not vary from the plan thickness by more than 1/2 inch.

(6) The grade stakes, placed for the purpose of controlling the trimming operation, shall be protected for use in erecting the taut reference line for controlling the elevation of the pavement.

(7) At the Contractor's option, a fog seal may be applied in accordance with the requirements of Section 513.

(8) The Contractor will not be allowed to operate construction equipment on the bituminous foundation course if the placement of portland cement concrete on bituminous foundation course is to be performed with equipment which is designed to deliver the material from a position which is outside of the limits of the prepared surface, unless otherwise approved by the Engineer.

(9) The Contractor will minimize the operation of construction equipment on the bituminous foundation course if the placement of asphaltic concrete is required, unless otherwise approved by the Engineer.

3. Crushed Concrete Foundation Course:

a. The Contractor shall load the crushed concrete at the locations shown in the plans or listed in special provisions, haul it to the project site, and distribute, place, and compact the crushed concrete to form a foundation course as shown in the plans.

b. After compaction, the foundation course shall be trimmed so the thickness of the crushed concrete foundation course will not vary from the plan thickness by more than 1/2 inch (13 mm).

c. The grade stakes, placed for the purpose of controlling the trimming operation, shall be protected for use in erecting the taut reference line for controlling the elevation of the concrete pavement.

4. Foundation course density and thickness testing is the Department's responsibility.

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. a. The foundation course weight that is paid for by the ton (megagrams) of accepted material shall be measured on the Contractor's approved scales under the supervision of the Engineer.

b. At the time of weighing, the moisture content of the combined material for the foundation course shall be between optimum and 3 percentage points below optimum moisture content for the mixture as determined by NDR T 99.

c. Weight tickets shall be prepared in duplicate.

d. A copy of the ticket shall accompany the load to the placement site and shall be furnished to the Engineer. Acceptance of the foundation mixture at the placement site will be based upon verification that the material, when compacted, becomes an adequate pavement foundation.

e. Loads which are not accompanied by weight tickets and/or do not arrive in satisfactory condition shall be rejected.

3. 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.

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 percent 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 shall be considered subsidiary to the relevant foundation course bid item.

6. Payment is full compensation for all work prescribed in this Section.

SECTION 308 -- MEDIAN CONSTRUCTION

308.01 -- Description

Median construction shall consist of placing embankment on non-surfaced medians to the elevations shown in the plans.

308.02 -- Material Requirements

1. Embankment materials shall be obtained from the locations shown in the plans.

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 plans.

2. The work shall be performed in accordance with the requirements of Subsection 304.03.

308.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 309 -- CALCIUM CHLORIDE TREATMENT

309.01 -- Description

This work shall consist of furnishing and spreading calcium chloride for dust control on detours, haul roads, or parking lots.

309.02 -- Material Requirements

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 prescribed in the plans.

2. The initial application of calcium chloride shall be at a rate of 2 lb/SY (1 kg/m^2). The calcium chloride can be applied dry or dissolved in water.

3. Additional calcium chloride shall be applied as needed. The additional applications shall be at the rate and at the time directed by the Engineer.

4. 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. Payment will be made for the actual amount of pure calcium chloride applied.

2. The weight, in tons (megagrams), will be determined on approved scales.

309.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Calcium Chloride Applied	Ton (Tn) [Megagram (Mg)]

2. Water applied at the direction of the Engineer will not be paid for directly, but shall be considered subsidiary to the calcium chloride.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 310 -- ROCK OR GRAVEL SURFACING

310.01 -- Description

This work shall consist of furnishing, delivering, and spreading 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 7.

2. Gravel shall conform to the requirements in Table 1033.07.

3. Crushed rock shall conform to the requirements in Table 1033.08.

310.03 -- Construction Methods

1. The Contractor shall deliver rock and/or gravel to the site specified in the plans or as directed by the Engineer.

2. The Contractor shall spread rock and/or gravel as shown in the plans or as directed by the Engineer.

310.04 -- Method of Measurement

1. a. Rock and gravel surfacing material will be measured by weight or volume.

b. 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 must be filled to a predetermined volume mark on the truck bed.

c. The weight, in tons (megagrams), shall be determined on approved scales.

2. Gravel surfacing material is grouped into lots of 1,000 cubic yards (765 m^3) or 1,350 tons (1,225 megagrams).

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. a. The Engineer shall take 5 random samples from each lot of gravel.

b. The percentage passing the No. 10 (2 mm) sieve for the 5 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 m^3) or 540 tons (490 Mg), then one sample for every 200 cubic yards (150 m^3) or 270 tons (245 Mg) shall be taken and averaged.

e. If the material is less than 400 cubic yards (300 m^3) or 540 tons (490 Mg), then 2 samples will be taken and averaged.

Table 310.01

Gravel 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 prescribed in this Section.

SECTION 311 -- FURNISH ROCK OR GRAVEL

311.01 -- Description

This work shall consist of furnishing and delivering the rock and/or gravel. The point of delivery is shown in the plans 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 7.

2. Gravel shall conform to the requirements in Table 1033.07.

3. Crushed rock shall conform to the requirements in Table 1033.08.

311.03 -- Construction Methods

The Contractor shall deliver the rock and/or gravel to the locations shown in the plans.

311.04 -- Method of Measurement

1. Rock and gravel surfacing material shall be measured by weight or volume.

2. Volume 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 must be filled to a predetermined volume mark on the truck bed.

3. The weight 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. Payment is full compensation for all work prescribed in this Section.

SECTION 312 -- REMOVAL AND PROCESSING OF CONCRETE PAVEMENT

312.01 -- Description

This work shall consist of breaking, hauling, crushing, and stockpiling Portland cement concrete pavement. This work will be paid for under the pay item “Crush Concrete Pavement”.

312.02 -- Material Requirements

1. The portland cement concrete shall be crushed to the requirements in Subsection 1033.02 Paragraph 9. and the gradations shown in Table 1033.11.

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 crushed shall be shown in the plans.

2. The pavement to be removed shall be broken to a size determined by the Contractor.

3. a. Before removing concrete pavement, the Contractor shall remove the preformed cellular flexible polyurethane and 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.

4. During processing, washing the crushed material will not be required unless the specified gradation cannot be met.

5. The crushing operation shall not be performed during periods of precipitation or when the concrete is too wet to obtain the required gradation limits.

6. The crushing operation shall be suspended when winds create an excessive amount of blowing dust.

7. When crushing, the Contractor shall avoid overloading the screens. The Contractor should suspend the crushing operation if the gradation requirements are not being met due to this or any other condition.

8. The Department will sample and test one crushed sample for each 4 hours of continuous crusher operation. If the crusher is operated intermittently, additional samples shall be taken and tested to the extent necessary to assure compliance with the gradation requirement.

9. All reinforcing steel and wire mesh shall be removed from the salvaged concrete prior to or during the crushing operation and shall become the property of the Contractor and be removed from the stockpile area.

10. The Contractor shall stockpile the crushed concrete at the site shown in the plans or as directed by the Engineer.

11. If state property is used for a crushing and stockpiling site, then the Contractor shall clean up and remove from the area all debris, reinforcing steel, and scattered pieces of concrete remaining from the crushing operation; and the work area shall be left in a neat and presentable condition.

12. The Contractor shall dispose of all unused and waste material.

312.04 -- Method of Measurement

"Crush 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**
Crush Concrete Pavement	Square Yard (SY) [Square Meter (m^2)]

2. Deductions from the payment quantity will be made for any equivalent area that is not crushed to the required gradation. The Engineer will determine the equivalent area.

3. Payment is full compensation for all work prescribed in this Section.

DIVISION 400 -- LIGHTING, SIGNS, AND TRAFFIC CONTROL

SECTION 401 -- LIGHTING AND TRAFFIC SIGNAL GENERAL REQUIREMENTS

401.01 -- Description

1. The requirements in this Section apply when the Contractor furnishes and/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. Dynamic message signs

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 the item at no additional cost to the Department and install it.

   a. Specifications for State supplied items are available for viewing at the Nebraska Department of Roads Construction Office, Room 104, 1500 Nebraska Highway 2, Lincoln, Nebraska.

401.02 -- Material Requirements

1. a. The Contractor shall, prior to ordering any material, submit to the NDR Construction Division, for approval, 8 copies of a list showing all roadway lighting system, sign lighting system, and traffic signal system 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 approved before installation. Once approved, 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 approval.

3. The Contractor shall provide submittals as required by Table 401.01. These submittals will be reviewed for compliance with the plans and specifications. 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 manufacturer's warranty and guarantee documentation and all operation and part manuals shall also be given to the Department.

5. All items shown on the "Materials List" will be checked for compliance with the plans and specifications. Two copies of the reviewed "List", showing

approval or disapproval of each specific item, will be returned to the Contractor. If sufficient data is not available to 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 supplier(s) 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 diskette in standard IES format.

8. All materials shall conform to the requirements of Table 401.02.

Table 401.02

Material Requirements	
Item	**Section**
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. a. 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 approved submittals. These lighting and traffic signal materials have been installed in accordance with the National Electric Code and other appropriate electrical safety codes."

b. 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 Systems

1. a. 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.

b. Each circuit's voltage and current readings shall be taken ahead of the contactor and in the base of the light pole furthest from the source.

c. Data from the above tests shall be furnished to the NDR Lighting Engineer in writing.

d. 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.

2. 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 -- 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.

2. a. All permanent lighting systems shall have a grounding conductor (equipment ground) installed throughout the system. 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.

b. The grounding conductor shall be grounded at the 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. All Dynamic Message Sign Supports, controllers, and service disconnects shall be properly grounded by means of a copper clad ground rod and copper grounding electrode conductor. All pull box rings and covers shall be grounded as shown in the plans.

a. All dynamic message sign systems shall have a grounding conductor (equipment ground) installed throughout the system.

b. 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.

401.05 -- General Construction Requirements

1. Electrical Services:

a. In most instances, the location at which the Contractor is to obtain electrical power for a lighting system will be pre-arranged with the local utility, and this location will be shown on the plans. These locations are approximate and subject to change. Services not predetermined shall be arranged for by the Contractor.

b. Electrical services for traffic signals will usually be arranged by the Contractor at the approximate locations shown in the plans.

c. Electric service locations shown in the plans are subject to changes in order to adapt to field conditions. Changes will be determined by the utility and the Engineer.

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 NDR Traffic or Lighting Engineer shall be notified at least 2 NDR work days before energizing any electrical system.

c. Electrical systems shall not be put into operation until the NDR Traffic or Lighting 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.

g. The Contractor shall assist and coordinate their work with Dynamic Message Sign vendor’s representative, who will make the final electrical connections and perform on-site system testing.

3. The installation shall be in accordance with the *National Electric Code* and all governing local ordinances and regulations. Roadway lighting and traffic signal 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 journeyperson 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 not attach or connect any equipment to any utility without specific permission from the owner of the facility. The Contractor shall contact the local electrical utility company 3 work days prior to installing any equipment on the utility's poles or requesting final service connections.

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 Contractor shall not be required to pay for electrical energy consumed by the permanent lighting system or traffic signal system.

9. With the exception of "Safety Lighting Systems", the Contractor shall not be required to pay for electrical energy consumed by temporary lighting systems.

10. The Contractor shall verify the location of all underground utilities as prescribed in the One Call Notification System Act.

401.06 -- Secondary Electrical Connections

1. a. 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.

b. Traffic Signal Systems:

(1) 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 Roads 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.

(2) 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:

(a) 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.

(b) Direct Bury Splice Kits as shown on the NDR Approved Products List.

(3) 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.

(4) Ends of spare conductors shall be sealed with flexible electrical coating compound.

c. Dynamic Message Sign Systems

Cable connections shall only be made in Dynamic Message Sign controller cabinets, Overhead Sign Support bases, 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.

2. 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.

3. Breakaway Connectors:

a. "Breakaway Type" connectors shall be installed in each breakaway pole base as shown in the plans. Line and load sides of the connector shall be identified.

b. The phase conductor(s) 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.

4. An antioxidant compound shall be used on all dissimilar metal connections.

5. a. The Engineer may inspect 5 electrical connections at random.

b. If any of the 5 connections are found unacceptable, 10 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

The Contractor shall furnish and install wire and cable of the size and type shown in the plans. 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

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 (CID) 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 lighting systems shall be installed as conductors in conduit.

2. a. Conductors shall be installed in conduit only after the conduit system is completed and in place.

b. The conduit must be continuous, reasonably dry, completely free of debris, and without any sharp projections, edges, or short bends.

c. 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.

d. 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.

3. 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.

4. 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.

402.04 -- Method of Measurement

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 plans. Cable in Duct (CID) 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)]
_____ 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)]

2. Payment is full compensation for all work prescribed 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 plans. This work 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. In some instances, the Contractor will be required to pick up and install utility supplied predicted cable. The size and type of cable, together with the pick up location, will be shown in the plans. Installation of the cable shall be according to guidelines issued by the utility.

403.02 -- Material Requirements

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 predicted cable as shown in the plans.

2. 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.

3. The cables shall be lifted section by section and placed in the trench in such a manner as to prevent damage to the cables.

4. Cable shall be placed in trenches without dragging or stretching.

5. Cable shall be placed a minimum of 30 inches (750 mm) below ground level.

6. The bottom of the trench shall be firm and level. Sharp objects shall not protrude from the walls or the bottom of the trench.

7. Direct buried wire, cable, and predicted cable shall not be plow-pulled into place.

8. 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 density so that the trench surface will remain level with the surrounding surfaces.

9. a. The cables shall be neatly trained to their destinations in cabinets, pole bases, pull boxes, and all other terminations.

b. 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.

10. 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.

11. Conduit bushings or bell ends shall be installed whenever the conductor enters or leaves a section of conduit or conduit bend.

403.04 -- Method of Measurement

Direct buried wire, cable, and predicted 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 plans.

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 Predicted Cable	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 404 -- AERIAL CABLE

404.01 -- Description

The Contractor shall furnish and install aerial cable of the size and type shown in the plans. 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

Traffic signal and roadway lighting aerial cable and conductors shall conform to the requirements of Section 1073.

404.03 -- Construction Methods

The Contractor shall install the aerial cable in strict compliance with the latest industry standards, practices, and procedures.

404.04 -- Method of Measurement

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 plans 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 prescribed 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 plans. This applies to underground conduit and conduit in or on bridges, median barriers, retaining walls, tunnels, and similar structures. This work 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

Conduit and fittings shall conform to the requirements of Section 1073. The Contractor may use Cable in Duct (CID) in place of cable and conduit on lighting and sign lighting systems only, and the CID shall conform to the requirements of Section 1073.

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. 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.

4. Field bends must be properly formed with appropriate tools and shall not reduce the conduit cross section area.

5. 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.

6. 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.

7. Spare conduits shall be capped or plugged with standard fittings.

8. Unless otherwise provided or directed by the Engineer, underground conduit shall be placed 30 inches (750 mm) below finished grade.

9. The locations of conduit runs indicated in the plans 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.

10. 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.

11. Conduit placed under surfaces which are not to be disturbed may be jacked or augured 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.

12. 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.

13. 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.

14. "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. If the Contractor elects to install the conduit after the paving is in place by either jacking or boring, there shall be no increase in cost to the State.

15. Conduit under surfaced medians may be placed by jacking or auguring. 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.

16. Metallic junction boxes installed in bridges or median barriers shall be drilled and tapped to receive a grounding lug.

17. 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 to protect the cable they carry from chafing or abrasion.

405.04 -- Method of Measurement

Conduit shall be measured in linear feet (meter) for each type and size shown in the plans. 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 (CID) will be measured as 2 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 prescribed in this Section.

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 plans and, if required, install a spare bend in the pull box as shown in the plans. This work shall include furnishing and installing the pull box, spare conduit bend, grounding connectors and ground rod (if required), 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 plans. A spare bend, if required, shall be installed in the relocated pull box as shown in the plans. "Relocate Pull Box, Type PB _____" shall include removing the existing pull box, installing the pull box at the new location, tapping into existing conduit, extending conduit to the relocated pull box, spare conduit bend(s), grounding connectors and ground rod(s) (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 plans.
2. Pull boxes shall be on the NDR Approved Products List.
3. 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

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 PB _____	Each (ea)
Relocate Pull Box, Type PB _____	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 407 -- POLE AND TOWER FOUNDATIONS

407.01 -- Description

1. Concrete Foundations (Conventional and High Mast):

a. Concrete foundations for poles and towers shall be of the size and type shown in the plans. Foundations shall include a ground rod(s), reinforcing steel, anchor bolts, conduit entrance bends, and a spare conduit bend (if required).

b. If the foundation details are not shown in the plans, the Contractor shall obtain the required 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 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 plans. Power installed foundations shall be of the size and type shown in the plans.

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. 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 a conflict situation or at an elevation that would cause the amount of foundation above grade to conflict with specifications for the type of foundation being constructed.

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 and/or elevation.

2. a. For conventional light poles, the Contractor shall construct the size and type of foundations shown in the plans.

b. For high mast towers, the Contractor shall construct foundations according to the design details shown in the plans or to those he/she has been required to furnish.

3. Concrete foundations for both pole and tower installations shall be constructed according to the following:

a. All foundation excavations shall be dry and 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.

4. 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.

c. The Contractor shall backfill and compact around the foundation to 95 percent of the maximum density as determined by NDR T 99.

407.04 -- Method of Measurement

1. If the pole or tower foundation design is shown in the plans, no measurements are necessary as the foundation is subsidiary to the pole and/or tower.

2. If the pole and tower foundation design is not shown in the plans:

a. The pole and tower foundation design is measured by the each per structure.

b. The pole and tower foundation concrete is measured by the cubic yard (cubic meter).

c. Reinforcing steel for the pole or tower foundation is measured by the pound (kilogram).

3. Anchor bolts for the relocated pole and tower foundations are measured by the each.

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. Pole and tower foundations shall be subsidiary to the pole and tower when the foundation design is provided in the plans.

3. Anchor bolts for new pole and tower foundations are subsidiary to the towers and poles.

4. Payment is full compensation for all work prescribed 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 plans and described in the special provisions.

2. This Section describes the 3 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 plans. Each 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) Conventional light poles, unless shown or stated otherwise, shall be furnished complete with pole shaft, base plate, mast arm(s), handhole with cover and watertight gasket, anchor bolts with nuts, nut covers, luminaire(s), foundation, breakaway device (if required), in-line fuses and fuse holders, wire and cable in the pole and mast arm(s), 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, 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 plans. 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 and/or tower with all associated items from its foundation and reinstalling the pole and/or tower on a new foundation at a new location together with removing or breaking back (removing the concrete pole foundation, including steel and anchor bolts to a minimum depth of 2 feet (600 mm) below finish grade) the old foundation and 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.

c. Temporary Pole Installation:

(1) The Contractor shall install temporary poles as shown in the plans. Temporary poles are usually supplied by the Department.

(2) Items not furnished by the Department and required for a complete system will be furnished by the Contractor.

408.02 -- Material Requirements

1. Pole and tower materials shall conform to the requirements of Section 1073 and to the requirements shown in the plans.

2. a. Department-furnished poles and other lighting items and the locations where they are to be picked up are shown in the plans.

b. Items not furnished by the Department and required for a complete system shall be furnished by the Contractor.

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.

3. The entire assembly shall meet all applicable local, county, state, and national codes.

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. 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.

c. Each pole shall be grounded to a ground rod and to the system grounding conductor.

3. Breakaway devices, when used on conventional pole installations, shall be installed in strict compliance with the manufacturer's details and instructions.

4. 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.

This space shall not be grouted but shall be left open for ventilation and covered with a strip of expanded aluminum mesh as shown in the plans.

5. 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.

6. a. Poles and towers being relocated shall be installed at their new locations and connected electrically as shown in the plans.

b. Existing luminaires or traffic signals being reinstalled on relocated poles shall be cleaned and provided with new lamps.

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 must be replaced by the Contractor.

7. a. Aluminum poles may be used in place of steel poles.

b. Design criteria for steel poles will apply to aluminum poles.

c. Aluminum poles shall have bases of cast aluminum.

d. All hardware used with aluminum poles, except the anchor bolts, shall be stainless steel.

8. Foundation dimensions and materials shall be as indicated in the plans. Anchor bolts shall be of the correct size and spacing for the pole(s) being furnished.

9. 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.

10. a. Poles or other lighting items being returned to the State must be disassembled, clean and free of internal wiring. Handhold 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.

b. DR Form 147, "Stock Return for Credit", properly filled in and signed by the Engineer, must accompany the items being returned.

408.04 -- Method of Measurement

Installation and relocation of the various types and sizes of poles, towers, lighting units, and signal 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 prescribed in this Section.

SECTION 409 -- SIGNAL HEADS

409.01 -- Description

1. Traffic Signals and Pedestrian Signals

The Contractor shall furnish and install signal heads of the type and size shown in the plans. 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

The contractor shall furnish and install LED traffic signal modules of the type and size shown in the plans. 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 NDR Approved Products List.

3. LED traffic signal modules shall be on the NDR Approved Products List.

409.03 -- Construction Methods

1. The Contractor shall install signals plumb, level, securely attached with all fittings, and 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

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)
Install LED Traffic Signal Module, Type _____	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 410 -- DETECTORS

410.01 -- Description

The Contractor shall furnish and install pedestrian pushbuttons and vehicle detectors of the type and size shown in the plans.

410.02 -- Material Requirements

1. Vehicle detectors shall be in conformance with requirements in Section 1073.

2. a. Pedestrian pushbuttons shall be of the type and style specifically intended for this application. They shall be housed in a durable casting and be weathertight. 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 buttons.

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. Each sign shall include an arrow to indicate the direction of the crossing to which the button applies.

410.03 -- Construction Methods

1. The Contractor shall install all detectors shown in the plans, 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. 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.

d. The use of sharp instruments such as screwdrivers, etc., is not allowed.

e. Caution shall be exercised at all corners and sharp bends so as not to damage the insulation or introduce undue stresses in the wire.

f. Testing of the loops during and after installation shall be performed in the manner described by the Engineer.

5. 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.

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 plans.

410.04 -- Method of Measurement

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 prescribed 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 plans. The Contractor shall take care that all conduits within the cabinet are 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.

2. All equipment required to be installed on the power pole, such as 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

The controller shall be placed on a concrete pad as shown in the plans. 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 plans.

411.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 412 -- LUMINAIRES

412.01 -- Description

The Contractor shall furnish and install luminaires of the size and type indicated in the plans.

412.02 -- Material Requirements

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 plans.

c. Unless otherwise indicated in the plans 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 plans.

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 may determine the need for adjustments to the luminaires.

e. When shielding is required, shielding methods proposed must be approved by the NDR Lighting 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 plans. 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 plans.

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 plans and in accordance with the manufacturer's instructions.

b. The lamps shall be 150 watt high pressure sodium or as shown in the plans.

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 plans. 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 plans.

d. Unless otherwise indicated in the plans 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

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 prescribed 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 plans. 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 plans. 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 prescribed new location and connected electrically as shown in the plans. 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 prescribed in the plans.

4. 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 plans. The Contractor shall provide all other materials required for a complete installation and shall install all materials as shown in the plans.

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 DR Form 146, "Stock Requisition." The Contractor will not be issued materials without a properly completed "Stock Requisition."

413.02 -- Material Requirements

Lighting control centers shall conform to the requirements shown in the plans and Section 1073.

413.03 -- Construction Methods

1. In most instances, 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 plans. Lighting control center locations are approximate and subject to change.

The Contractor will be required to contact the Utility Company and NDR prior to installing the conduit, cable, and lighting control center to determine if the location for the electrical service remains as shown in the plans. If the location for the service has changed, the Contractor shall advise the Project Manager of this change and shall refrain from installing the lighting

control center, conduit and cable until he has received the Project Manager's approval of a new location.

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 plans 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

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. Payment is full compensation for all work prescribed in this Section.

SECTION 414 -- HIGH MAST LOWERING SYSTEMS

414.01 -- Description

The Contractor shall furnish and install a new high mast lowering system on a new or existing tower as indicated in the plans. 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.

414.02 -- Material Requirements

High mast lowering systems shall be on the NDR Approved Products List.

414.03 -- Construction Methods

1. 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.

2. Installation of a new high mast tower lowering system may require some modification to the tower. Modifications shall be made as detailed in the plans or as directed by the Engineer.

3. The installation of an approved lowering system shall be under the direct supervision of a qualified representative of the manufacturer. The manufacturer's representative shall be on site to advise the Contractor during the installation of at least one complete assembly. Duties of the manufacturer's representative shall include, but not be limited to, the following:

a. Directing all adjustment to the lowering system to insure positive latching and unlatching. This will consist of a minimum of 3 complete raising and lowering cycles without malfunction.

b. Educating the maintaining utility and/or NDR personnel in the methods of proper maintenance to avoid lowering system malfunctions together with the proper procedures to follow in the event of a malfunction.

414.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 415 -- PROJECT LIGHTING SYSTEM MAINTENANCE

415.01 -- Description

1. "Project Lighting System," when used in this Section, shall be taken to mean all the lighting units and their associated circuitry (conduit, cable, and controls) located within the limits of the project. A lighting unit is a pole, luminaire, and, usually, a mast arm and breakaway device. Occasionally included are, tennon top and anchor base units.

2. The Contractor will 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.

3. The Contractor will be totally responsible for any damage caused by his/her forces to any existing equipment like lighting units, pull boxes, controls, or conduit and cable. Any damage shall be repaired within 24 hours. 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.

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 must be on the NDR Approved Products List.

415.03 -- Construction Methods

1. 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.

2. Lamps for all units will be supplied by the Contractor.

3. If for any reason a lighting unit fails or is damaged, it shall be repaired or replaced and put back in working order within 24 hours from the time of failure or damage.

415.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 416 -- TEMPORARY LIGHTING SYSTEMS

416.01 -- Description

1. Temporary lighting systems are used to provide illumination on temporary traffic ways such as detours, fly-by lanes, and traffic crossover lanes through and/or around zones of construction.

2. The Contractor shall install the temporary lighting systems as prescribed in the plans. The plans shall indicate whether poles, luminaires, lamps, photo controls, power foundations, and breakaway bases are to be Department or Contractor-furnished.

3. The Contractor shall operate and maintain the lights daily from dusk to dawn throughout the construction period. The Contractor will be responsible for the proper operation and maintenance of the temporary lighting system. Any failure or malfunction of the system shall be promptly corrected by dusk of the following day.

416.02 -- Material Requirements

1. a. The poles, luminaires, lamps, photo control, power foundations, and breakaway bases will be furnished by the Department or the Contractor as indicated in the plans.

b. All other lighting materials such as replacement lamps, connector cables, fittings, and splice kits are to be furnished by the Contractor.

c. The Contractor shall obtain the State-furnished materials from the NDR's storage area at Lincoln, Nebraska. The Contractor will be responsible for transporting the material from the NDR storage area to the job site.

2. Contractor-furnished lighting units and all other items required for a complete system shall conform to the requirements in the plans and specifications.

3. 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 prescribed in Subsection 109.06.

4. In the event of damage to or failure of a lighting unit on a Department-furnished system, the Department will provide additional lighting units for replacement by the Contractor.

5. a. When the temporary lighting units are no longer required, the Contractor will carefully dismantle, clean, and return the salvaged material to the Department's storage area indicated in the plans. All components not ordered salvaged will become the property of the Contractor and removed from the project.

b. The Contractor shall notify the NDR storage area superintendent 2 days before delivery of the materials to the storage area. Upon delivery, the

materials shall be placed in the storage area at the location(s) designated by the storage area supervisor.

6. When the units are returned:

a. All luminaires are to have the photo control removed and the photo control receptacle and the luminaire mounting hole covered with duct tape. Photo controls will become the property of the Contractor.

b. All poles shall have handhold covers fastened securely in place.

c. Power foundations and transformer bases shall have all associated bolts, nuts, and washers attached. Breakaway support couplings are to be bundled in sets of 4 held together with duct tape with all bolts, nuts, and washers fastened in place on the couplings.

7. a. The plans shall indicate whether the Contractor or the Department arranges and pays for electrical power.

b. 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. The power source must be a dependable, well regulated source of power adequate for the requirements of the lighting system.

c. Where power to the temporary lighting system is arranged for by the Department, the Contractor will not be responsible for the cost of the electrical energy required for the operation of the temporary lighting.

416.03 -- Construction Methods

1. 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.

2. When shown in the plans, the Contractor shall be responsible for providing the electrical power and connecting it to the lighting system.

3. It will be the Contractor's responsibility to protect the 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.

416.04 -- Method of Measurement

1. a. Installation of Contractor and Department-furnished temporary lighting systems shall be measured by the each.

b. 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.

c. When the bid proposal's Schedule of Items contains the pay item "Install Temporary Lighting System, Type _____", the temporary lighting

system components are provided by the Department.

2. Operation and maintenance of the temporary lighting systems 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)
Install 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 prescribed in this Section.

SECTION 417 -- HIGHWAY SIGNS

417.01 -- Description

This work shall consist of all materials and labor necessary to provide, fabricate, and install highway signs at the locations shown in the plans.

417.02 -- Material Requirements

1. Materials for highway signs shall conform to the requirements of Section 1070 and 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 reflective sheeting and the message either directly applied or reverse screened on the sign face, all in the colors specified in the plans. 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 having a sheeted with reflective sign sheeting and direct applied letters, numerals, symbols, and border.

2. a. "Type A Signs" shall be mounted on breakaway posts made from aluminum, steel, or wood as indicated in the plans.

b. Type B ground mounted signs are to be mounted along the roadside as shown in the plans and supported by structural steel beam breakaway posts with the post stub extending into round, reinforced concrete footings.

c. Type B overhead signs are to 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. Letters, numerals, symbols, and the border for "Type B Signs" shall be reflective materials meeting the requirements of ASTM D 4956 for Type VII or VIII sheeting direct applied or detachable copy.

4. Reflective background sheeting for all signs shall meet the requirements of ASTM D 4956 Type III.

5. All concrete shall be Class 47B-3000 conforming to the requirements of Section 1002.

417.03 -- Construction Methods

1. The Contractor shall prepare the sheet aluminum for reflective sheeting on both Type A and B 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. (1) The aluminum sheet and extrusheet panels shall be acid etched in a 6 to 8 percent 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.

(4) 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.

(5) There shall be no opportunity for metal to contact greases, oils, or other contaminants before the application of reflective sheeting.

2. a. (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.

b. Reflective sheeting shall be mechanically applied to properly treated base panels using the sheeting manufacturer's recommended procedures and equipment.

c. After aging 48 hours at 75°F (24°C), adhesion of reflective 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. (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 plans.

b. (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 plans.

4. a. The extrusheet panels for each sign shall be of the length and width specified in the plans.

b. The width of the top, intermediate, and bottom panels shall be in the sequence shown in the plans 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 plans.

g. The vertical supports shall be flush with the top of the sign.

5. a. (1) Letters, numerals, symbols, and border for Type B signs shall be directly applied.

(2) 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.

b. 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.

c. 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 plans.

7. a. 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. (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. a. Type B signs shall be erected so that the sign face is vertical and positioned as shown in the plans. 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.

b. Type B 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.

c. Type A signs shall be fastened to sign posts with threaded bolts as prescribed in Section 1071.

9. a. The Contractor shall drill wood posts as shown in the plans to provide a breakaway feature.

b. (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.

10. The fuse plate bolt shall be tightened by the turn-of-the-nut method prescribed in Subsection 708.03. The base connection assembly shall follow the procedure outlined in the plans which shall include rechecking the torques until all bolts in the base have the prescribed torque. This procedure shall be repeated immediately preceding the final inspection of the project.

11. a. Footings for roadside mounted signs on steel beam breakaway posts shall be concrete.

b. The footing shall be circular in shape and of the diameter and depth shown in the plans.

c. Before placing concrete footings, stub posts shall be placed so the posts are plumb and correctly spaced.

d. Footings shall be no higher than 4 inches (100 mm) above the ground to prevent snagging.

e. Footing construction shall be in accordance with the applicable requirements of Sections 702, 704, and 707.

12. 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 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 and B signs shall be measured by the square foot (m^2).

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)]
Install Type A Sign	Square Foot (SF) [Square Meter (m^2)]
Install Type B 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 is subsidiary to the relevant pay item.

4. Payment is full compensation for all work prescribed 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 plans (including attachment of sign brackets to the structure).

(4) Providing the Department copies of the manufacturer's designs of the overhead sign support structure and the reinforced concrete foundations for all sign support structures. Steel cantilever and steel truss or aluminum box truss structures shall be manufacturer-designed. Bridge brackets shall comply with the design provided in the project plans.

b. Aluminum or steel trusses that span multi-lane roadways 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 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 (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. 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.

c. Anchor bolts of the specified size for each support shall be supplied in a welded assembly by the manufacturer (no welding on the anchor bolts will be permitted) to ensure proper bolt spacings and alignment. 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 permitted. The bolts shall be truly vertical, with no more than a 1/8” deviation in 12” (3 mm in 300 mm) of length permitted. All cantilever sign structures shall use a **minimum** of 6, 2-inch (50 mm) diameter bolts.

d. A two-inch (50 mm) diameter non-metallic electrical conduit shall be installed in each foundation as shown in the plans, with caps on both ends

to keep the conduit clean until wiring is installed.

5. Anchor Bolts for Overhead Sign Supports:

a. The structure manufacturer shall design and furnish the anchor bolts in accordance with AASHTO M314 Grade 55 and designed for fatigue. A bolt sample (including nuts and washers) from each heat of steel used on the project (or multiple projects) shall be submitted to the Materials and Research Division for destructive testing. Threads on anchor bolts shall be rolled in accordance with standard industry practice, the use of cut threads shall not be permitted. The top 12 inches (300 mm) of the anchor bolt shall be cleaned and painted with zinc rich paint prior to shipment with a minimum dry film thickness of 4 mils (100 μm). The type of paint and the method of application shall be as approved by the Materials and Research Division. After installation the Contractor shall touch-up paint threads using approved methods.

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. The plate washer shall conform to the requirements of ASTM A 36/A 36M. Only flat washers shall be used, the use of lock washers shall not be permitted.

d. 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. Full 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) The sign spans, sign locations, and sign mounting heights used for structure calculations shall be as shown in the plans.

(3) The design areas used for calculations shall be the sign areas shown plus 30 percent or as noted on the plans.

b. (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.

(3) 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.

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 ¼" out in 3 feet] (6 mm in 900 mm).

d. 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 must be performed by individuals proficient in that line of work.

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.

The foundation design drawings and computation must 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.

The minimum foundations design acceptable will be one detailing six – 2 inch (50 mm) diameter anchor bolts of AASHTO M-314, Grade 55 or Equivalent Steel. 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 Requirements.

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 dirt 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 *NDR Approved Products List*.

f. Corrosion of aluminum caused by contact with dissimilar metals shall be prevented by proper design considerations and installation procedures.

g. (1) The structure shall be lighted with walkways provided in front of and in back of the entire length of the signs.

(2) The walkways shall be continuous to the vertical access point/support.

(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.

(5) The 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).

(6) Both front and back walkways (closest to cantilever arm) shall extend a minimum of 2 feet (600 mm) beyond the sign's vertical edge.

(7) Vertical deflection of the cantilever arm shall be limited to L/120.

h. 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.

i. Sign lighting and electrical equipment for the structure shall be in accordance with the applicable requirements of Sections 401 to 413 and 1073.

j. Connecting bolts on structures will be ASTM A 325 Type I, galvanized.

k. 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 plans, the finished diameter of the holes shall be not more than 7 percent 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 plans. Sign brackets shall be painted in accordance with the applicable requirements of Section 709 and as required by the plans.

3. Aluminum Welding Requirements:

a. (1) The aluminum alloys shall be welded in accordance with the ASTM requirements listed below:

Wrought heat-treatable alloys Alloy 6061 Alloy 6063 Cast heat-treatable alloy Alloy 356.0

(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 percent helium and 25 percent 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 percent 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 percent for amperage and plus or minus 7 percent 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 of 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 prescribed 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 prescribed 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 ¾" diameter and a Standard Combination wrench 36 inches in length for bolts equal to or greater than 1 ¾" 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 ¾", 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 ¾" 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 *NDR 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 plans. 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 plans.

b. The luminaires shall be on the *NDR Approved Products List.*

c. The sign lighting luminaires shall be mounted as shown in the plans and in accordance with the manufacturer's instructions.

d. The lamps shall be 150 watt high pressure sodium unless shown otherwise in the plans.

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 signs.

b. The structures that will support the Type B signs shall be constructed in conformance with Sections 417, 702, 704, 707, and 708 and as prescribed in the plans.

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. Final measurement for concrete reinforcing steel, and anchor bolts will be based on the shop plan quantities. The quantity of concrete for which payment will be made shall be the quantity arrived at using the design dimensions of the sign structure foundation. No payment will be made for concrete placed outside these dimensions.

418.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Overhead Sign Support, Location _____	Each (ea)
Sign Structure Foundation Design, Location _____	Each (ea)
Concrete for Foundation	Cubic Yard (CY) [Cubic Meter (m^3)]
Reinforcing Steel	Pounds (lbs) [Kilograms (kg)]

2. The reinforced concrete footing and anchor bolts required for the overhead sign support shall not be paid for directly, but shall be subsidiary to the item, "Overhead Sign Support, Location _____".

3. The anchor bolt assemblies shall not be paid for directly, but shall be subsidiary to "Overhead Sign Support, Location _____".

4. The sign structure grounding system is subsidiary to the item “Reinforcing Steel”.

5. Excavation for foundations is subsidiary to the item “Sign Structure Foundation Design, Location _____".

6. Soil borings and soil analysis for the sign structure foundation is subsidiary to “Sign Structure Foundation Design, Location _____".

7. Payment is full compensation for all work prescribed in this Section.

SECTION 419 -- PLOWABLE PAVEMENT MARKERS AND REFLECTORS

419.01 -- Description

This work shall consist of furnishing and installing two-way, plowable, all weather, abrasion resistant, prismatic, reflective pavement markers and/or removing and replacing the reflectors in accordance with the plans.

419.02 -- Material Requirements

1. Only plowable pavement markers and plowable pavement marker reflectors that are on the NDR Approved Products List shall be installed.

2. Epoxy shall meet the marker manufacturer's requirements.

419.03 -- Construction Methods

1. The Contractor shall install the plowable markers and reflectors in accordance with the manufacturer's instructions.

2. The markers shall be free of dirt, dust, oil, grease, rust, moisture, or any foreign matter which will impair adhesion to the pavement at time of installation.

3. Before beginning installation, the Contractor shall accurately and adequately lay out the location of all pavement markers to assure their proper placement and alignment. No marker shall be more than 1/4 inch (6 mm) or 10 degrees out of alignment with the locations shown in the plans.

4. a. Pavement markers shall not be placed on pavement surfaces that show visible evidence of cracking, checking, spalling, or failure of underlying base material.

b. If, during the pre-installation layout operation, it is determined that a marker would be placed at a point with a pavement surface defect, at a pavement construction joint, or within the intersection of a driveway or public street as the result of typical marker spacing, the affected marker shall be relocated longitudinally a sufficient distance to a point not to exceed 10 percent of the typical marker spacing or as approved by the Engineer.

5. a. The Contractor shall saw cut the pavement to the marker manufacturer's recommended dimensions.

b. Before placing the marker in the cut, the cut shall be brushed or blown clean.

c. Epoxy shall be placed in the cut in accordance with the manufacturer's recommendation.

d. The Contractor shall apply constant foot pressure for 30 seconds to seat the marker in the epoxy.

e. The 4 lugs on the marker shall rest on the pavement.

6. At the end of each day, markers shall be set and epoxied in place in all marker cuts.

7. a. The Contractor may attach the prismatic reflector to the casting in the field or in a shop.

b. If the reflector is attached in the field, it shall not be attached to the casting until after the adhesive in the pavement slots has properly hardened.

c. Any rust or foreign matter shall be removed from the surface of the casting on which the reflector is to be attached. The recessed attachment area shall be painted with an adhesive primer in accordance with the manufacturer's instructions.

d. The release paper shall then be peeled from the butyl adhesive on the bottom of the reflector, and the reflector shall be inserted into the recessed attachment area and pressed into place until a firm bond has been made with the casting.

e. The Contractor shall press the reflector into place with constant foot pressure applied for 30 seconds.

8. When the Contractor is required to remove and reinstall plowable pavement markers, the markers shall be refurbished to a like new condition before reinstallation. New reflectors shall be installed in the casing as part of the refurbishment process.

419.04 -- Method of Measurement

Plowable pavement markers will be measured for payment by the each.

419.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

Plowable Pavement Marker	Each (ea)
Install Pavement Marker	Each (ea)
Remove and Reinstall Pavement Marker	Each (ea)
Plowable Pavement Marker Reflector	Each (ea)

2. The item “Plowable Pavement Marker Reflector” shall include removing the existing reflector, cleaning the casting as required, and replacing with a new reflector.

3. Payment is full compensation for all work prescribed 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 plans. 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 plans 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 plans.

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. Chevrons (W1-8) are a Type A sign [18” X 24” (450 mm x 600 mm)] or as indicated by the plans.

420.02 -- Material Requirements

1. All reflectors for delineators and all flexible delineator posts shall be on the NDR 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 results in little or no damage to impacting vehicles.

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 plans) 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 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.

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 prescribed in this Section.

SECTION 421 -- REMOVING AND RESETTING DELINEATORS

421.01 -- Description

The Contractor shall remove and reset flexible post and standard delineators at the locations shown in the plans.

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 prescribed in the plans.

421.03 -- Method of Measurement

Removing and resetting delineators will be measured by the each.

421.04 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Remove & Reset Delineators	Each (ea)
Remove & Reset Flexible Post Delineators	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 422 -- TEMPORARY TRAFFIC CONTROL DEVICES

422.01 -- Description

1. This work consists of furnishing, installing at the locations shown in the plans, operating, maintaining, and when work is complete, removing the temporary traffic control devices described in this Section.

2. General Requirements:

a. All traffic control devices shall be located according to and meet all requirements prescribed in the MUTCD. 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.

b. (1) All barricades and signs shall be constructed and erected in accordance with the plans. Type A, B, and C barricade lights shall be on the NDR approved Products List.

(2) Temporary signs and temporary (portable) sign supports shall meet National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 requirements.

(i) The Contractor shall furnish “Temporary Signs”. The Contractor shall install “Temporary Signs” at the locations shown in the plans, maintain “Temporary Signs”, and, when no longer needed, remove the “Temporary Signs”.

(ii) All “Temporary Sign” supports (bases) shall be NCHRP 350 (TL-3) approved.

(iii) “Temporary Signs” are all temporarily mounted work zone signs that are not post-mounted in the ground at the typical 5’ (1.5 m) mounting height. Temporary signs are considered NCHRP 350 category 2 devices and are mounted on temporary sign stands. Temporary signs are generally mounted a minimum of 1’ (300 mm) above the ground, unless otherwise required to be mounted at a higher height.

(iv.) Temporary signs shall not be in place longer than 3 days. Any sign that is to be in place longer than 3 days shall be post mounted.

(v.) All stub steel posts used for temporary traffic control devices shall be removed immediately by the Contractor when a sign is no longer required at that location.

c. The initial placement, replacement, and removal of the lane dividers and other traffic control devices shall be done with extreme care and consideration for the traveling public.

d. Traffic control devices shall not be removed without the Engineer's approval.

e. The barricades and other traffic control devices, except materials furnished by the Department, shall remain the property of the Contractor.

f. (1) The Contractor shall provide hard covers for signs left in place and currently not in use.

(2) The covers shall be the same size as the sign and completely cover the sign when installed.

(3) Bolting the cover to the sign by drilling holes through the sign will not be allowed.

(4) 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.

(5) The cover will be fastened so that it will not come loose or damage the sign during normal or windy conditions.

(6) Spacer blocks are allowed in the border area of the sign.

g. The Contractor shall maintain a stock of spare lights, signs, devices, and repair parts at the project site for immediate emergency replacement or repairs.

h. 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.

i. 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.

j. (1) The Contractor shall take all necessary precautions for the protection of the work and the safety of the public.

(2) (i) 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.

(ii) 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.

(3) Type A, B, and C barricade warning lights shall comply with the requirements for warning lights in the MUTCD.

k. (1) The Contractor may be given notice, either written or verbal, of failure to install, replace, remove, or maintain a traffic control device.

(2) Upon notification by the Engineer, the Contractor shall respond to any site within 4 hours and take immediate steps to correct the deficiency.

(3) 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.

(4) 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.

(5) 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.

l. 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.

m. The Contractor shall immediately notify the Engineer of any hazard or changed roadway condition that is not identified in the plans.

n. 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.

o. 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.

3. Asphalt Pavement:

a. The Contractor shall control the traffic to protect any new bituminous surface work including patches, prime coat and tack coat as described in Division 500 and the plans.

b. Public traffic will not be allowed on new asphalt surfaces until compaction rolling is complete and the surface has cooled to less than 165°F (74°C).

c. When a detour is not shown in the plans, the Contractor may restrict the traveling public to one-way traffic. This restriction shall be limited to the minimum time and distance required to properly compact the mixture and allow sufficient reduction in temperature to prevent displacement of the surface or damage to the surface treatment and/or edges of the newly placed surface. Two-way traffic shall be allowed on the remainder of the project unless there are other traffic restrictions.

d. When traffic is restricted to one lane, the Contractor shall place at least one flagger at each end of the restricted section.

4. Temporary Pavement Markings:

a. (1) The pay item “Temporary Pavement Marking, Type _____” has 4 options and is used on major construction such as phased PCC pavement, bridges, and shooflys.

- 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 plans or other contract documents. The options are:

- Temporary Pavement Marking, Type I (Tape)
- Temporary Pavement Marking, Type II (Tape)
- Temporary Pavement Marking, Type Paint.
- Temporary Pavement Marking, Type RPM

(3) The application and type of pavement marking to be used shall be as specified in the project plans or as directed by the Engineer.

(4) All temporary pavement marking shall conform to the requirements in this Section for materials, equipment used, application, measurement and payment.

b. (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 (see Paragraph 4.c. below for requirements)

(ii) Tape – Type I (see Paragraph 4.d. below for requirements)

(iii) Tape – Type II (see Paragraph 4.d below for requirements)

(iv) Raised pavement markers (see Paragraph 4.g. below for requirements)

(3) Plans will indicate the appropriate marking material to be used. If the plans or other contract documents do 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 shall consist 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. They will be placed in the locations specified in the project plans or as directed by the Engineer.

(2) Temporary Traffic Paint that fails to provide a uniform appearance, or which fails to be clearly visible during the day or night shall be corrected or replaced by the Contractor in a manner acceptable to the Engineer and at no additional cost to the Nebraska Department of Roads.

(3) 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.

(4) The bead dispenser shall be equipped with an automatic cutoff control synchronized with the cutoff on the striping material.

d. Temporary Pavement Marking, Type I and II (tape):

(1) This work shall consist of the application of preformed temporary pavement marking tape meeting the materials requirements of section 1069.02 paragraphs 1 and 2 of the current Nebraska Department of Roads, Standard Specifications for Highway Construction.

(2) Type I tape will generally be used for asphalt projects.

(3) 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.

e. "_____Temporary Pavement Marking Type_____" is the pay item for temporary arrows, words, and symbols on all asphalt and PCC pavement. These markings can be either painted with beads or tape as indicated in the pay item.

f. Temporary pavement marking ("Temporary Pavement Marking, Type _____" and "Temporary Pavement Marking", and "_____ Temporary Pavement Marking, Type ___") includes removal of the markings when they are no longer needed at no additional cost to the Department.

g. The Engineer may approve the use of raised pavement markers for yellow solid lane lines with a maximum spacing of 5 feet (1.5 m). They may also be used as right edge lines, but **only** when shown in the plans.

h. Any broken or solid lines that fail to meet dimensions or spacing in Tables 422.01 and 422.02 shall not be accepted and no payment will be made for **all** pavement marking applied that day, until correct installation (to the satisfaction of the Engineer) resumes.

i. 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 plans or the Engineer.

j. The plans and the Specifications will indicate where each type of temporary pavement marking will be applied. The Engineer may direct the Contractor to apply any of the four optional temporary pavement marking line materials as are necessary for safe traffic flow.

5. National Cooperative Highway Research Program (NCHRP) Report 350 Requirements.

a. Contractor furnished 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. 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) All new Category 2 devices purchased or built after October 1, 2000 shall be NCHRP 350 (TL-3) compliant; and Contractors shall certify that all devices purchased or built after October 1, 2000 are NCHRP 350 compliant.

(ii) The Contractor shall provide the Engineer a copy of the FHWA acceptance letter for all NCHRP 350 (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) TMA's and WZCC purchased after October 1, 1998 must comply with NCHRP 350 TL-3. Existing TMA's and WZCC may be phased out as they complete their service life.

(ii) The Contractor shall provide the Engineer a copy of the FHWA acceptance letter for all NCHRP 350 (TL-3) Category 3 devices when supplied by the Contractor.

(iii) 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. The compliance date for Category 4 devices has not been determined.

422.02 -- Material Requirements

1. a. Warning Signs – The Department will furnish the permanent sign messages on an appropriately sized panel at one of the permanent maintenance headquarters located throughout the State. These are as follows:

Maintenance Headquarters			
Ainsworth	Geneva	Mullen	Scottsbluff
Alliance	Grand Island	Neligh	Sidney
Bridgeport	Hastings	Norfolk	South Sioux City
Broken Bow	Holdrege	North Platte	Tecumseh
Chadron	Imperial	Omaha	Valentine
Columbus	Kearney	O'Neill	Wayne
Fairbury	Lincoln	St. Paul	York
Fremont	McCook		

b. Temporary Signs

(1) Contractor-furnished "Temporary Signs" shall consist of approved retroreflective fluorescent orange or white roll-up signs mounted on temporary sign stands. The sign with stand shall be NCHRP-350, Test Level 3, approved. The roll-up signs shall be of the size and shape required by the plans. The color and design of the roll-up signs shall be as required by the MUTCD and the NDR Traffic Engineering Division. Sign legends and symbols shall be of professional quality workmanship and in uniformity with the Standard Highway Signs design guide. Temporary signs shall meet the requirements of the American Traffic Safety Services Association (ATSSA). "Quality Standard for Work Zone Traffic Control Devices", hand printing or poor workmanship shall not be allowed. The Contractor shall provide the Engineer a copy of the FHWA acceptance letter for all Category 2 "Temporary Signs" before they are used.

(2) Rigid plastic sign substrates that have been approved to NCHRP 350 (TL-3) may be used for roll-up signs. When used, the plastic sign substrate with sign sheeting and temporary sign support shall, all together as a single, testing unit, be NCHRP 350 (TL-3) approved. Aluminum sign substrates shall not be used.

(3) The temporary sign stands have enough vertical rigidity to support the roll-up signs 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, and temporary sign stands that fail to provide adequate visibility of the sign shall not be allowed.

(4) Retroreflective, orange fluorescent sheeting used for temporary, roll-up signs shall be on the NDR Approved Products List.

(5) Signs required for flagging shall meet the "Temporary Sign" requirements of this Section (422).

(6) "Contractor Furnished Sign Day" shall consist of approved retroreflective fluorescent orange or white signs mounted on NCHRP-350 approved traffic control devices, i.e. Type III Barricades or Plastic Drums. The Contractor furnished sign, mounted on a traffic control device, shall together be NCHRP-350 Test Level 3 approved. The signs shall be of the size and shape required by the plans. The color and design of the signs shall be as required by the MUTCD and the NDR Traffic Engineering Division. Sign

legends and symbols shall be of professional quality workmanship and in uniformity with the Standard Highway Signs design guide. Contractor furnished Signs shall meet the requirements of the American Traffic Safety Services Association (ATSSA), "Quality Standard for Work Zone Traffic Control Devices", hand printing or poor workmanship shall not be allowed.

Rigid sign substrates that have been approved to NCHRP 350 (TL-3) mounted on a traffic control device may be used.

Retroreflective orange fluorescent sheeting used for Contractor Furnished Signs shall be on the NDR Approved Products List.

2. The following items shall meet the requirements prescribed in the *Manual on Uniform Traffic Control Devices*:

a. Barricades (Type II & III)

b. Temporary Traffic Signals

c. Concrete Protection Barriers

d. Vertical Panels

e. Type B High Intensity Warning Lights

3. The following items must be on the NDR Approved Products List to be used on a Department project:

a. (1) Temporary Pavement Marking, Type I, II, & RPM.

(2) Overlay Broken Lines and Overlay Solid Lines (Type I, II, & RPM).

b. Inertial Barrier Systems

c. Flashing Arrow Panels

d. Tubular Posts

e. Opposing Lane Dividers

f. Temporary Glare Screen

g. Changeable Message Signs

h. 42" (1070 mm) Reflective Cones

4. 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 on the NDR Approved Products List.

5. The reflective sheeting on 42-inch (1067 mm) cones shall be fluorescent orange flexible sheeting.

422.03 -- Construction Methods

1. a. The Contractor shall install, maintain, and remove all signs in accordance with the details of and at the locations shown in the plans.

b. The Contractor shall furnish all necessary posts, support standards, bolts, or other fasteners for signs.

c. For the purpose of protecting and controlling traffic through or around a construction project, permanent signs are defined as those signs which provide protection and control on a 24-hour-per-day basis. All other signs shall be considered as temporary signs, including signs designated in the plans as "Temporary Signs", which must remain in place for variable periods of time. Construction speed zone signing shall be considered temporary signing and shall only be installed during those periods when the speed zone is required.

d. Permanent signs, complete with posts, bolts, or other fasteners, shall be placed at the time construction work begins in compliance with the applicable conditions of the standard and/or special plan(s) and shall be used until permission is granted, in writing, by the Engineer that the work is complete and that they may be removed.

e. Posts used to erect permanent signs shall be installed and maintained plumb, and the sign faces shall be positioned and maintained so that they face approaching traffic.

f. Signs shall be disassembled and returned to the maintenance headquarters from which they were obtained, or to a location designated by the Engineer, during normal working hours.

g. (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.

(3) If signs are damaged while issued to the Contractor, then the Contractor will be charged the replacement cost.

h. Steel drums shall not be used as sign holders.

i. (1) "Temporary Signs" shall be installed as shown in the "plans", "Standard Plans", or "Special Plans".

(2) "Temporary Signs" shall be installed as prescribed in the MUTCD.

j. (1) “Contractor Furnished Signs” shall be installed as shown in the plans, or as directed by the Engineer.

(2) “Contractor Furnished Signs” shall be installed as prescribed in the MUTCD.

2. Barricades:

a. This work consists of providing, installing, maintaining, and when no longer required, removing barricades and reflectorized drums at the locations shown in the plans or designated by the Engineer.

b. The *Manual on Uniform Traffic Control Devices* defines 2 types of barricades authorized for use in Nebraska:

(1) Type II

(2) Type III

c. 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.

d. When approved by the Engineer or shown in the plans, 42” (1070 mm) reflective cones may be used in lieu of Type II Barricades or Reflectorized Drums. 42” (1070 mm) reflective cones shall include a 30-pound (14 kg) rubber base and display four 6-inch (150 mm) wide bands of fluorescent orange flexible sheeting from the NDR Approved Products List. The bands shall alternate orange-white-orange-white. 42” (1070 mm) reflective cones shall not be used for lane-closure tapers or shifts, or the dropoff at the edge between the pavement and the shoulder.

3. Flagging:

a. (1) It shall be the responsibility of the Contractor to furnish flagger(s) to direct traffic when construction activity occurs on or adjacent to a surface being used by the traveling public.

(2) Except when necessitated by an emergency situation or for situations not reasonably expected to last for more than 15 minutes, flagging shall not be performed by other than certified flaggers. Flaggers must always carry a valid Flagger Certification Card. Flagger Certification Cards shall be valid for a period of 2 years from date of issue.

b. (1) The flagger(s) 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 plans and specifications.

(2) Flaggers shall position themselves appropriately and according to accepted flagging procedures.

c. (1) 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.

(2) 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.

d. 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 percent of the questions on an examination that accompanies the video.

e. Upon satisfactory completion of the training and examination procedure, the prospective flagger shall be issued a Flagger Certification Card by the examining Contractor. The flagger's name, social security number, and test score shall be reported to the Construction Engineer on DR Form 90, "Flagger Certification Report".

f. 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.

4. Temporary Traffic Signal:

a. Temporary traffic signal systems shall be furnished, installed, operated, and maintained by the Contractor at the locations shown in the plans.

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.

c. (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.

5. Concrete Protection Barriers:

a. (1) Concrete protection barriers shall be furnished by the Department and installed by the Contractor at the locations shown in the plans or designated by the Engineer for the pay item "Install Concrete Protection Barrier".

(2) The Contractor shall furnish and install concrete protection barriers at the locations shown in the plans or designated by the Engineer for the pay item "Concrete Protection Barrier".

(3) The repositioning of concrete protection barriers to locations directed by the Project Manager or as shown in the plans after the initial installation is included in and defines when the pay item “Relocate Concrete Protection Barrier” is used.

b. The Contractor shall obtain and return the concrete barriers to the location(s) indicated in the plans. These units, which are 1’-10” (560 mm) wide by 12’-6” (3.8 m) long by 32 inches (800 mm) high and with weigh approximately 4,900 pounds (2,222 Kg), shall be installed as shown in the plans.

c. The barrier unit ends shall be placed as close together as possible and in close alignment.

d. Adjacent ends of the barrier units shall be 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.

6. Temporary Pavement Marking/Overlay Solid Lines/Overlay Broken Lines:

a. (1) The Contractor shall install reflectorized temporary pavement markings of the color, width, line configuration, and dimensions shown in the plans or designated by the Engineer. Work includes arrows, words and symbols marked on the pavement.

(2 When markings are no longer needed, the Contractor shall remove them at no additional cost. **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.**

(3) When “over” painting existing lines, the pattern shall match the existing pattern.

b. Temporary Pavement Marking, Type I and Type 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

c. Raised pavement markers shall not be used for right edge lines unless shown in the plans.

d. (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 422.01
Rural Area

Marking	Minimum Dimension
Temporary Traffic Paint	Minimum 4 inches (100 mm) wide by **10 feet (3 m) long** with 30 foot (9 m) max. gaps.
Temporary Pavement Marking Tape	Minimum 4 inches (100 mm) wide by **4 feet (1.2 m) long** placed every 40 feet (12 m).
Raised Pavement Markers	3 markers, each a maximum of 5 feet (1.5 m) apart with 30 foot (9 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 422.02
Urban Area

Marking	Minimum Dimension
Temporary Traffic Paint	Minimum 4 inches (100 mm) wide by **6 feet (2 m) long** with 18 foot (5.5 m) max.
Temporary Pavement Marking Tape	Minimum 4 inches (100 mm) wide by **2 feet long** (600 mm) placed every 20 feet (6 m)
Raised Pavement Markers	3 markers, each a maximum of 3 feet (900 mm) apart with 18 foot (5.5 m) gaps.

e. In order to insure maximum adhesion, the Contractor shall clean all dirt, glaze and grease, road film, and all other foreign materials from the pavement area to be marked. The pavement shall be clean and dry prior to the application of the temporary pavement marking.

f. Pavement markings which fail to provide a uniform appearance, fail to be clearly visible during the day or night, or which fail to remain firmly in place on the roadway shall be replaced or corrected by the Contractor in a manner acceptable to the Engineer and at no additional cost to the Department of Roads.

g. To insure the satisfactory performance of pavement markings, new portland cement concrete pavement shall be sandblasted to remove the curing compound from the surface on which pavement markings are to be applied. Sandblasting may be done seven days after the placement of the concrete surface unless otherwise directed by the Engineer.

h. Temporary Pavement Marking, Type Paint and Overlay Solid/Broken Lines (Paint):

(1) The material shall be applied to the pavement at a minimum wet film thickness of 0.015 in. (.38 mm).

(2) 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.

(3) 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 of Roads, 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.

(4) 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.

(5) Application shall not be permitted when atmospheric temperature is below 40° F (4° C) and falling.

(6) The Contractor shall follow all manufacturer recommendations for application of traffic paint so as to obtain the best results.

(7) The paint shall be applied 4 ± 1/2 inches (100 mm ± 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).

(8) The equipment used to paint the line shall be designed to apply painted traffic lane markings of the type, width, and thickness required.

(9) 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, except in emergency situations.

(10)The Contractor shall remove all temporary lines when they are no longer needed. If removing markings from the final wearing surface, the removal process shall not mar or damage the surface. Removed markings shall no longer be visible on the final wearing surface.

i. Projects without Detour:

(1) Not more than 1/2 mile (0.8 km) of roadway behind the finish rolling operation, completed asphaltic surface treatment, or the milling operation shall be unmarked. 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. The Contractor shall clean or replace all temporary marking and reflective surfaces at no additional cost to the Department.

(2) 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.

(3) The top layer shall be marked with three raised pavement markers placed at 5 foot (1.5 m) spacing approximately 6 inches (150 mm) off centerline at 40 foot (12 m) intervals or 4 inch (100 mm) by 48 inch (1.2 m) reflectorized tape every 40 feet (12 m).

(4) When possible, the location of the temporary edge line should coincide with the permanent line in its final position.

j. Projects with Detour:

(1) A temporary centerline will be required for all layers of asphaltic concrete placed. Lower layers shall be marked with reflectorized tape applied in sections 4 inches (100 mm) by 24 inches (600 mm) at 40-foot (12 m) intervals, painted line applied 4 inches (100 mm) by 10 feet (3 m) with 30-foot (9 m) gaps, or two raised pavement markers at 5 foot (1.5 m) spacing placed approximately 6 inches (150 mm) off centerline at 40-foot (12 m) intervals. The Contractor shall remove raised pavement markers before successive resurfacing operations.

(2) The top layer shall be marked with two raised pavement markers placed approximately 6 inches (150 mm) off centerline at 40-foot (12 m) intervals or 4 inch (100 mm) by 48 inch (600 mm) reflectorized tape every 40 feet (12 m).

k. The Engineer may direct that raised pavement markers are left in place. The Engineer shall consider the RPM's location and color.

7. Temporary Rumble Strips:

a. The Contractor shall furnish, install, and maintain temporary rumble strips at the locations shown in the plans 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.

8. Vertical Panels:

The Contractor shall furnish, install, and maintain vertical panels at the locations and spacing shown in the plans or designated by the Engineer. The vertical panels shall comply with the requirements shown in the MUTCD and any pertinent modifications shown in the plans. A vertical panel unit may be single- or double-sided (back-to-back) as required by the plans, and the supporting post shall not cover any of the reflective area of the panel(s).

9. 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 plans or as required by the Engineer.

b. (1) The Contractor shall furnish an FHWA approved inertial barrier system that is on the NDR 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 graduation requirements of fine aggregate for concrete.

(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) For inertial barriers which are required to remain in place during the winter, 5 to 15 percent (by volume) rock salt shall be mixed with the filler material.

(6) 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. A 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 Type III reflective sheeting without buttons. The object marker shall be placed approximately 2 inches (50 mm) below the top of the first module.

10. Flashing Arrow Panel:

a. The Contractor shall furnish, install, and operate mounted flashing arrow panels for use in traffic control at the locations shown in the plans. The Contractor shall remove the panels when work is complete and the Engineer has approved their removal.

b. (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.

(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 percent for the flashing arrow and flashing diamonds and equal intervals of 25 percent for each sequential phase.

c. (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 percent reduction in intensity when ambient light falls below 5 foot candles.

d. (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. (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.

11. Type B High Intensity Warning Lights:

a. Type B High Intensity Warning Lights shall be furnished, placed, operated, and maintained as shown in the plans.

b. When work is complete and their removal has been approved by the Engineer, the warning lights shall be removed by the Contractor.

12. Pilot Vehicle:

a. 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.

b. (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 shall carry the Contractor's monogram or company insignia and shall be equipped with a rear facing, rigidly mounted sign having a fluorescent orange background 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.

c. 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.

d. Pilot vehicle drivers shall be certified flaggers and must have their Flagger Certification Card in their possession at all times.

13. Tubular Post:

a. The Contractor shall furnish, install, maintain, and remove reflectorized tubular posts at the locations shown in the plans or as directed by the Engineer.

b. (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 not 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.

(2) Each complete tubular post and each replacement post must have a minimum of two 3-inch (75 mm) wide reflective 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 are shown in the NDR 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. (1) The tubular posts shall be spaced at the intervals shown in the plans or as directed by the Engineer and shall be attached to the existing surface by epoxy or other suitable adhesive. 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.

(2) Reflective sheeting which is no longer effective shall be replaced.

(3) 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.

d. 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 removal, initial installation, and replacement. The Contractor

must explain this phase of traffic control to the Engineer before installation, replacement, and removal.

14. Opposing Lane Dividers:

a. (1) The Contractor shall furnish, install, and maintain reflectorized opposing lane dividers at the locations shown in the plans.

(2) When work is complete and the Engineer has approved their removal, the Contractor shall remove the reflectorized opposing lane dividers.

b. (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.

c. 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 AASHTO M 268 Type III reflective sheeting or approved equivalent.

d. (1) The opposing lane dividers shall be attached to the existing surface by an epoxy or other approved adhesive.

(2) The adhesive shall be given adequate time to harden before the divider can be attached and the road opened to traffic.

e. (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.

15. Pavement Marking Removal:

The Contractor shall remove conflicting permanent (not “temporary”) pavement markings as shown in the plans or as required by the Engineer.

16. Temporary Glare Screen:

a. The Contractor shall furnish, install, maintain, and remove temporary glare screens (TGS) on Department-furnished concrete protection barriers at the locations shown in the plans.

b. The TGSs shall be installed as required by the manufacturer. The anchors shall be flush mounted. The TGSs shall consist of a white base rail [10 feet (3 m) length] and green blades [2 foot (600 mm) height] angled at 0.384 radians. Every 10 feet (3 m), a 2 x 12 inch (50 mm x 300 mm) vertical, yellow, high intensity AASHTO M 268 Type III reflective sheet shall be placed at the midpoint on the right side of the vertical blade, one for each direction of travel.

c. Before installing the TGS, the Contractor shall furnish and install the internally threaded sleeve into the protection barrier. The top of the sleeve shall be flush with the top of the barrier.

d. Damaged sheeting, blades, base rails, and blades which no longer provide glare protection (such as bent blades or blades which move significantly in the wind) shall be immediately repaired or replaced by the Contractor at no additional cost to the Department.

e. Upon completion of the project, the Contractor shall remove the temporary glare screens (base rail and blades). The anchor sleeves in the concrete barriers shall be plugged with weatherproof plugs provided by the manufacturer. The plugs become the property of the owner of the concrete barriers.

17. Changeable Message Signs:

The Contractor shall furnish, install, operate, and maintain changeable message signs as prescribed in the plans. When their removal is approved by the Engineer, the Contractor shall remove the changeable message signs.

18. Install Impact Attenuator:

a. (1) The Contractor shall pick up the impact attenuator from the location designated by the Engineer and assemble the attenuator in accordance with the details shown in the plans. The Contractor shall transport, maintain, and install the units at the location shown in the plans or designated by the Engineer.

(2) A second unit shall be stored with replacement cartridge sets in the Lincoln Maintenance Yard. 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.

b. The Contractor shall perform all earthwork and provide the reinforced concrete pad (required for off-the-road installations) needed to place the unit. The Contractor shall immediately repair or replace any damaged units.

c. Upon completion of the pavement work on an initial construction phase, the Contractor will be required to relocate the attenuator to the position required for the traffic protection for pavement work on the subsequent phases.

d. Upon completion of the work, the Contractor shall disassemble the system and return it to the location designated by the Engineer.

19. Mobile Traffic Control Operations

The Contractor shall furnish and operate the mobile traffic control operation as prescribed in the plans.

422.04 -- Method of Measurement

1. a. (1) “Sign Day” is the pay item for permanent signs, and “Sign Day shall be measured by the each. Signs must be installed in accordance with the plans or as directed by the Engineer.

(2) “Temporary Sign Day” is the pay item for temporary signs, and “Temporary Sign Day” shall be measured by the each. Signs must be installed in accordance with the plans or as directed by the Engineer.

(3) “Contractor Furnished Sign Day” is the pay item for contractor furnished signs, and “Contractor Furnished Sign Day” shall be measured by the each. Signs must be installed in accordance with the plans or as directed by the Engineer.

b. The quantity of sign days shall 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 shall be 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 shall be paid for separately, even if more than one sign is installed on the same post or device.

2. a. Type III barricades shall be measured for payment by the number of calendar days each Type III barricade is in place and positioned as shown in the plans or as directed by the Engineer. The unit is barricade-day (BDay).

b. (i) “Type II Barricades, Reflectorized Drums, 42” (1070 mm) Reflective Cones, and Vertical Panels shall be measured for payment by the number of calendar days each is in place and positioned as shown in the plans or as directed by the Engineer. Payment shall be made at the established contract unit price.

(ii) Vertical panels will be paid at ½ the contract unit price for “Barricade Type II”.

(iii) Reflectorized Drums and 42” (1070 mm) reflective cones are paid at the unit price for “Barricade Type II:

c. Payment for "Barricades, Type II", "Barricades, Type III", 42” (1070 mm) Reflective Cones and Vertical Panels will not be made for any devices which are not kept clean and properly positioned.

d. 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 Project Manager, shall remain in service at no cost to the Department.

3. a. “Flagging” will be measured for payment for each flagger location 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, and removing up to eight temporary signs per flagger situation as directed by

the Engineer, 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. a. "Temporary Traffic Signal" is 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. a. “Concrete Protection Barrier” is measured by the length in feet (meters) based on the 12’-6” (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 plans, and these relocations shall be measured by the length of the concrete barriers so relocated based on the 12’-6” (3.8 m) nominal length of the individual units.

6. a. (1) “Temporary Pavement Markings _____” and “Temporary Pavement Marking” shall be measured by the linear feet (meter) of each line applied.

(2) All gaps are not measured.

b. (1) “Overlay Solid Lines” and “Overlay Broken Lines” are measured by the station.

(2) Measurements can be made from the estimated length of each segment.

(3) When necessary, measurements shall be along the centerline or edgeline, as appropriate, between the beginning and ending points of the project and between the beginning and ending points of any intersecting roadway, shoofly, detour, or ramp.

(4) Breaks or gaps that are not part of a standard pattern (such as identified in Tables 422.01 and 422.02.) 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.

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 of previously applied lines, replacement of previously applied lines that have worn or were covered by asphalt or any other substance and applications that are necessary to accommodate the Contractors schedule; as prescribed in Paragraph 9. of Subsection 422.05 of these applications are subsidiary.

e. Replacement of all temporary lines necessary because of required daily maintenance or the Contractor’s work quality or schedule of operation shall not be measured for payment and is subsidiary to the relevant pay item.

f. When traffic must be routed over a new application of asphalt and the traffic is directed over payment markings, then the Department will pay to replace the markings that have been removed by traffic.

7. 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.

8. 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.

9. a. The inertial barrier system shall be measured by the each.

b. The replacement modules for the inertial barrier system shall be measured for payment by the each for each module installed on the project.

10. a. Flashing arrow panels are 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 prescribed in the plans.

11. Type B High Intensity Warning Lights shall be measured by the each per day for the number of calendar days each Type B light is in place and operating. The unit is light-day (LDay).

12. a. “Pavement Marking Removal” shall be measured by the linear foot (meter) along the centerline of the traveled roadway for each permanent (not “temporary”) line removed.

b. Directional Arrows, Railroad Crossing Symbols, Stop Bars, Pedestrian Crossings, etc., will be measured by the square foot (meter).

13. 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.

14. Tubular posts are measured by the each.

15. Opposing lane dividers are measured by the each.

16. Temporary Glare Screen is measured by the length in linear feet (meters) of base rail initially installed, complete with blades.

17. Changeable message signs are measured by the each per day for the number of calendar days each sign is in place and operating.

18. "Install Impact Attenuator" is measured by the each.

19. a. “Replacement Module” is the pay item for inertial barrier system replacement modules and the unit of measurement is each (EA).

b. “Relocate Inertial Barrier” is the pay item for moving the inertial barrier to a new location after initial installation and operation.

20. 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.

422.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

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 Pavement Marking, Type ___	Linear Foot (LF) [Meter (m)]
Raised Pavement Marker	Linear Foot (LF) [Meter (m)]
Temporary Rumble Strip	Each (ea)
Inertial Barrier System	Each (ea)
Flashing Arrow Panel	Day (d)
Type B High Intensity Warning Light	Light-Day (LDay)
Pavement Marking Removal	Linear Foot (LF) [Meter (m)]
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)]
Changeable Message Sign	Day (d)
Tubular Post	Each (ea)
Install Impact Attenuator	Each (ea)
Temporary Sign Day	Each (ea)
Overlay Broken Lines	Station (Sta) [Station (StaM)]

Overlay Solid Lines	Station (Sta) [Station (StaM)]
Relocate Inertial Barrier	Each (ea)
Replacement Module	Each (ea)
Relocate Concrete Protection Barrier	Linear Feet (LF) [Meter (m)]
Temporary Pavement Marking	Linear Feet (LF) [Meter (m)]
____ Temporary Pavement Marking Type ____	Each (ea)
Pavement Marking Removal	Square Foot (SF) [Square Meter (m^2)]

2. 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. (1) Temporary Signs which are required for "Flagging" are subsidiary to "Flagging".

(2) The "Temporary Sign" pay item shall 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 "Barricades, Type II" is used to pay for four (4) items (Vertical Panels, 42 inch (1070 mm) Reflectorized Cones, Reflectorized Drums, & Barricades, Type II).

b. Vertical Panels shall be paid for at 1/2 the contract unit price established for the item, "Barricades, Type II".

c. "42 inch (1070 mm) Reflectorized Cones", "Reflectorized Drums" and "Barricades, Type II" shall be paid for at the contract unit price established for the item, "Barricades, Type II".

4. Barricades, Type II are paid for as an "established" contract unit price item, which is shown in the bid proposal "Schedule of Items".

5. 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. Except for Type B High Intensity Warning Lights, all warning lights shall 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, or replaced or for their removal.

8. The repositioning and/or reattachment, removal, and/or replacement of a tubular post is subsidiary to the pay item "Tubular Post."

9. a. Maintenance of temporary pavement markings is subsidiary to the appropriate pay item. Maintenance includes replacement of lines worn by traffic or covered by asphalt or any other substance. The Engineer will determine when the lines are no longer effective and direct the Contractor to replace the lines at no additional cost to the Department.

b. Replacement of~~,~~ temporary markings which is necessary because of the Contractors schedule of operation or the Contractor's work quality is subsidiary to the relevant pay item.

c. Temporary marking removal (broken and solid lines; raised pavement markers; and arrows, words, symbols) is subsidiary to the relevant pay item.

d. Overlay markers shall be subsidiary to the relevant temporary pavement marking pay item.

e. Sandblasting to remove the curing compound from the pavement surface before placing pavement markings shall be considered subsidiary to the relevant temporary pavement marking pay item.

10. 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" is paid for each relocation.

11. The pay item "Temporary Pavement Marking" includes the following material options:

- Temporary Pavement Marking, Type I (Tape)
- Temporary Pavement Marking, Type II (Tape)
- Temporary Pavement Marking, Type Paint
- Temporary Pavement Marking, Type RPM

12. "_____Temporary Pavement Marking Type_____" is the pay item for arrows, words, and symbols.

13. Removal of markings is subsidiary to all temporary pavement marking and overlay marking except:

a. If the Department denies the Contractor the opportunity to apply his own temporary paint and then applies its own paint (the Department), then the Contractor is entitled to reimbursement for removing the Department's paint.

b. The Contractor shall match the existing pattern when an area must be restriped.

14. Marking material specified in the plans or other contract documents should not be changed to a less expensive material (usually paint) without a change order.

15. Payment is full compensation for all work prescribed in this Section.

SECTION 423 -- PERMANENT PAVEMENT MARKING

423.01 -- Description

This work shall consist of furnishing and installing retroreflective preformed pavement markings in accordance with these *Specifications* and in reasonably close conformance to the dimensions and lines shown in the plans or established by the Engineer. This specification covers the following permanent pavement marking materials and application methods:

1. Durable Retroreflective Preformed Pavement Marking, Type I [60 mil (1.5 mm) thickness].

2. Durable Retroreflective Preformed Pavement Marking, Type II (preformed marking film).

3. Durable Retroreflective Preformed Pavement Marking, Type III (intersection grade).

4. Durable Retroreflective Preformed Patterned Pavement Marking, Type IV (with improved retroreflectivity retention).

5. Thermoplastic Pavement Marking.

6. Thermoplastic Pavement Marking, Type Spray.

7. Epoxy Pavement Marking.

8. Preformed Pavement Marking Tape, Type IV in Grooved Pavement.

9. Permanent Pavement Marking, Paint and Beads.

423.02 -- Material Requirements

1. Acceptable Durable Retroreflective Preformed Pavement Marking, Types I, II, III, and IV shall be on the NDR Approved Products List.

2. 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 Spheres	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 percent lead-free content.

c. The alkyd binder shall consist of maleic modified rosin ester and not more than 20 percent 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		
	Magnesium Oxide	
Scale Definitions	**Standard**	**Sample**
RD Reflectance	100	75% Min.
a Redness-Greeness	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:			
	x - 0.470	0.493	0.516	0.490
Coordinates x, y	y - 0.455	0.467	0.444	0.433

f. Color Retention:

(1) 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.

Note: 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 percent 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 cm^2) 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 (10°C) for a period of 24 hours. When removed and allowed to come to room temperature, the sample shall still adhere to the contract substrate with no cracking or flaking.

j. Reheating:

The thermoplastic compound shall maintain proper performance properties when heated 4 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 4 separate samples shall not be less than 10.0 inches/pounds (560 mm/kg) 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 Spheres:

(1) Refractive Index:

The reflective glass spheres pre-mixed into the compound and the reflective glass spheres 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 percent of the beads overall and not less than 70 percent of the beads retained on any specified sieve shall be true spheres when tested by ASTM D 1500.

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 percent.

(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:

(1) The intermixed and surface applied glass beads shall meet the gradation requirement in Table 423.04.

Table 423.04

Glass Bead Gradation	
Sieve Size	**Percent Passing**
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

(2) The surface application of beads shall be not less than 12 lb/100 SF (0.58 kg/m^2).

(3) 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.

w. 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.

3. Hot Spray Thermoplastic Pavement Marking Material:

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 percent 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 percent) titanium dioxide (TiO_2). The white pigment content shall not be less than 10 percent 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 percent lead-free content. The yellow pigment shall not be less than 5 percent 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 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 ± 5 minutes at 375° ± 3°F (191° ± 2°C) and cooled at 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 percent minimum				
* Yellow: Daylight Reflectance (Y) 42-59 percent				
* 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 ± 5 minutes at 375° ± 3°F (191° ± 2°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 ± 5 minutes at 375°F (191°C), the drawdown film thickness shall be 0.065 inch (1.65 mm); and when tested at 75° ± 2°F (24° ± 1°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 is heated for a period of 4 hours 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. Allow the sample to reach room temperature by standing overnight. Using a suitable falling ball apparatus that includes the male indentor 5/8 inch (16 mm) (no female die), impact 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 (8 kN) pounds 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 percent 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	
Sieve Size	**Percent Passing**
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	
Sieve Size	**Percent Passing**
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 percent 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 percent silica ($Si0_2$).

(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 T-T-B-1325A, Section 4.3.11 (water resistant soxhlet extraction method), with the following exceptions:

(i) Under "Procedure", the size of sample to be tested shall be 1 ounce (28 g).

(ii) Under "Testing", Paragraph (1), the reflux item shall be 5 hours and, upon examination after testing, the glass beads shall show no dulling effect.

(iii) Under Paragraph (2), use of more than 0.15 fluid ounce (4.5 mL) of 0.1N hydrochloric acid to reach the end point shall constitute failure of the test.

(5) Flowing Properties:

(i) The glass beads shall flow uniformly through dispensing equipment in atmospheric humidity up to 94 percent.

(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.

4. Epoxy Pavement Marking

a. Glass Beads

(1) Glass beads for epoxy pavement marking shall conform to AASHTO M 247, Type I and Type IV, except that they shall be coated as required by the epoxy manufacturer. The glass beads shall have a minimum of 80 percent rounds per screen for the two highest sieve quantities (determined visually) and no more than 3 percent angular particles per screen (visual). The remaining sieve fractions shall be no less than 75 percent rounds (determined visually per aspect ratio using microfiche reader). Type IV only is 70 percent by roundometer overall (ASTM D 1155). Angulars will be

determined visually for Type IV at 3 percent overall. (Angulars are defined as particles with sharp edges).

(2) The glass beads shall have a refractive index of 1.50 to 1.52.

(3) Sieve Size

Type 1		Type 4	
English Sieve No. (Metric)	**% Passing**	**English Sieve No. (Metric)**	**% Passing**
20 (850 μm)	95 - 100	10 (2.00 mm)	100
30 (600 μm)	80 - 95	12 (1.70 mm)	95 - 100
50 (300 μm)	9 - 42	14 (1.40 mm)	80 - 95
80 (180 μm)	0 - 10	16 (1.18 mm)	10 - 40
100 (150 μm)	-	18 (1.00 mm)	0 - 5
		20 (850 μm)	0 - 2

(4) Glass beads shall be furnished in fully identified containers and shall be free of extraneous material or clumps.

b. Formulation

(1) Epoxy pavement marking material shall be a two component, 100 percent solids, material formulated to provide simple volumetric mixing ratio of two volumes of component A and one volume of component B unless otherwise recommended by the material manufacturer.

c. Composition

(1) The component A of both white and yellow shall be within the following limits:

Pigments	White	Yellow	Non-Lead Yellow
Titanium Dioxide (ASTM D 476 Type II & III)	18-25%		14-17%
Chrome Yellow (ASTM D 211 Type III)		23-30%	
Organic Yellow			7% Min.

d. Binder

Epoxy Resin	75-82%	70-77%	80-85%

e. Epoxy Content

(1) The epoxy content of the epoxy resin in Part A will be tested in accordance with ASTM D 1652 and calculated as the weight per epoxy equivalent (WPE) for both white and yellow. The epoxy content will be determined on a pigment free basis. The epoxy content shall meet a target value provided by the manufacturer. A $\pm$ 75 tolerance will be applied to the target value to establish the acceptance range.

f. Amine Value

(1) The amine value of Part B shall be tested in accordance with ASTM D 2074 to determine its total amine value. The total amine value shall meet a target value provided by the manufacturer. A ±75 tolerance will be applied to the target value to establish the acceptance range.

g. Toxicity

(1) Upon heating to application temperature, the material shall not produce fumes which are toxic or injurious to persons or property.

h. Yellowness Index (ASTM D 1925)

Cure 72 hours after sample preparation
Take yellow index reading, XYZ C/2 deg., following
72-hour cure and preceding QUV
Maximum index before QUV: 5
Place sample in QUV for 72 hours
Maximum index after QUV: 20

i. Directional Reflectance (ASTM E-97)

j. Directional Reflectance after QUV using XYZ Scale D65/10 deg. using ASTM E-97.

White	Yellow
Minimum: 75	Minimum: 38

k. Drying Time

(1) The epoxy pavement marking material, when mixed in the proper ratio and applied at 20 mils ± 0.5 (510 μm ± 12 μm) mil wet film thickness at 75°F ± 2 F (24±1°C) and with the proper saturation of glass spheres, shall exhibit no tracking when tested according to ASTM D 711 8 minutes after application, when installed on an active roadway; or 30 minutes after application when installed on a closed roadway.

l. Curing

(1) The epoxy material shall be capable of fully curing under the constant surface temperature condition of 32 degrees F (0° C) and above.

m. Adhesion to Concrete

(1) The catalyzed epoxy pavement marking material, when tested according to ACI Method 503, shall have such a high degree of adhesion to the specified (4,000 psi (28 MPa) minimum) concrete surface that there shall be a 100 percent concrete failure in the performance of this test. Samples shall be allowed to cure at room temperature (75° F ± 2°F [24±1°C]) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated test.

n. Hardness

(1) The epoxy pavement marking materials, when tested according to ASTM D 2240, shall have a Shore D Hardness over 80. Samples

shall be allowed to cure at room temperature (75 degrees F ± 2 degrees F [24±1°C]) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated test.

o. Abrasion Resistance

(1) The abrasion resistance shall be evaluated, according to ASTM D 4060, on a Taber Abrader with a 1000 gram (2.2 lb.) load and CS-17 wheels. The duration of the test shall be 1000 cycles. The wear index shall be calculated based on ASTM test method C 501 and the wear index for the catalyzed material shall not be more than 70. The tests shall be run on cured samples of material which have been applied at film thickness of 15 ± 1/2 mils (380 μm ±13 μm) mils to code S-16 stainless steel plates (to be run without glass spheres). The samples shall be allowed to cure at 75° F ± 2° F (24±1°C) for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated tests.

p. Tensile Strength

(1) When tested according to ASTM D 638, the epoxy pavement marking materials shall have a tensile strength of not less than 6,000 psi (41 MPa). The Type IV Specimens shall be cast in a suitable mold and pulled at the rate of 1/4 inch (6.4 mm) per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at room temperature (75°F± 2°F) [24+1°C] for a minimum of 24 hours and a maximum of 72 hours prior to performing the indicated test.

q. Compressive Strength

(1) When tested according to ASTM D 695, the catalyzed epoxy pavement marking materials shall have a compressive strength of not less that 12,000 psi (80 MPa). The cast sample shall be conditioned at room temperature (75 degrees F ± 2 degrees F) (24±1°C) for a minimum of 72 hours prior to performing the test. The rate of compression of these samples shall be no more than 1/4 inch (6.4 mm) per minute.

r. Certification of Compliance

(1) The Contractor shall furnish a manufacturer's certification that the material complies with the provisions of this specification.

5. The pavement marking tape shall be Preformed Pavement Marking, Type 4, when tape is in grooved pavement.

6. Permanent Pavement Marking Paint and Beads

a. Traffic Paint

The Contractor shall use a type of traffic paint that can be applied under the temperature conditions existing at the time of application. Traffic paint selected for use by the Contractor shall be one of the following:

1. Acrylic Resin Waterborne Traffic Paint

2. VOC Compliant Alkyd Resin Lead Free Traffic Paint

The paint shall be a VOC compliant lead and chromium free traffic paint meeting the requirements of the current Nebraska Department of Roads' Specifications. The paint shall be furnished ready mixed and shall not be diluted or thinned. When applied at a wet film thickness of 15 mils (380 μm), the paint shall provide a five-inch (125 mm) wide stripe that dries within the specified time. The traffic paint shall be compatible with drop-on glass beads, providing good adhesion and good refraction. The color for the 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.

The traffic paints will be accepted on the basis of a Manufacturer's Certified Test Results indicating that the paint meets the requirements of the current Nebraska Department of Roads' Specification for Traffic Paint.

b. Glass Beads

Glass Beads for use with Acrylic Resin Waterborne Traffic Paint with VOC Compliant Alkyd Resin Traffic Paint shall be classified as AASHTO M247 Type 1 Coarse Dual-Coated Moisture Resistant.

Glass Beads shall be coated with the necessary coating to provide both good embedment and adhesion into the traffic paint film. The glass beads shall be transparent, clean, colorless, smooth and spherical shaped, free of pitting or excessive air bubbles. When applied at a rate of eight pounds of beads per gallon (0.96 Kg of beads per liter) of traffic paint [five inch (125 mm) stripe], the glass beads shall show good adherence to the paint and provide good night visibility throughout the useful life of the reflectorized traffic paint. The beads shall allow sufficient capillary action to form a firm embedment when dropped on a freshly applied wet paint film.

Detailed Requirements

1. Imperfect Beads – The glass beads shall have not more than 30 percent imperfect beads retained on any sieve. The total imperfect beads on all sieves shall not exceed 20 percent. Imperfect beads are defined as ovate or otherwise nonspherical in shape; two or more beads fused together; and beads that show turbidity, pitting, scratching, surface wrinkling, internal air bubbles, or other inclusions. The percentage of imperfect beads and nonglass material shall be determined by microscopic inspection of a representative sample of not less than 500 beads. All particles in the sample shall be counted regardless of shape or material.

2. 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.

3. Gradation – The drop-on glass beads in a representative sample shall meet the following gradation requirements when tested in accordance with Standard Method of Tests for Sieve Analysis of Glass Spheres, ASTM Designation D1214.

4.

U.S. Standard Sieve No.	Sieve Opening Millimeters	Amount Passing, %
20	0.850	90-100
30	0.600	55-80
50	0.300	5-25
80	0.180	0-5

5. Moisture Resistance – The glass beads shall pass the "Moisture Resistance Test" as defined in AASHTO M247, Section 5.4.2.

6. Embedment Coating – The glass beads shall be tested for verification of silane presence/adhesion promoter, by performing the "Dansyl Chloride Test."

7. Bead Embedment – A minimum of 90 percent of the beads shall be embedded between 40 percent and 60 percent into the paint film.

Apply waterborne traffic paint to a glass panel at a wet film thickness of 0.012 inch (0.3 mm) followed immediately by an application of glass beads dropped onto the surface of the paint. After drying for at least 23 hours, observe the amount of bead embedment with a 30-power microscope. At least 90 percent of the beads shall be embedded between 40 and 60 percent.

Glass beads will be accepted on the basis of a Manufacturer's Certified Test Results indicating that the beads meet the requirements of the Nebraska Department of Roads' Specification for Type I Coarse Dual Coated Moisture Resistant Glass Beads as shown above.

7. Performance Life/Acceptance.

All permanent pavement markings, except "Permanent Pavement Marking Paint and Beads", shall have the following acceptance requirements:

a. Following initial completion of all pavement marking, there will 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 will be 95 percent.

b. Determination of Percentage Retained:

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. (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 September 1, the replacement material shall be installed during the same construction season. Replacement materials for any notification after September 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 essentially 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 percent, 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.

(1) After the installation of pavement marking tape, the tape must be cut one inch (25 mm) on either side of all pavement joints that the tape crosses.

e. When deemed necessary by the Engineer to achieve specified alignment, the Contractor, at his/her expense, shall place any additional markings required to achieve the specified alignment throughout both straight and horizontally-curved sections of roadway. 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.

f. The Contractor shall have on the project at all times during the application of the permanent pavement markings at least one employee with a valid "American Traffic Safety Services Association" (ATSSA) certification. The ATSSA certification may be for either a "Certified Pavement Marking Technician" or a "Certified Pavement Marking Specialist." The Contractor shall provide the Engineer a copy of the employee's certification prior to the beginning of work.

g. 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.

h. The pavement upon which the pavement markings are to be placed shall be cleaned and prepared in a manner and to the extent recommended by the manufacturer prior to placement of the markings. Cleaning shall be by any effective method, approved by the Engineer, that completely and effectively removes contaminants, loose materials, and conditions deleterious to proper adhesion without damaging the roadway.

i. Existing painted pavement markings on both concrete and asphalt pavement shall be removed prior to placement of the permanent markings. Existing durable pavement markings (plastic or old epoxy) 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. The area of removal shall be the width needed for the new pavement marking and/or the existing line(s), whichever is greater.

2. "Durable Retroreflective Preformed Pavement Marking, Type _____ Grade _____":

a. The Contractor's liability will be limited to material replacement only for the amount of markings actually missing from the roadway.

b. The markings shall be applied in accordance with the manufacturer's recommendations. Marking configurations shall be in accordance with the *Manual on Uniform Traffic Control Devices*.

c. When markings are specified in the contract for newly paved asphaltic concrete surfaces, they shall be applied before public traffic is allowed on the freshly paved surface. Preferably, the markings should be inlaid in the fresh surface during final rolling of the mat; but in any case, they shall be applied before the close of the shift on the day which the surface is paved. These markings can also be overlaid on existing pavement surfaces.

d. (1) The Contractor and/or manufacturer shall provide application equipment, manual or automatic as necessary for the job requirements. These applicators shall be capable of applying two, 4 inch (100 mm) lines simultaneously with 4 inch (100 mm) spacing between lines. These units shall be capable of applying an unlined, precoated, pressure sensitive adhesive pavement marking tape.

(2) The manual unit shall have manually actuated product feed advance system and a foot operated product cutting mechanism.

(3) The automatic unit shall have the capability of advancing, applying, and cutting the pavement marking tape at specific preprogrammed lengths at speeds up to 6.5 mph (10.5 km/h) when towed by an appropriate vehicle.

3. Thermoplastic Pavement Marking:

a. Dirt, grease, or any foreign 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. The Contractor shall check the pavement surface moisture each day prior to marking application as follows:

(1) Apply a thermoplastic line on a piece of tar paper [approximately 6 feet (1.8 m) long] over the area to be striped.

(2) After 30 seconds, visually inspect the underside of the tar paper. If the underside is wet, **do not** install the thermoplastic.

(3) Another test for moisture is to place and hold a two square foot (0.2 m^2) 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. This will allow testing the pavement without waiting to heat up the thermoplastic.

c. A binder-sealer material, either epoxy, butadiene, styrene, neoprene, or others recommended by the thermoplastic manufacturer, must be applied in sufficient quantities to entirely cover the surface on which the marking is to be applied. This binder-sealer is required on all portland cement concrete pavement surfaces, as well as on all bituminous pavements over 60 days old.

d. Thermoplastic marking material shall not be applied until approval from the NDR Materials and Research Division has been received. The Contractor is required to notify the appropriate District Construction Office 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 must indicate the manufacturer and lot numbers of thermoplastic and glass beads intended for use. A check should be made to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

e. 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).

f. Thermoplastic material must be installed in a molten state between 450°F and 465°F (232° C and 241°C).

g. Thermoplastic material must be installed at a thickness of not less than 1/8 inch (3 mm) or more than 0.188 inch (5 mm). The initial measurement should be made above the pavement surface. In some cases, however, primarily on fresh bituminous concrete, the material may slightly penetrate the pavement.

h. If the material appears to be less than 1/8 inch (3 mm) thick above the pavement surface, the line shall be "chipped" and checked to determine the actual thickness. If the actual thickness is found to be 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.

i. Thermoplastic material may be applied over the temporary painted edge line markings. Unless otherwise specified, 4 inch (100 mm) lines shall be laid a minimum of 2 inches (50 mm) from longitudinal joints.

j. Unless otherwise specified, pavement markings, words, and symbols shall be the *MUTCD* standard size. Deviations from reasonable standards of workmanship are cause for rejection.

k. Thermoplastic pavement marking material may be installed by the following methods:

(1) Extrusion Method:

This is basically a "slip form" method. As the applicator moves forward, a "die" or "shoe" with a fully-adjustable gate is dragged along the pavement to apply the material to the specified area.

(2) Ribbon Extrusion Method:

In this method, the hot thermoplastic material moves through a heated "block" where it drops through an orifice onto the pavement as the applicator moves forward.

l. Equipment used for placing markings shall be manufactured for that purpose and of sufficient size and stability to ensure a smooth and straight application for the following facility types:

(1) Freeways:

(i) A full-sized, truck-mounted unit capable of maintaining an operating speed of 3 to 5 mph (5 to 8 km/h) is required. It must 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.

(ii) 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, provided sufficient traffic control is in place to close the lane adjacent to the marking operations.

(2) Non-Freeway:

Thermoplastic pavement marking may be placed with either truck-mounted or hand-operated equipment. Small riding units are considered "hand-operated."

m. Reflectivity:

Immediate reflectivity is 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 should be dropped or sprayed 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/m^2). These beads are in addition to those that are provided as part of the thermoplastic mixture itself.

4. 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. Glass Bead Dispenser. The thermoplastic dispenser shall be equipped with a drop-on type glass bead dispenser. The glass bead dispenser shall be located so as to drop the glass beads immediately after the molten thermoplastic material is applied. 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.

e. 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.

f. 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. Temperatures are to be obtained in accordance with MHTD Test Method T20.

g. Primer Application. A primer is not 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.

h. Thermoplastic Application. The thermoplastic marking material shall be sprayed onto the pavement surface.

i. 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.

j. Pavement striping shall comply with the standard striping practices shown on the plans. 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.

k. 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.

l. Damage to pavement marking caused by the Contractor's operation shall be repaired or replaced at his/her expense.

m. Glass Bead Application. 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/m^2). 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.

n. (1) Workmanship. The applied thermoplastic markings should 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 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.

5. Epoxy Pavement Marking

a. General

(1) The Contractor shall use a crew experienced in the work of installing epoxy pavement markings and shall supply all the equipment and materials necessary for the placement of the pavement markings.

(2) The epoxy pavement marking compound shall be applied with equipment that will precisely meter the two components in the ratio given. The equipment shall automatically shut off or warn the operator if one component is not being mixed. The equipment shall produce the required amount of heat at the mixing head and gun tip to provide and maintain the temperatures specified.

(3) Before mixing, the individual epoxy components A and B shall each be heated to a temperature of 80° F to 140° F (27°C to 60°C). After mixing, the application temperature for the combined material at the gun tip shall be 80° F to 140° F (27°C to 60°C). The 140° F (60°C) upper limit is the maximum temperature under any circumstances. Discard all material heated over 140° F (60°C).

(4) Both pavement and air temperatures shall be at least 4° F (4°C) at the time of epoxy pavement marking application. Application shall not be performed at pavement and air temperature below 40°F (4°C).

b. Material Purchase

(1) The Contractor shall field verify the pavement marking quantities required for the project prior to purchasing materials. The Department will not be held responsible for the Contractor's shortage or surplus of material. The Contractor's verification of quantities and purchasing material shall not delay the project or the installation of pavement marking when required.

c. Surface Preparation

(1) The surface areas of new Portland cement concrete pavement and decks that are to receive markings shall be sandblasted or shotblasted clean prior to placement of the epoxy pavement marking. The amount of blasting shall be sufficient to remove all dirt, laitance, and curing compound residue.

(2) Existing painted pavement markings on both concrete and asphalt pavement shall be removed prior to placement of the epoxy markings. Existing durable pavement markings (plastic or old epoxy) shall be removed or prepared in a manner and to the extent recommended by the manufacturer, prior to placement of the new epoxy markings. All conflicting lines shall be removed completely. Removal and preparation of existing pavement marking for the placement of the new epoxy shall be considered subsidiary to the pavement marking items.

(3) The surface areas of new asphalt pavement, existing asphalt pavement, and existing concrete pavement that are to receive markings shall be dry and cleaned with a high pressure air blast to remove loose material prior to placement of the epoxy pavement marking. Should any pavement become dirty, from tracked mud etc. as determined by the Engineer, it shall be cleaned prior to the placement of the epoxy pavement marking. All preparation of the roadway surface will be included in the bid price for this item.

(4) Epoxy pavement marking shall be applied to the road surface according to the epoxy manufacturer's recommended methods at 20 mils (500 μm) minimum thickness. Glass beads shall be applied on the epoxy using two bead dispensers. Immediately apply Type IV glass beads on the epoxy at a minimum rate of 12 lbs/gal (1.4 kg/l) of epoxy, immediately followed by an application of Type I glass beads at a minimum rate of 12 lbs/gal (1.4 kg/l).

(5) Epoxy pavement marking and beads shall be applied within the following limits:

Application Rate or Coverage
Per Gallon of Epoxy Pavement Marking

	Minimum	Maximum
20 mil (500 μm) Marking:	75 sq. ft. (7 m^2)	82 sq. ft. (7.6 m^2)
Beads: Type 4	12 lbs. (5.44 kg)	-
Type 1	12 lbs. (5.44 kg)	-

d. Protecting the Newly Installed Pavement Marking

(1) Paint lines, symbols and legends shall be protected from tracking during the setting period by one or more of the following methods:

(i) Cone off wet lanes from traffic.

(ii) Use of a convoy of moving vehicles to prevent traffic crossing the wet lines.

(iii) Saturate line or symbols and legends with glass beads to prevent tracking.

e. Alignment Adjustments

(1) The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed two inches (50 mm) and, in addition, the deviation in alignment of the marking being placed shall not exceed one inch per 200 feet (25 mm/60 m) of roadway nor shall any deviation be abrupt.

(2) When deemed necessary by the Engineer to achieve a specified alignment, the Contractor, at his expense, shall place any additional markings required to achieve alignment specified throughout both strait and horizontally-curved sections of roadway. Any and all additional marking 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 the alignment markings and equipment used to place such markings shall be approved by the Engineer.

f. Defective Epoxy Traffic Stripes

(1) Epoxy traffic markings which after application and curing are determined by the Engineer to be defective and not in conformance with these Specifications shall be repaired. Repair of defective markings shall be made

at the Contractor's expense and shall be performed to the satisfaction of the Engineer as follows:

(i) Insufficient film thickness, line width, glass bead coverage or retention.

(ii) Deficient glass bead coverage and/or retention shall be based on yield determinations made during installation and visual comparison by the Engineer of newly applied field traffic markings to standard test plates manufactured in accordance with these Specifications.

(iii) Replacement method: Prepare the surface of the defective epoxy markings by grinding. No other cleaning methods will be permitted. Surface preparation shall be performed to the extent that substantial amount of the reflective glass beads are removed and a roughened epoxy marking surface remains.

(iv) Immediately after surface preparation, remove loose particles and foreign debris by brooming and/or blasting with compressed air.

(v) Deficient curing, color or bond to substrate.

(vi) Uncured epoxy shall be defined as applied material that fails to cure (dry) in accordance with drying time (field) of this subsection.

(2) Repair shall be made by restriping over the cleaned surface, in accordance with the requirements of this specification and at a full 15 mil (380 μm) minimum line thickness.

(3) Discoloration shall be defined as localized areas or patches or brown or grayish colored epoxy marking material. These areas often occur in a cyclic pattern and, often are not visible until several days or weeks after markings are applied.

(4) Deficient bond shall be defined as any lack of adhesion (e.g. separation, chipping, cracking, etc.) between the new epoxy material and the substrate.

g. Observation Period

(1) Following initial completion of all pavement marking, there will be a 180 day observation period before final acceptance. During the observation period, the Contractor, at no expense to the Department of Roads, shall replace any marking that the Engineer determines are not performing satisfactorily due to defective materials and/or workmanship in manufacture and/or application. At the end of the observation period the minimum required retention percentage for marking installed shall be 90%.

(2) Determination of Percentage Retained - 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.

(3) A claim, made by the State against the Contractor, shall be submitted to the Contractor in writing within 30 days after the 180-day observation period.

(4) When such a claim is made prior to August 1, the replacement material shall be installed during that same construction season. Replacement material for any claim after August 1 shall be installed prior to June 1, of the following year. Marking replacement shall be performed in accordance with requirement specified herein for the initial application, including but not limited to surface cleaning, sealer application, etc.

(5) Final acceptance of all marking 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 expense to the Department of Roads.

(6) Final acceptance of the pavement marking will be: (1) 180 days after the initial completion of all work, or (2) upon completion of all corrective work, whichever occurs last.

6. Preformed Pavement Marking Tape, Type 4 in Grooved Pavement

a. The permanent preformed pavement marking, Type 4 white dashed lines on this project, shall be applied to the pavement in Contractor installed grooves.

b. The grooves shall be made in a single pass dry cut using stacked diamond cutting heads, the equipment used shall be self vacuuming and leave the cut groove ready for tape installation. The equipment and method used shall be approved by the tape manufacture. The bottom of the groove shall have a fine corduroy finish. If a course, tooth pattern is present, increase the number of blades and decrease the spacers on the cutting head. The pavement marking tape shall be placed in the grooves the same day as the cut. Grooves shall be clean and dry prior to tape application. All conflicting pavement markings remaining after tape installation shall be removed, this removal shall be subsidiary to the pavement marking

Groove width:	tape width + 1 inch ± 1/8 inch (25 mm ± 3 mm)
Groove depth:	50 mils ± 5 mils (1270 μm ± 125 μm)
Groove length:	full length of tape + required grooving transition
Groove position:	2 inches (50 mm) left of joint line

c. After the installation of pavement marking tape, the tape must be cut one inch (25 mm) on either side of all pavement joints that the tape crosses.

7. Permanent Pavement Marking Paint

a. The work of Permanent Pavement Marking shall consist of painting centerline, lane lines, no-passing zone lines, barrier lines and edgelines at the locations detailed in the plans and these special provisions 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 plans and to a dry thickness of 12± 1 mils (300 μm ±25 μm) that is uniform across the width and length of the stripe.

(iii) The reservoirs shall 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 plans and these special provisions. The bead applicator shall be equipped with an automatic shut off synchronized with the paint flow.

(2) The trailing vehicles must be capable of carrying the traffic control as shown in the plans.

c. Pavement Surface Preparation. The roadway to be striped shall be cleaned of foreign matter that would prevent the paint from adhering to the roadway. The paint shall be applied to a dry pavement surface.

d. The Contractor shall supply as a minimum the traffic control shown in the plans. 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 prevent tracking of the paint.

e. 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 be applied in such a manner as to follow the existing lines on the roadway or as directed by the Engineer. No-passing zones shall be laid out in advance of the striping by the Contractor with information provided by the Engineer. When deemed necessary by the Engineer to achieve the correct alignment the Contractor shall, at no additional cost, place additional markings to guide the placement of the lane lines. The guide markings shall be temporary in nature and the material and equipment used to place these guide markings shall be approved by the Engineer. The paint shall have a dry thickness of 12± 1 mils (300 μm ±25 μm) and shall be the width shown in the plans ±1/2" (12 mm). The Engineer will take periodic samples to ensure the thickness and width of the stripe. 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 State. 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.

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. The preformed pavement marking tape, Type IV installed in grooves shall be measured and paid for by the linear foot (meter) of actual pavement marking material installed.

3. Permanent Pavement Marking Paint and Beads will be measured by the nominal length, excluding gaps, of line applied and accepted by the Engineer. The beads shall be subsidiary to items for which direct payment is made. Any striping ordered removed and replaced shall be done at no expense to the Department. The pay item is "Permanent Pavement Marking Paint" and the unit of measurement is Linear Foot (LF) [Meter (m)].

4. 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) _____ Preformed Pavement Marking, Type _____	Linear Foot (LF) [Meter (m)]
_____ Preformed Pavement Marking, Type _____	Each (ea)
_____ inch (mm) _____ Thermoplastic	Linear Foot (LF) [Meter (m)]
_____ Thermoplastic	Each (ea)
_____ inch (mm) ____ Thermoplastic, Type ____	Linear Foot (LF) [Meter (m)]
_____ Thermoplastic Type _____	Each (ea)
Permanent Paving Marking, Paint	Linear Foot (LF) [Meter (m)]
____ Inch (mm) ____ Preformed Pavement Marking, Type IV Grooved	Linear Foot (LF) [Meter (m)]
Preformed Pavement Marking, Type IV Grooved	Each (ea)
_____ Inch (mm) _____ Epoxy	Linear Foot (LF) [Meter (m)]
_____ Epoxy	Each (ea)

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. Payment is full compensation for all work prescribed in this Section.

SECTION 424 -- VIDEO CAMERAS

424.01 -- Description

The Contractor shall furnish and install video cameras as shown in the plans. This work shall include furnishing and installing the video camera, mounting bracket, cable harness, and junction box. This work will also include aiming the camera.

424.02 -- Material Requirements

Video cameras shall be as specified in the plans or will be supplied by the State.

424.03 -- Construction Methods

1. Do not aim the camera at the sun as this can cause permanent damage to the camera.

2. The Contractor shall band and pin the mounting bracket to the pole/mast arm.

3. When a junction box is required, the Contractor shall band the junction box to the pole/mast arm.

4. Connect the video camera as required by the camera manufacturer.

5. The Contractor shall aim cameras as directed by the Traffic Engineering Division.

424.04 -- Method of Measurement

Video cameras shall be measured by the each.

424.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Video Camera	Each (ea)
Install Video Camera	Each (ea)

2. Payment is full compensation for all work prescribed in this section.

SECTION 425 – DYNAMIC MESSAGE SIGNS

425.01 -- Description

The Contractor shall install State supplied dynamic message signs of the type and at the locations designated on the plan. This work shall include installing the sign on the sign support structure, installing conduit and cable from the sign support structure into the sign cabinet, and for all materials, labor, tools, and incidentals required to put the sign into working order.

425.02 – Material Requirements

The State supplied Dynamic Message Signs shall be shown in the plans.

425.03 – Construction Methods

1. Dynamic Message Signs

a. The Contractor shall arrange for the delivery of State supplied signs directly from the vendor. Contact the NDOR Traffic Engineering Division to obtain the name and phone number of the vendor's representative.

b. The Dynamic Message Sign shall be transported, handled, and stored in an upright position at all times.

c. The sign shall be protected from vandalism and rodent damage during storage.

d. The Contractor shall furnish all fasteners and hardware necessary to attach the sign to the sign support structure.

e. The Contractor shall furnish and install all conduit and electrical hardware necessary to run the dynamic message sign communication cable and the service cable into the sign case.

f. The Contractor shall terminate the cables in the sign per manufacturer specifications.

g. The installation shall be in accordance with the National Electric Code. All inspections will be by the Department of Roads personnel. Inspection by other State or local agencies is not required.

h. All work shall be performed by competent trades persons experienced in their craft and under the supervision of a licensed journeyperson electrician or lineperson. The licensed supervisor shall be on the job site whenever work is being performed. Any portion of the installation that presents an appearance of careless or shoddy work will be rejected.

i. The Contractor shall replace and restore all plant materials and roadway structures disturbed by trenching, excavating, or back-filling

operations. The Contractor shall dispose of all excess excavation and trenching material.

j. The Contractor shall be responsible for any tree trimming required.

k. The Contractor shall verify the location of all underground utilities as prescribed in the One Call Notification System Act.

2. Power and Communications

a. Electric power service and communication service for each sign has been requested by the State. The service locations shown on the plan are the locations suggested by the State to the utility companies and are subject to change.

b. The Contractor shall not attach or connect any equipment to any utility without specific permission from the owner of the facility. The Contractor shall contact the local electrical utility company 3 work days prior to installing any equipment on the utility's poles or requesting final service connections.

c. The Contractor shall no be required to pay for electrical energy consumed by the Dynamic Message Sign system.

3. System Operation

a. NDOR shall be notified at least 2 NDOR workdays before energizing any electrical system.

b. Electrical systems shall not be put into operation until the NDOR authorized representative is present.

c. Un-energized circuits may be tested at any time.

d. 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.

e. The Contractor shall assist and coordinate their work with the vendor's representative who will make the final electrical connections and perform on-site system testing.

4. Tests of Systems

a. 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 testes at no additional cost to the State.

b. Resistance to ground shall be measured at random locations for non-current carrying components, and insulation resistance tests shall be conducted when required by the Engineer.

c. 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.

5. Grounding

a. All sign supports, controllers, and service disconnects shall be properly grounded by means of a copper clad ground rod and copper grounding electrode conductor. All pull box rings and covers shall be grounded as shown in the plans.

b. Unless indicated otherwise, grounding conductors of No. 10 AWG or larger diameter wire shall be stranded.

c. All dynamic message sign systems shall have a grounding conductor (equipment ground) installed throughout the system.

d. The grounding conductor shall be grounded at the service disconnect and bonded to all ground rod and all non-current carrying components within the system.

e. The grounding conductor shall not be used for a neutral wire in the system.

6. Secondary Electrical Connections

a. Cable connections shall only be made in Dynamic Message Sign controller cabinets, Overhead Sign Support bases, 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 Electric Code*. Submersible, secondary, mechanical connectors meeting ANSI C119.1 are required for all splices outside of the controller cabinet and the sign housing.

b. 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 solder-less 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.

c. An antioxidant compound shall be used on all dissimilar metal connections. The Engineer may inspect 5 electrical connections at random. If

any of the 5 connections are found unacceptable, the Engineer may select an additional 10 connections 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 State.

425.04 – Method of Measurement

Dynamic message signs shall be measured by the each.

425.05 – Basis of Payment

1. **Pay Item** **Pay Unit**

   Install Dynamic Message Sign Each (ea)

2. Payment is full compensation for all work prescribed in this section.

SECTION 426 – DYNAMIC MESSAGE SIGN CONTROLLER

426.01 -- Description

The Contractor shall install State supplied dynamic message sign controllers of the type and at the locations designated on the plan. This work shall include furnishing and installing the controller, controller cabinet, concrete foundation, ground rod, conduit bends, power service with a disconnect, and all excavation, backfilling, grading, slope protection, labor, equipment, tools, and incidentals required to complete the work.

All equipment required by the power company to be installed on the power pole or power pedestal is subsidiary to the dynamic message sign controller installation.

426.02 -- Material Requirements

1. The State supplied controller and cabinet shall be shown in the plans.

2. Concrete shall meet the requirements of Section 1002.

3. The Contractor shall furnish all equipment and hardware necessary for a complete operational cabinet and controller. This includes conduit, ground rod, wiring, and related electrical appurtenances not supplied by the State with the controller. These items shall meet the requirements of Section 1073, and the *National Electric Code.*

4. The AC power field service shall be connected directly to a circuit breaker appropriated sized for the sign load. This circuit breaker shall be a single or double pole, nonadjustable, magnetic breaker rated for 120 or 240 VAC operation. The breaker shall be 10 amperes greater than the breaker in the sign, 50 amperes minimum. It shall be equipped with a solderless connector suitable for terminating the appropriate gauge wire for the dynamic message sign service. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the “ON” and “OFF” positions.

5. All wire insulation shall have a minimum rating of 600 volts.

426.03 – Construction Methods

1. The Contractor shall arrange for the delivery of State supplied controllers directly from the vendor. Contact the NDOR Traffic Engineering Division to obtain the name and phone number of the vendor’s representative.

2. The controller shall be transported, handled, and stored in an upright position at all times.

3. The Controller shall be protected from vandalism and rodent damage during storage.

4. The cabinet shall be placed on a concrete pad as shown on the plan. The cabinet shall not be placed in a ditch or depression that is subject to water ponding or flooding.

5. The Contractor shall take care that all conduits within the cabinet are clear of any braces or equipment that would interfere with cable runs. One spare 2-inch (50 mm) conduit bend shall be installed in each controller pad. The ends of the spare bend shall be capped.

6. The Contractor shall terminate the cables in the controller cabinet per manufacturer specifications.

7. All electrical, telephone, and sign communication cable within the cabinet shall be neatly trained 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 sheating material. The cabling shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors.

8. 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.

9. 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.

10. Un-fused 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.

11. The dial-up modem supplied with the controller shall be installed in the cabinet and connected to the telephone service.

426.04 – Method of Measurement

Dynamic message sign controllers shall be measured by the each.

426.05 – Basis of Payment

1. **Pay Item** **Pay Unit**

   Install Dynamic Message Sign Controller Each (ea)

2. Payment is full compensation for all work prescribed in this section.

DIVISION 500 -- BITUMINOUS PAVEMENT

SECTION 501 -- GENERAL REQUIREMENTS

501.01 -- General

1. Bituminous surfacing work will include the application of prime coats, tack coats, fog seals, slurry seals, and armor coats and the construction of bituminous sand base courses and asphaltic concrete surface and base courses. The work shall be done in accordance with the plans and these *Specifications.*

2. Before the application of asphaltic materials, the Contractor shall clean the surface to be treated with mechanical brooms or hand tools as necessary to remove all foreign materials (vegetation, loose surface materials, dirt, mud, and old crack sealant). 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.

3. Stockpiling is not allowed in aquatic areas, including rivers, streams, and wetlands. Techniques should be employed to prevent petroleum, chemicals, harmful materials, and excessive suspended solids from entering waterways.

4. The Contractor shall protect all structures and roadway appurtenances like signs, guardrails, and curbs when bituminous materials are used. If any items are damaged by the Contractor or because of the Contractor's negligence, then they shall be repaired or replaced at no additional cost to the Department.

5. Asphaltic concrete operations shall not be allowed between sunset and sunrise without permission of the Engineer.

6. The Contractor shall apply asphaltic materials within the temperature ranges shown in Table 501.01 or within written manufacturer recommended temperatures so that uniform mixing and spreading is attained.

Table 501.01

Required Asphaltic Temperatures			
		Temperature	
Asphaltic Material	**Grade**	**Minimum**	**Maximum**
Emulsified Asphalt	All	105°F (40°C)	220°F (104°C)
MC	70	105°F (40°C)	250°F (120°C)
MC	250	150°F (65°C)	275°F (135°C)
MC	800	175°F (80°C)	300°F (150°C)
Asphalt Cements	All	250°F (120°C)	392°F (200°C)

7. Table 501.02 shall be used when there is a need to restrict the routine placement of asphaltic concrete as a result of cold temperatures. Other conditions, such as wind velocity, cloud cover, and other project specific conditions, will be considered by the Engineer when determining the need to restrict the placement of asphaltic concrete.

Table 501.02

Cold Weather Asphaltic Concrete Placement	
Lift Thickness	**Minimum Surface Temperatures**
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)

8. 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 or 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 thermometer or other approved 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. 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, rotating spray bars with rotating nozzles.

(4) Heating coils and a burner or approved auxiliary heating device.

(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 shall be able to conform to the roadway crown and provide uniform coverage. The spray bar shall be designed to shift laterally during operation. The spray bars and nozzles shall be constructed to prevent clogging. The distributor shall be equipped with a full circulating type spray bar having positive shut-off devices to prevent dripping after the flow is shut off.

d. The Contractor shall furnish certified copies of the distributor and supply tank calibrations to the Engineer.

6. a. Aggregate spreaders shall be self-propelled and designed, equipped, coordinated, and operated so that the aggregate will be spread uniformly and continuously over the full width of the asphaltic material in one operation.

b. (1) The spreading hopper shall be equipped with adjustable cutoff gates to allow spreading of aggregate over the required width of asphaltic material.

(2) The unit shall be able to spread the aggregate uniformly at the required rate.

(3) The unit shall have a rear hopper to receive the aggregate from the haul trucks.

(4) The aggregate shall be transferred from the receiving hopper to the spreading hopper without segregation.

(5) 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 NDR 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 asphaltic concrete pavement smoothness, and defines defective pavement smoothness. The intent of the specification is to produce a finished asphaltic concrete pavement driving surface with a Profile Index no greater than 12 inches per mile (189 mm per kilometer) for multi-lift roadways and no greater than 14 inches per mile (221 mm per kilometer) for single-lift roadways. Pavement smoothness will be evaluated as prescribed 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 payment item “Asphalt Pavement Smoothness Testing” is included in the contract, the incentive/disincentive provisions of this section do not apply, but the smoothness testing shall be performed as prescribed. The asphaltic concrete pavement shall be evaluated in accordance with Paragraph 11. of Subsection 503.04.

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 25-ft. (7.6 m) California profilograph approved by the Nebraska Department of Roads.

2. The profilograph shall have multiple, non-uniformity spaced, articulated support wheels arranged such that no two wheels pass the same location on the pavement surface at the same time (ASTM Designation: E 1274, Paragraph 5.1.2).

3. The profilograph shall be equipped with a computerized system that will record, analyze, and print the test data.

4. The profilograph shall produce a printed pavement profile trace (profilogram) with a vertical scale of 1:1, and a horizontal scale of 1:300 (1” paper = 25’ pavement) (1 mm paper = 300 mm pavement). The profilogram 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. Blanking (Null) band width
k. Profile counts for each test section
l. Profile Index for each test section
m. Bump locations for each test section

502.03 – Certification and Independent Assurance Testing

1. The Department shall calibrate and certify the Contractor's profilograph annually at a test site established by the Department.

a. The profilograph shall be inspected for compliance with general equipment requirements, including wheel configuration, effective length, data analysis system, guidance system, and overall condition.

b. The profilograph shall be calibrated for distance measurement by moving it over the prescribed path of a premeasured test distance at walking speed, and determining its distance calibration factor.

c. The profilograph shall be checked for vertical measurement accuracy by placing a 1-inch (25 mm) and 2-inch (50 mm) calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The vertical measurement indicated by the profilograph shall be within 4.0% tolerance of the actual premeasured block height.

d. The profilograph shall be checked for overall performance by moving it over the prescribed path of a pre-measured pavement test section at walking speed.

e. Distance measurement indicated by the profilograph 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 level used for calibration.

f. The Profile Index reported by the profilograph for the test section shall be within 10.0% tolerance of the Profile Index reported by a Nebraska Department of Roads' profilograph for the same test section.

g. A dated and signed decal will be placed on the profilograph to certify its acceptability for use on Nebraska Department of Roads' pavement construction projects.

2. The Department shall certify the Contractor's profilograph 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 Nebraska Department of Roads.

3. The Department shall schedule and perform Independent Assurance tests for the Contractor's profilograph 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 – Profilograph Test Procedures

1. The Contractor shall perform all pavement smoothness specification tests except the 10-foot (3 meter) straight edge testing as shown in Paragraph 15. below.

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 (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 shall be combined with the preceding 528 feet (200 m) long test section for analysis.

3. The Contractor's certified profilograph 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°C) or lower when smoothness tests are performed.

5. The profilograph operator shall perform pavement smoothness measurements in the right-hand or left-hand wheel path of all driving lanes, as directed by the Engineer, including climbing and fly-by lanes. 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. All wheels of the profilograph shall be on the new pavement for which the Contractor is responsible.

6. The Contractor shall remove all objects and foreign material from the pavement surface before testing.

7. The profilograph operator shall guide the profilograph along the specified wheel path of each traffic lane at walking speed. Propulsion may be by personnel pushing manually, or by a suitable propulsion unit that does not exceed a speed of 4 miles (6.5 Kilometers) per hour.

8. A lateral location indicator shall be used to keep the profilograph in the required test path during testing. Pavement edges, longitudinal joints, or longitudinal pavement markings may be used as reference lines. An additional person may be required to hold the back end of the profilograph on the required path on horizontal curves.

9. Before testing, the profilograph operator shall lower the profilograph's recording wheel to the pavement surface and move the profilograph forward to the beginning location of a test section to stabilize the measurement system.

To ensure consistent distance measurement, the profilograph operator shall also check and adjust the recording wheel tire pressure several times a day.

10. All station references on the profilograms and report forms shall be actual project stations. Stations shall be accurately noted on the profilogram at least every 200 feet (50 m).

11. The profilograph operator and the Engineer shall sign the profilograms immediately after completion of the tests, and the Engineer shall take immediate possession of the profilograms.

12. The Engineer shall perform or schedule verification tests on at least 10 percent of the pavement surface, using a profilograph owned by the Department.

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 of the following:

a. require the Contractor to calibrate the profilograph and re-run the tests.

b. disqualify the Contractor's equipment and/or operator.

c. perform the tests for part, or all, of the project with a profilograph 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 Profile Index, unless otherwise specified in the Special Provisions.

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 or rest areas, acceleration/deceleration lanes, and interchange ramps and loops.

d. Pavement within 50 feet (15 m) 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. Additional exceptions shown on the summary sheet in the plans.

15. Excluded pavement sections shall be measured for bumps with either a profilograph or a 10-foot (3 m) straight edge. If the profilograph is used, the deviation shall not exceed 0.40 inch (10 mm). The deviation of the surface shall not exceed 1/8 inch (4 mm), if a 10-foot (3 m) straightedge is used.

502.05 – Evaluation

1. The Contractor shall determine a Profile Index 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 profilograms, to the Engineer.

a. The Profile Index shall be calculated by adding the absolute value of the vertical deviations (inches or millimeters) outside of a 0.1 inch (2.5 mm) blanking band and dividing the sum by the length of the test section (miles or kilometers). The resulting Profile Index is in units of inches per mile (millimeters per kilometer).

b. Correctable bumps shall be separately identified on the profilograms. They appear as high points on the profilogram and correspond to high points on the pavement surface. Correctable bumps are vertical deviations on the pavement surface that exceed 0.40 inch (10 mm) in height above a base line span of 25 feet (7.62 m).

c. Correctable dips shall be separately identified on the profilograms. They appear as low points on the profilogram and correspond to low points on the pavement surface. Correctable dips are vertical deviations on the pavement surface that exceed 0.40 inch (10 mm) in depth below a base line span of 25 feet (7.62 m).

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 Profile Index of a test section is 21 in/mi (331 mm/km) or less, bump and dip correction is the only corrective work allowed for that section.

b. When the Profile Index of a test section exceeds 21 in/mi (331 mm/km), corrective work shall be performed.

c. The Contractor shall retest all corrected test sections with the profilograph.

3. All bumps, as defined in Subsection 502.05, Paragraph 1.b., and all test sections with a Profile Index exceeding 21 in/mi (331 mm/km) shall be corrected by diamond grinding.

a. Bumps shall be considered corrected when they are at or below the 0.40 inch (10 mm) maximum height.

b. Sections with a Profile Index exceeding 21 in/mi (331 mm/km) shall be considered corrected when the Profile Index for that section has been reduced to a value of 21 in/mi (331 mm/km) or less.

4. All dips, as defined in Subsection 502.05, Paragraph 1.c., shall be corrected until they are at or below the 0.40 inch (10 mm) maximum depth. The Contractor shall have the following options:

a. diamond grind on either or both sides of the dip.

b. with the approval of the Engineer, 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.

c. a combination of the grinding and removal and replacement methods, or

d. with the approval of the Engineer, elect to leave an uncorrected or partially corrected dip in place for a monetary deduction.

5. 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.

502.07 – Traffic Control

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 asphalt concrete pavement and performance graded binder in the surface layer of each profilograph 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 502.01a.

Payment Adjustment Schedule (Multi-Lift Roadways)	
Profile Index Inches Per Lane Mile (Millimeters per Lane Kilometer)	**Percent of Contract Prices**
0 to 2 (0-32)	107
Greater than 2 to 4 (32 to 63)	105
Greater than 4 to 6 (63 to 95)	103
Greater than 6 to 8 (95 to 126)	102
Greater than 8 to 12 (126 to 189)	100
Greater than 12 to 14 (189 to 221)	98
Greater than 14 to 16 (221 to 252)	96
Greater than 16 to 18 (252 to 284)	94
Greater than 18 to 20 (284 to 315)	92
Greater than 20 to 21 (315 to 331)	90
Greater than 21 (331)	Corrective Work Required

Table 502.01b.

Payment Adjustment Schedule (Single-Lift Roadways)	
Profile Index Inches Per Lane Mile	**Percent of Contract Prices**
0 to 2	107
Greater than 2 to 4	105
Greater than 4 to 6	103
Greater than 6 to 8	102
Greater than 8 to 14	100
Greater than 14 to 16	97
Greater than 16 to 18	95
Greater than 18 to 20	93
Greater than 20 to 21	90
Greater than 21	Corrective Work Required

3. When the initial Profile Index of a test section is 21 in/mi (331 mm/km) 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 Profile Index of a test section is greater than 21 in/mi (331 mm/km), corrective work performed in that section may increase the percent of pay up to the 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 pay factor for the accepted quantity of asphaltic concrete and performance graded binder in the surface layer of all profilograph test sections shall be determined according to the formula in Table 502.02.

Table 502.02a.

Pay Factor Formula (Multi-Lift Roadways)
$$PF = \frac{A(1.07) + B(1.05) + C(1.03) + D(1.02) + E(1.00) + F(0.98) + G(0.96) + H(0.94) + I(0.92) + J(0.90)}{A + B + C + D + E + F + G + H + I + J}$$
Where:
A = Length of pavement with a Profile Index of 0 to 2 inches per mile. (0 to 32 mm/km)
B = Length of pavement with a Profile Index greater than 2 to 4 inches per mile. (32 to 63 mm/km)
C = Length of pavement with a Profile Index greater than 4 to 6 inches per mile. (63 to 95 mm/km)
D = Length of pavement with a Profile Index greater than 6 to 8 inches per mile (95 to 126 mm/km)
E = Length of pavement with a Profile Index greater than 8 to 12 inches per mile (126 to 189 mm/km)
F = Length of pavement with a Profile Index greater than 12 to 14 inches per mile (189 to 221 mm/km)
G = Length of pavement with a Profile Index greater than 14 to 16 inches per mile (221 to 252 mm/km)
H = Length of pavement with a Profile Index greater than 16 to 18 inches per mile (252 to 284 mm/km)
I = Length of pavement with a Profile Index greater than 18 to 20 inches per mile (284 to 315 mm/km)
J = Length of pavement with a Profile Index greater than 20 to 21 inches per mile (315 to 331 mm/km)

Table 502.02b.

Pay Factor Formula (Single-Lift Roadways)
$$PF = \frac{A(1.07) + B(1.05) + C(1.03) + D(1.02) + E(1.00) + F(0.97) + G(0.95) + H(0.93) + I(0.90)}{A + B + C + D + E + F + G + H + I}$$
Where:
A = Length of pavement with a Profile Index of 0 to 2 inches per mile.
B = Length of pavement with a Profile Index greater than 2 to 4 inches per mile.
C = Length of pavement with a Profile Index greater than 4 to 6 inches per mile.
D = Length of pavement with a Profile Index greater than 6 to 8 inches per mile
E = Length of pavement with a Profile Index greater than 8 to 14 inches per mile
F = Length of pavement with a Profile Index greater than 14 to 16 inches per mile
G = Length of pavement with a Profile Index greater than 16 to 18 inches per mile
H = Length of pavement with a Profile Index greater than 18 to 20 inches per mile
I = Length of pavement with a Profile Index greater than 20 to 21 inches per mile

2. The Contractor shall be assessed $500 each for all uncorrected or partially corrected dips left in place.

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 smoothness testing as set forth in this specification.

SECTION 503 -- ASPHALTIC CONCRETE

503.01 -- Description

This work shall consist of placing asphaltic concrete as shown in the plans.

503.02 -- Material Requirements

1. Asphaltic concrete shall conform to the requirements in Section 1028.

2. Asphalt cement shall be the type and grade specified in the plans and shall conform to the requirements in Section 1029.

3. The asphalt cement 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. If asphaltic concrete is obtained from a commercial plant not under the Contractor's direct control, the Contractor shall reach an agreement with the commercial producer to perform the required calibrations and adjustments.

   c. Tank volumes shall be available at the plant.

2. Asphalt Mixing Equipment:

   a. General Requirements:

   (1) The equipment that is used for heating, proportioning, and mixing the aggregates and asphalt cement 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 asphalt cement in dryer-drum type mixing plants shall be avoided.

   (3) Salvaged bituminous material 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 copy of the temperature reading 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 asphalt cement storage tank. (The Contractor may manually take and record the temperature. Readings shall be taken every 2 hours when the plant is in operation.)

(5) (i) Equipment used for heating asphalt cement shall conform to the requirements of Section 501.

(ii) During storage, the asphalt cement temperature shall be maintained between 250°F and 350°F (120°C and 180°C). All plants shall be equipped with a circulating system for asphalt cement which is designed to assure proper and continuous circulation 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 asphalt cement 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 significantly from the material taken directly from the plant.

(iii) The first material entering the bin shall be the first material removed.

(iv) The surge bin shall be completely emptied at the end of each operating day unless insulated or heated.

(7) All plants shall be equipped with a continuously operated dust collector. The collected material may be wasted or returned to the mix.

(8) Mineral filler bins shall be protected from moisture.

b. Pugmill Plants:

(1) General:

(i) Pugmill plants shall include cold aggregate feeders, oversize screens, storage bins for dried aggregate, ingredient proportioning devices, and all other equipment necessary to produce the specified mixture.

(ii) The pugmill blades shall have a minimum clearance of 3/4 inch (19 mm) from all fixed and moving parts.

(iii) The mixer shall be equipped with a discharge hopper holding approximately 1 ton (900 Kg) of hot mixture and capable of intermittent discharge.

(2) Batch Plants:

(i) [1] Batch plants shall have an accurate time lock to control the operations during a complete mixing cycle.

[2] They shall lock the scale box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle.

[3] They shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods.

[4] The dry mixing period is defined as the time between the opening of the scale box gate and the addition of bituminous material.

[5] The wet mixing period is the interval of time between the addition of bituminous material and the opening of the mixer gate.

[6] The control of the timing shall be flexible and capable of being set at 5-second intervals or less throughout a total cycle of not less than 3 minutes.

[7] A mechanical batch counter shall be installed as a part of the timing device and shall be designed and constructed to register only upon the release of the bituminous material. It shall not register any dry batches or any material wasted through the bins.

[8] The timing device shall have a suitable case with a locking door that shall always be kept closed and locked except when adjustments or repairs are required.

(ii) Each batch plant shall be equipped with an asphalt cement volume meter or a heated or insulated asphalt bucket with scales.

(iii) Scale hoppers and scales for proportioning aggregates and asphalt to the batch plant's mixer shall be accurate within 0.5 percent; and they shall be sensitive within 0.2 percent or 2 pounds (1 Kg), whichever is greater, throughout the range of use.

(3) Continuous Type:

(i) Plants shall be equipped with a pump synchronized to the feeding mechanism so that the required percentage of asphalt cement is applied continuously and uniformly.

(ii) The feeding system shall be synchronized to the rest of the plant.

c. 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 asphalt cement will be applied continuously and uniformly.

(3) The feeding system shall be synchronized to the rest of the plant.

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 undue delays shall not be used.

4. Placement Equipment:

a. Asphaltic Concrete Mixture Finish Machines:

(1) Finishing equipment shall place the full-lane width shown in the plans. The machines shall be self-propelled and able to spread and finish the material to the required thickness without 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 finishing machine 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 finishing machine shall produce continuous and uniform consolidation of the asphaltic concrete. The screed of the finishing machine shall be adjustable to the crown and heated across its entire length. Controls will be provided to prevent overheating the bituminous 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 finishing machine 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 mm) 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 percent 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:

(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:

a. Elevating machines shall transfer without segregation asphaltic concrete from the roadway surface to the finishing machine's receiving hopper.

b. The 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:

Material transfer vehicles are authorized. Before crossing any bridge, these vehicles must be unloaded to a weight approved by the NDR Bridge Division.

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 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.

b. The Contractor shall calibrate the scales accurate to 0.5 percent 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 daily 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.

503.04 -- Construction Methods

1. Preparation:

a. (1) The Contractor shall prepare the roadbed, subgrade, base, and/or foundation courses as prescribed in Division 300.

(2) Before placing the asphaltic concrete, the surface of the trimmed subgrade shall be tight, dust-free, and rolled to firmly incorporate any loose or disturbed material and provide a suitable foundation for the subsequent construction.

b. When resurfacing a roadway, the Contractor shall remove and dispose of any materials whenever correction of grade elevation is required at project, bridge, and railroad crossing approach ends. Disposal shall be paid for as equipment rental in accordance with Section 919.

c. The Contractor shall clean the pavement surface of all dirt, foreign material, loose surfacing material, crack filler or joint sealing materials, and unstable bituminous patches.

d. (1) When grade correction is necessary to meet a surface elevation, it shall be accomplished by milling or removal as shown in the plans.

(2) The Contractor shall dispose of any surfacing material along the project right-of-way left by maintenance forces.

(3) All asphaltic crack filler or joint sealing material in joints or cracks less than 1 1/2 inches (38 mm) in width shall be removed flush with the surface of the pavement. 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.

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 before spreading each 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.

f. 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 plans shall take place in the lower layers.

2. Asphalt Mix Control Strip:

a. On the first production day, a 1000 ton (900 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 laydown and compaction procedures that are representative for the project.

The Contractor shall take at least 4 control strip mixture samples and record the test results for the mixture properties identified in Paragraph 4.h.(3) of Subsection 1028.03. The Contractor will also record compaction density values and rolling pattern information. This data will be for information only and shared with the Engineer.

b. (1) 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 #	Ton (Mg)	Air Voids
1	0 to 200 (0-180 Mg)	2.0 to 6.0
2	201 to 400 (181 – 350 Mg)	2.5 to 5.5
3	401 to 700 (351 – 650 Mg)	3.0 to 5.0
4	701 to 1000 (651 – 900 Mg)	3.0 to 5.0

(2) Marshall air voids of each sample shall be calculated using the average of 4 theoretical maximum specific gravity sample results.

(3) 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 assurance from the Contractor that adjustments will be made in an effort to attain and then maintain target Specifications.

(4) The mixture is acceptable if all test results are within specification limits.

(5) NDR personnel will observe testing procedures.

c. The Contractor shall repeat the control strip process for each mix type and until an acceptable control strip is produced.

d. Accepted control strips, when placed in areas that are to be paved, will remain in place and be measured as a part of the completed pavement.

e. When a control strip for a specific mix type is accepted, full production of that mix type may begin.

f. 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.

g. When the test results for a control strip indicate the mixture does not meet the specifications, the control strip will be rejected. The Contractor shall remove and replace the strip at no additional cost to the Department.

h. Routine quality control testing will be conducted on all asphalt mix produced except the 1000 tons (900 Mg) control strip, which is tested separately.

i. Asphaltic Concrete Type SPS is excluded from any control strip requirements.

j. The Contractor will be allowed to select three of the four individual air void tests within the control strip and apply those three selected individual values to the individual air void test result of the first 750 ton (680 Mg) sublot of Lot 1 to calculate the initial moving average of four and resulting pay factor for the initial 750 ton (680 Mg) sublot. The Contractor must select the three results to be used prior to the testing of the first 750 ton (680 Mg) sublot of Lot 1.

3. Placement Limitations:

a. The Contractor shall place the asphaltic concrete mixture on a dry and frost-free surface.

b. The minimum laydown temperatures are shown in Table 501.02.

c. (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 bed shall be insulated and have an "R" value of approximately 1.0.

(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.

d. No asphaltic concrete mixture shall be placed after October 31, unless specifically ordered by the Engineer.

4. Delivery and Production Requirements:

The delivery of asphaltic concrete shall be scheduled to allow continuous laydown operations.

5. Placement Operations:

a. (1) The actual mixing temperature shall be selected by the Contractor to provide adequate aggregate coating and mixture compaction at laydown.

(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 asphalt cement from the aggregate will result.

b. (1) Asphaltic concrete used in the construction of sections having a uniform width, including the surface layer of surfaced shoulders and the surface layer of intersections and driveways, shall be spread with finishing machines.

(2) All asphaltic concrete shoulder material may be placed with a side-delivery machine except the surface lift. The surface lift shall be placed with a finishing machine.

(3) In deep, irregular, or narrow sections and in flumes, ditch lining, island noses, or where it is impractical to use a mechanical finishing machine, the Contractor may use other approved 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, when a layer in one lane is 500 feet (150 m) or more in advance of the corresponding layer in an adjacent lane at the end of a day, the Contractor shall not resume placement operations in the farthest advanced lane until both lanes have been placed the same distance.

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 plans, the roadway or shoulder resurfacing shall be feathered onto the 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 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 pass over the unprotected end of the freshly placed mixture only when the placement of a layer is to be discontinued. When placement is discontinued, 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 all vertical surfaces 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.

(3) Before acceptance, the finished transverse joint will be checked for smoothness with a 10 foot (3 m) straightedge. The allowable surface variation is 1/8 inch (3 mm).

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.

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 plans.

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. 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.

10. Density Core Samples:

a. The Contractor shall sample the pavement as prescribed in NDR T 168.

b. The Department will perform density testing on the pavement sample as prescribed in NDR T 166.

11. The Engineer may evaluate any surface irregularities caused by workmanship with a 10-foot (3 m) straight edge. The maximum allowable deviation will be 1/8 inch (3 mm) in 10 feet (3 m) measured longitudinally. If the deviation exceeds 1/8 inch (3 mm) in 10 feet (3 m), then the area shall be corrected by grinding with a machine equipped with diamond blades with spacers until the deviation is less than 1/8 inch (3 mm) in 10 feet (3 m) or the Engineer may authorized a $500.00 deduction for each irregularity.

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 truck driver shall carry the original copy of the scale ticket to the delivery point and give it to the NDR placement inspector.

d. (1) The measured quantity shall be the total weight of asphaltic concrete shown on the scale ticket without deduction for the asphalt cement 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. Asphalt cement will be measured in tons (megagrams).

b. In the event the Contractor cannot verify the asphalt cement quantity from the scale ticket, the Contractor's laboratory test shall be used to determine the asphalt cement percentage.

c. No payment will be made for excess asphalt cement in the mix. Excess asphalt cement is all the cement that is more than 0.7 percent by weight beyond the specified amount.

4. Expansion relief joint preparation is measured by the linear foot (meter). All asphaltic materials are included in the pavement overlay quantities and are not measured separately.

503.06 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Asphaltic Concrete, Type ____	Ton (Tn) [Megagram (Mg)]
Asphalt Cement ____	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)]

2. a. For each lot of Asphaltic Concrete Type SPS, the asphaltic concrete unit price is multiplied by the average density per lot pay factor for the item “Asphaltic Concrete, Type SPS”.

b. (1) If the mean result of the lot 3750 tons (3400 Mg) acceptance tests for asphalt density deviates from the required minimum by more than the extreme value shown under the 0.7 pay factor in Tables 1028.03 or 1028.04, the Engineer may order the removal of any or all such material in the lot 3750 tons (3400 Mg).

(2) For each sublot of Asphaltic Concrete Type SP0, SP1, SP2, SP3, SP4, and SP5, the asphaltic concrete unit price is multiplied by the product of the sublot pay factors for single test air voids and running average of four air voids and average density per lot for the item "Asphaltic Concrete, Type ____". Included in a sublot, following approval of the control strip(s), may be any roadway Asphaltic Concrete Type SP0, SP1, SP2, SP3, SP4, or SP5 which is produced, sampled and tested and approved by the Engineer for use as Patching, State Maintenance Patching, and Asphalt for Intersections and Driveways on project shall be eligible for inclusion in sublot(s) tonnage pay factor determination using the roadway Asphaltic Concrete Type _____ unit price.

(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:

$$\frac{P1(T1) + P2(T2) + P3(T3)\ldots}{T1 + T2 + T3\ldots}$$

Where P1, P2, P3 = % pay factor for each sublot
T1, T2, T3 = tons (Mg) at respective pay factor

3. Deductions will be made for materials which have been damaged by overheating, which have been allowed to cool excessively before laying, which are required to be removed because of defective work, which have been wasted, or which have not been used as directed by the Engineer.

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. a. 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 in Tables 503.01 A & B. The pay factors are applicable to the asphalt materials properties shown in Table 503.01 B.

Table 503.01 A

Asphalt Materials - Pay Factors		
	Specified Property	
Pay Factor *	Upper Limit	Lower Limit
1.00	+ 1% to +10%	- 1% to -10%
0.95	Greater than +10% to +15%	Less than -10% to -15%
0.90	Greater than +15% to +20%	Less than -15% to -20%
0.80	Greater than +20% to +25%	Less than -20% to -25%
0.70	Greater than +25% to +30%	Less than -25% to -30%
0.40 or Reject	Greater than +30%	Less than -30%

* If the resultant pay factor for the material is less than 0.70, the material shall be rejected if not already used. If incorporated in any work which is judged to be unsatisfactory, the material shall also be rejected.

* If the pay factor is less than 0.70 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material shall be 0.40.

Table 503.01 B

Applicable Properties						
	Asphalt Cement		Asphaltic Oil		Emulsified Asphalt	
Property	Viscosity Grade	Penetration Grade	Original Material	Distillation Residue	Original Material	Distillation Residue
Viscosity	X[1]		X		X[3]	X
Penetration	X	X[1]		X		X[2]
Distillation to 435°F(224°C)			X			
Distillation to 500°F (260°C)			X			
Distillation to 600°F (316°C)			X			
Percent Residue			X		X	
Float Test						X
Absolute Viscosity						X
Softening Point						X

[1] Original material and thin film residue.
[2] Penalties cannot be based on tests made on Residue by Evaporation.
[3] No penalties will be assessed if more than 1 day has elapsed between the sampling and the testing of the material.

b. When asphaltic concrete in any lot 3750 tons (3400 Mg) or portion of a lot 3750 tons (3400 Mg) is rejected and removed from the road, payment will not be made for the asphaltic concrete or for the asphalt cement contained in the rejected material. The determination of the quantity of asphalt cement for which payment will not be made will be based on the percent of cement used in the rejected material.

c. The order of precedence to determine the asphalt cement quantity is:

(1) Actual lot 3750 tons (3400 Mg) tests.

(2) The average of the day's run.

(3) The job mix formula.

6. If all required data is available, actual lot 3750 tons (3400 Mg) tests will determine the quantity of asphalt cement in the rejected material.

7. Pay factors for asphaltic concrete mixtures do not alter the price paid for asphalt cement.

8. Tack coat will be paid for in accordance with Section 504.

9. Disposal of the surfacing material discarded by maintenance forces and the removing and disposing of materials for grade correction elevations and core outs will be measured in accordance with the requirements of Subsection 919.04 and paid for in accordance with Subsection 919.05.

10. a. Any bituminous mixture found contaminated by petroleum distillates 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 percent of the bituminous mixture's contract unit price.

b. The quantity of bituminous mixture to be removed or paid for at the reduced price will be based on full lane widths extending beyond the visible limits of the contaminated area 25 feet (7.6 m) in both directions.

11. If more than one type of asphaltic concrete is required, the pay item will be subdivided so the quantities of each type are documented.

12. Pavement thickness cores are paid for as an "established" contract unit price item, which is shown in the bid proposal "Schedule of Items."

13. Density cores are subsidiary to “Asphaltic Concrete, Type ____”.

14. The control strip is subsidiary to the materials used.

15. Payment is full compensation for all work prescribed in this Section.

SECTION 504 -- TACK COAT

504.01 -- Description

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

The type and grade of asphaltic materials shall be specified in the plans and shall conform to the requirements in Sections 1031 or 1032.

504.03 -- Construction Methods

1. Before the application of tack coat, the surface shall be cleaned as prescribed in Section 501.

2. The Contractor shall furnish and apply the tack coat.

3. a. An approved pressure distributor shall be used at the rate designated by the Engineer. Uniform application is required. Hand sprayers may be used in applying tack coat to small or irregular sections.

b. Emulsified asphalt shall be diluted in the distributor with sufficient potable water to reduce the asphalt content in the mixture to approximately 30 percent of the total volume. (Usually, emulsified asphalt is supplied at 60 percent residual asphalt and 40 percent water. The addition of an equal volume of water will produce an emulsion with 30 percent residual asphalt.)

c. The rate of application of the 30 percent residual asphalt shall be adequate to bond the new bituminous layer to the existing surface. This generally will be from 0.10 to 0.20 Gal/SY (0.45 to 0.90 L/m^2) when applied to existing or milled surfaces and from 0.05 to 0.10 Gal/SY (0.23 to 0.45 L/m^2) when applied to the freshly laid asphaltic concrete.

4. The Contractor shall furnish and apply a tack coat to seal surfaces and prevent infiltration of moisture when construction will be interrupted by weather and the project is shut down for the winter.

504.04 -- Method of Measurement

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. When materials do not meet plan and specification requirements, deductions will be made according to Table 503.01.

3. Water used to dilute emulsified asphalt is subsidiary to "Tack Coat" and is included in the solution (30 percent emulsified asphalt and 70 percent water) that is placed and measured for payment.

4. Payment is full compensation for all work prescribed in this Section.

SECTION 505 -- ASPHALTIC CONCRETE CURB

505.01 -- Description

This work consists of constructing asphalt curbs as shown in the plans.

505.02 -- Material Requirements

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 hot 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.

505.04 -- Method of Measurement

Asphaltic concrete curb length is measured by the linear foot (meter).

505.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Constructing Asphaltic Concrete Curb	Linear Foot (LF) [Meter (m)]

2. Materials required to construct curbs are included in the pay items "Asphaltic Concrete, Type _____" and "Asphalt Cement for Asphaltic Concrete" of the surface course in Section 503.

3. Payment is full compensation for the work prescribed in this Section.

SECTION 506 –
ASPHALTIC CONCRETE ISLAND NOSES AND MEDIANS

506.01 -- Description

This work consists of constructing asphaltic concrete island noses and medians as shown in the plans.

506.02 -- Material Requirements

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 hot 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 shall 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 "Asphalt Cement for Asphaltic Concrete."

3. Payment is full compensation for all work prescribed in this Section.

SECTION 507 –
ASPHALTIC CONCRETE FOR STATE MAINTENANCE PATCHING

507.01 -- Description

Asphaltic concrete for State maintenance patching shall be the type designated by the pay item. NDR 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

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)]
Asphalt Cement for State Maintenance Patching _____	Ton (Tn) [Megagram (MG)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 508 -- JOINT SEALING - ASPHALT TO CONCRETE

508.01 -- Description

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 blend of new or reclaimed synthetic or natural rubber, paving grade asphalt cement, and other additives. The joint sealing material shall be submitted to the NDR's Materials and Research Laboratory for approval.

2. The blend, 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 not 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. a. The safe heating temperature is the highest temperature to which the joint filler can be heated and still conform to all requirements of this specification.

b. A maximum of 20°F (7°C) higher than the manufacturer's minimum recommended application temperature is considered the safe heating temperature.

c. For testing purposes, the pouring temperature for specimen preparation is the safe heating temperature recommended by the manufacturer.

d. Laboratory testing may begin only after the testing agency has received the safe heating temperature. All containers must maintain their safe heating temperature when in use.

e. The joint filler shall meet the following requirements:

(1) Softening Point: Minimum temperature of 150°F (66°C).

(2) Cone Penetration: At 77 ± 0.2°F (25 ± 0.1°C), using a 5.3 ounces (150 g) for 5 seconds, shall not exceed 70 units. At 39 ± 0.2°F (4±0.1°C), using 7 ounces (198 g)for 60 seconds, the minimum shall be 15 units.

(3) Resilience: At 77 ± 0.2°F (25±0.1°C), resilience shall be at least 30 percent recovery.

(4) Asphalt Compatibility: There shall be no failure in adhesion, nor formation of an oily exudate at the interface between the joint filler and the asphaltic concrete specimen, nor softening or other deleterious effects on the asphaltic concrete or joint filler when tested at 140°F (60°C) for 72 hours.

6. If granulated rubber is used, it shall not contain wire, fabric, or other contaminating materials.

7. Acceptance of the manufactured material will be based on a Certificate of Compliance for each lot or batch furnished by the supplier. The Certificate of Compliance shall state the type of rubber used and that material is in compliance with these *Specifications*. Random samples may be tested to verify compliance with these *Specifications*.

8. The rubber-asphalt joint filler shall be packaged in meltable [300°F (149°C)] polyethylene bags contained in cardboard boxes. Each cardboard box shall contain two 25 pound (11 Kg) packages of the rubber-asphalt joint filler. The net weight shall be 50 pounds (22 Kg) per box. 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. Boxed material shall be furnished on pallets weighing approximately 2,000 pounds (900 Kg). Pallets shall be covered with clear plastic and banded.

9. The concrete to asphalt joint sealant shall meet requirements in ASTM D 5078.

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 plans. 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.

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. Payment is full compensation for all work prescribed in this Section.

SECTION 509 -- BITUMINOUS SAND BASE COURSE

509.01 -- Description

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 plans. 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 always 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 plans.

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 density 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 plans. 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 percent 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 prescribed 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 plans.

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 percent.

(3) The allowable moisture content of the combined aggregate will be 5.0 to 9.0 percent 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 percent or more than 105 percent 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 later. 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 percent.

(2) The upper 80 percent of the base course material shall be aerated uniformly to the required degree, but such aeration shall not exceed 75 percent, as determined by the method described below:

Percent of Aeration

$$A = \text{Percent aeration} = 100 - \frac{100E(100 + N)}{5\,ND}$$

E = milliliters of distillate in a 500 g sample tested as described in NDR 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 percent 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 percent 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 density 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 plans.

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/m^2) in accordance with Subsection 504.03, Paragraphs 1., 3.a., and 3.b. The fog seal emulsion type will be identified in the plans.

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 m^3) 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 prescribed 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 tear it up, 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 plans.

4. Water used in adjusting the moisture content of the combined mineral aggregate when emulsified asphalt is used will be measured as prescribed 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 plan and specification 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 prescribed in this Section.

SECTION 510 -- COLD MILLING

510.01 -- Description

Cold milling shall consist of removing and salvaging existing surfacing material as shown in the plans. Cold milling is divided into the following classes and types:

1. 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 where shown in the plans.

b. Cold Milling, Class 2. The surface shall be milled to remove surface irregularities and to attain the slope shown in the plans. Milling will include inlays to meet fixed elevations where shown in the plans.

c. Cold Milling, Class 3. The surface shall be milled to a uniform depth shown in the plans or described in the special provisions. Milling to a specified transverse slope will be required if shown in the plans.

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.

e. Cold Milling, Class 5. Irregular sections of surfacing shall be milled as shown in the plans or described in the special provisions.

2. Concrete Surfaces:

a. Milling Concrete Curb. Concrete curbs shall be milled to a uniform depth shown in the plans or described in the special provisions.

b. Milling Concrete for Inlays. Concrete surfaces shall be milled to create an area to place an asphaltic concrete inlay.

c. Concrete Surface Milling. The concrete surface shall be milled as shown in the plans or described in the special provisions.

510.02 -- Material Requirements

1. Essentially all of the 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 shall be done with a commercially manufactured machine 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. Pavement removal by scarifying, blading, or heating will not be allowed as milling.

2. a. The cold milling machine shall be equipped with automatic controls for establishing profile grades at each edge of the machine. The reference shall be the existing pavement or taut reference lines erected and maintained by the Contractor true to line and grade. A single reference may be used if the machine can maintain the designated transverse slope.

b. When referenced from existing pavement, the cold 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 percent 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 if the machine is unable to maintain the surface texture requirements.

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. If the milling results in a vertical longitudinal face greater than 1 inch (25 mm) in depth between the lanes, milling shall be performed on the adjacent lane in the same day. At the end of each day, no more than 500 feet (150 m) shall have a drop off of over 1 inch (25 mm). Work shall be scheduled so that a vertical drop off will not be present between traffic lanes over weekends, holidays, or other extended periods when work is not being performed.

c. Transitions between milled and unmilled surfaces 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. If traffic has been detoured from the milled area, the surface shall be swept once per day. When milling is performed under traffic maintained conditions, the milled surface shall be swept with a mechanical broom before traffic is placed on it.

6. 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 plans.

8. 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.

9. a. The Contractor shall stockpile salvaged material for the Department at the locations shown in the plans or special provisions.

b. The Engineer shall locate each stockpile. The maximum height of stockpiles is 10 feet (3 m). Equipment shall not be driven over the stockpiled material.

10. a. When both the driving lane(s) and the shoulders are to be milled, they shall be milled the same day to eliminate traffic lane surface drainage restrictions.

b. When the surfaced shoulders are not milled, drainage channels in the shoulders may be cut by milling or by any other method approved by the Engineer. The width shall be 2 feet (600 mm) minimum, and the depth shall be the same as the milling depth with sufficient spacing to provide proper drainage. This operation shall be performed as directed by the Engineer.

c. Drainage channels shall be repaired by patching with asphaltic concrete of the type in the adjacent surfacing before the outside surfaced shoulders are fog sealed or surfaced.

d. Earth shoulders must be cut to an elevation that will allow drainage.

11. Concrete 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. a. The bid proposal "Schedule of Items" shall indicate whether the milling will be measured for payment by the ton (Mg), station, or square yards (m^2) of completed and accepted work.

b. (1) (i) 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. Areas outside the typical cross

section shown in the plans will be measured in equivalent stations based on one station's area for the immediately adjacent roadway.

(ii) 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.

(2) (i) Each shoulder will be measured separately in stations of 100 feet (meters) without regard to width. Stations will be measured horizontally along the project centerline between the beginning and ending points.

(ii) Areas where there is no shoulder for 300 feet (91 m) or more shall be deducted from the total measured length of shoulder. Small [less than 300 feet (91 m)] intersections shall not be deducted from the shoulder station measurements.

c. (1) Roadways that are measured by the square yard (square meter) shall be measured to ± 1 SY ($\pm$1 m^2).

(2) Areas outside the typical cross section shown in the plans will also be measured to ± 1 SY (1 m^2).

(3) Deductions will be made for all areas greater than 1 SY (1m^2) 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 plans or special provisions indicate payment is by the ton (Megagram).

2. Measurement of temporary traffic control devices will be made in accordance with Section 422.

3. Milling 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.

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 "Asphaltic

Cement, Type _____" as prescribed in Section 503. Construction and patching of the drainage channels is subsidiary to these bid items.

4. Payment is full compensation for all work prescribed in this Section.

SECTION 511 –
SALVAGING AND STOCKPILING BITUMINOUS MATERIAL

511.01 -- Description

1. This work will consist of removing, salvaging, and stockpiling existing bituminous surfacing as shown in the plans or described in the special provisions.

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

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. If the Contractor selects cold milling for the salvaging operations, approximately 1 inch (25 mm) of the bituminous surfacing may be left in place during the milling operation to serve as a working platform.

2. The Contractor shall dispose of the bituminous surfacing platform in the subsequent operations at no additional cost to the Department.

3. Surface texture shall conform to the requirements of Subsection 510.04.

4. The weight of all salvaged, pulverized bituminous material stockpiled at State sites shall be measured.

5. All stockpile sites shall be prepared and the bituminous material stockpiled in accordance with the requirements of Subsection 510.04.

6. When salvaged bituminous material is stockpiled at a Department provided site, the material shall be stockpiled in accordance with the requirements of Subsection 510.04.

511.05 -- Method of Measurement

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. Payment is full compensation for all work prescribed in this Section.

SECTION 512 -- BITUMINOUS SURFACE COURSE

512.01 -- Description

This work will consist of constructing a surface course composed of salvaged bituminous material obtained from sources shown in the plans or described in the special provisions. The bituminous material shall be distributed and spread as shown in the plans.

512.02 -- Material Requirements

The salvaged bituminous material shall meet the requirements in Subsection 510.02.

512.03 -- Construction Methods

1. The Contractor shall obtain and place the salvaged bituminous materials as shown in the plans.

2. Before placing the salvaged 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 surfacing material with 3 complete coverages of a roller or other approved compaction equipment.

512.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 513 -- FOG SEAL

513.01 -- Description

A fog seal is a light application to an existing surface of a slow-setting asphalt emulsion diluted with water, similar to a tack coat, and applied at the required application rate. The application locations will be as shown in the plans, specifications, or as directed by the Engineer.

513.02 -- Material Requirements

Fog seal shall be of the type and grade shown in the plans, and asphalt shall conform to the requirements of Sections 1031 or 1032.

513.03 -- Construction Methods

1. Before the application of fog seal, the Contractor shall clean the surfaces as prescribed in Section 501.

2. The Contractor shall furnish and apply fog seal materials in accordance with the requirements specified in Subsection 515.03 except as follows:

a. The rate of application shall be as shown in the special provisions.

b. The emulsified asphalt shall be diluted in the distributor with potable water as shown in the special provisions.

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/m^2); 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.

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. When materials do not meet plan and specification requirements, deductions will be made according to Tables 503.01A and B.

3. Clean fine sand will be subsidiary to fog seal.

4. Water used to dilute emulsified asphalt is subsidiary to fog seal.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 514 -- MICROSURFACING

514.01 -- Description

This work shall consist of an application of microsurfacing material to an existing surface. The microsurfacing material shall be a mixture of latex-modified emulsified asphalt, aggregate, mineral filler, water, and other additives properly proportioned, mixed, and spread.

514.02 -- Material Requirements

1. The asphalt for use in this work shall be Cationic Emulsified Asphalt (CSS-1H). It shall show no separation after thorough mixing and shall conform to the requirements of AASHTO M 208 "Cationic Emulsified Asphalt" except that the requirements for the cement mixing test will be waived. The required properties of CSS-1H are shown in Table 514.01.

Table 514.01

CSS-1H Properties		
Test on Emulsion	**Min.**	**Max.**
Viscosity, Saybolt Furol at 25°C, Sec.	20	100
Storage stability test, one day, percent	---	1
Particle charge test	positive	
Sieve test, percent of emulsion	---	0.1
Distillation:		
Oil distillate, by volume of emulsion, (percent)	---	0.5
Residue, (percent)	62	---
Tests on Residue from Distillation:		
Penetration 25°C, 100 g, 5 seconds	55	90
Softening Point, R. & B.	135°C	---
Viscosity, absolute 60°C, MilliPascal-Seconds	800,000	---

2. a. Mineral aggregate for use in this work shall be gravel conforming to the requirements in Table 514.02.

b. In addition, chat aggregate that is a by-product from the mining of lead and zinc ores shall conform to the gradation requirements shown in Table 514.02. Quartzite or granite conforming to either gradation may be used.

c. The job mix formula shall provide a minimum Marshall stability of 1,850 psi (12.8 MPa) when tested according to AASHTO T 245. In the event the selection of the aggregate results in a design that fails to meet the stability requirements, either chat aggregate or quartzite and granite may be added to achieve a design meeting the minimum stability requirement. The gradation of any two-aggregate combination shall conform to the requirements of Table 514.02.

Table 514.02

Microsurfacing Gradations	
Chat Gradation	
Sieve Size	**Percent Passing**
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 mm)	10 - 25
No. 200 (75 μm)	5 - 15
Crushed Aggregate Gradation *	
Sieve Size	**Percent Passing**
3/8 inch (9.50 mm)	100
No. 4 (4.75 mm)	100 - 84
No. 10 (2.00 mm)	64 - 50
No. 50 (300 μm)	29 - 13
No. 200 (75 μm)	5 - 15
* - Aggregate shall have a minimum fine aggregate angularity of 43%.	
* - Los Angeles Abrasion loss percentage shall not exceed 40.	

3. To limit the amount of clay-like fines in any of the aggregates specified, a sand equivalent value of 60 or higher will be required when tested according to AASHTO T 176.

4. Aggregate shall be sampled and tested at the rate of one sample for each 650 cubic yard (500 m^3). Aggregate shall be sampled and tested in accordance with the requirements shown under the heading "Asphaltic Concrete Materials" in the NDR Material Sampling Guide.

5. The weight of the aggregate shall be measured at the Contractor's stockpile before delivery to the job site. The Contractor must pass the aggregate over a 1/2 inch (13 mm) screen to remove any oversize material. This screening procedure shall occur just before the aggregate enters the mixing unit.

6. 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 percent may be allowed when the microsurfacing is being placed if it is found necessary for better consistency or set times.

7. Water shall be potable and free of harmful soluble salts.

8. a. The latex-based modifier shall be milled into the asphalt emulsion. This additive will allow the microsurfacing mixture to cure sufficiently to allow normal traffic on the surfaced roadway within 1 hour without damage to the surface.

b. 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.

9. a. The Contractor shall be responsible for the design and proportioning of the microsurfacing mixture.

b. Before the production of the mixture, the Contractor shall submit, in writing, a tentative design to the NDR Materials and Research Engineer at the Central Laboratory for approval.

c. The design shall list all the ingredients of the mixture and their proportions and the gradation of the proposed aggregate.

d. Based on the dry weight of the aggregate, the microsurfacing mixture shall contain:

(1) 6 to 11 percent of residual asphalt.

(2) 0.5 to 3.0 percent of mineral filler.

(3) Latex-based modifier as needed to provide the specified properties.

(4) A sufficient quantity of water to produce a mixture having the proper consistency.

10. 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.

11. Aggregates shall have a soundness loss of not more than 12 percent by weight at the end of 5 cycles using sodium sulfate solution.

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 equipped with a manufacturer's self-loading device that provides for the loading of all materials while continuing to apply the microsurfacing.

d. The laydown machine shall have opposite side driver stations and operator control of the rate of motion.

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. Approximately 3 feet (900 mm) behind the original strike off shall be a secondary strike off which is cantilevered to the laydown box. It shall have 3 elevation adjustments similar to the primary strike off and be adjustable in width. The secondary strike off shall have a pivot point where it can be tilted for texturing or raised completely off the surface. It shall be equipped with a flying gutter guard that is a flexible squeegee running along the curb line to protect the gutter from microsurfacing material spilling into the curb line. It shall also be flexible at the center to allow for quarter point crown elevation changes.

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 -- Construction Methods

1. The Contractor shall furnish and apply the microsurfacing materials.

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. The width and rate of application and the methods employed shall result in the rut depressions being completely filled with the least possible

application to the remainder of the surface. Depending on the depth of the depressions, more than one application may be required.

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. a. Ruts more than 1 inch (25 mm) deep require two applications of microsurfacing.

b. The first pass will bring the ruts up to the level of the existing pavement profile.

c. The second pass will place microsurfacing material over the entire lane.

11. 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 insure 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.

12. 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.

514.05 -- Method of Measurement

1. "Aggregate for Microsurfacing" shall be measured by the ton (Megagram). The weight shall be determined on approved scales under the supervision 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.

2. The "Emulsified Asphalt for Microsurfacing" is measured by the gallon (kiloliter). The refinery certified volume shall be used as a basis of measurement for emulsified asphalt if the entire shipment is used.

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).

514.06 -- 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)]

2. The approved latex-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 the item "Emulsified Asphalt for Microsurfacing".

4. When materials do not meet plan and specification requirements, deductions will be made according to Tables 503.01A and B.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 515 -- ARMOR COAT

515.01 -- Description

Armor coat is the sprayed application of asphaltic material with a covering of aggregate at the locations shown in the plans or as directed by the Engineer.

515.02 -- Material Requirements

1. Armor coat asphaltic material shall be the type and grade shown in the plans and shall conform to the requirements of Section 1032 or the special provisions.

2. Aggregate for armor coat shall conform to the requirements of Subsection 1033.02, Paragraphs 1., 2., and 6., and Table 1033.06.

515.03 -- Construction Methods

1. The Contractor shall furnish and place the armor coat as indicated in the plans.

2. Emulsified asphaltic material shall be applied at the appropriate temperature.

3. The surface shall be prepared as prescribed in Section 501.

4. Armor Coat Application:

a. (1) The Contractor shall demonstrate the ability to distribute a uniform coat of asphaltic material before beginning work. A coat of the specified asphaltic material 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 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.

(2) Asphaltic materials shall be applied with an approved pressure distributor at the rate designated by the Engineer. Generally, the application rate will be 0.22 to 0.33 Gal/ (1.00 to 1.50 L/m^2) when applied on bituminous sand base and from 0.17 to 0.33 Gal/SY (0.75 to 1.50 L/m^2) when applied on other surfaces. The distributor shall be shut off before the tank is entirely empty.

(3) Special care shall be taken to secure an overlap of adjoining longitudinal applications.

(4) Hand sprayers shall be used in applying asphaltic materials to small or irregular sections.

b. The cover aggregate shall be applied immediately (within 1 minute) after the application of the asphaltic material.

c. The application of asphaltic materials shall be allowed only when:

(1) The ambient 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 with squeegees and no further precipitation is expected.

d. (1) The Contractor shall conduct the operations to minimize construction traffic on completed portions of the armor coat. Armor coat equipment will not be allowed to travel on uncovered asphaltic materials.

(2) Application widths shall coincide with existing traffic lane lines to the maximum extent possible. The armor coat shall be applied to one-half of the width of the surface at a time, confining traffic to the portion of the surface not being treated.

(3) When armor coat is required on both roadway and surfaced shoulders, armor coat materials shall be applied to the shoulder's full width before armor coat materials are applied on any section of the adjacent traffic lane. Application widths shall coincide with lane and shoulder widths.

(4) Traffic will not be allowed on the completed armor coat until the aggregate is well embedded in the bituminous material.

e. The aggregates for the armor coat shall be distributed uniformly over the surface at the rate specified by the Engineer, generally from 15 to 27 lb/SY (8 to 15 Kg/m^2). An aggregate spreader conforming to the requirements of Section 501 shall be used. For irregular areas, the Contractor may employ hand methods to provide uniform distribution.

f. The moisture content of mineral aggregate for armor coat, at the time of application, shall be satisfactory to the Engineer. If the aggregate is dry, water shall be applied to thoroughly and uniformly moisten the aggregate before application.

5. Armor Coat Rolling:

a. (1) The Contractor shall perform all rolling with self-propelled, multiple-wheel, pneumatic-tired rollers.

(2) Rolling operations shall be arranged to ensure uniform rolling of all portions of the area to which armor coat materials have been applied.

(3) Rolling operations shall provide uniform embedment of the aggregate.

(4) Immediately after the armor coat materials have been distributed and before traffic is allowed upon the surface, the rolling shall begin.

(5) Rolling shall be completed during daylight hours and under favorable weather and temperature conditions during the day on which the armor coat materials are applied.

b. (1) 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.

(2) As soon as the emulsified asphalt has set and no further aggregate can be embedded, but by the day following the application of the armor coat materials, all loose aggregate shall be gently swept from the roadway surface by the Contractor. Care shall be taken to avoid dislodging embedded aggregate.

(3) Sweeping will be conducted between 8 a.m. and 7 p.m.

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 will be measured by the cubic yard (cubic meter) at the point of delivery. The Contractor is required to 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.

c. The basic sampling frequency shall be 4 random samples for each "Lot" of 400 cubic yards (300 m^2).

515.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Armor Coat Emulsified Asphalt	Gallon (Gal) [Kiloliter (kL)]
Armor Coat Aggregate	Cubic Yard (CY) [Cubic Meter (m^3)]

2. The aggregate shall be paid at the contract unit price per cubic yard for the item “Armor Coat Aggregate”. Aggregate not meeting the gradation requirements listed in Table 1033.06 will not be accepted and paid for.

3. a. Any lot of armor coat emulsified asphalt which is determined to be out of the specified property limits defined in Tables 503.01A and B shall also have its payment adjusted by the appropriate pay factors in Tables 503.01A and B.

b. Asphalt materials used in the test strip are subject to the payment adjustments in Tables 503.01A and B.

4. All test strips are subsidiary to the armor coat pay items.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 516 -- BITUMINOUS PAVEMENT PATCHING

516.01 -- Description

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 specified locations. Patching shall include the correction of faulty subgrade conditions.

516.02 -- Material Requirements

All materials shall conform to the requirements in Table 516.01.

Table 516.01

Material Requirements	
Applicable Materials	**Section**
Asphaltic Concrete.....	1028
Asphalt Cement	1029
Liquid Asphalt	1030
Emulsified Asphalt	1031, 1032
Aggregate	1033

516.03 -- Equipment

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. a. The removal of old concrete shall be performed in accordance with the requirements in Section 203.

b. Any material that is removed or is excess shall be disposed of by the Contractor.

3. All pavement patching shall be completed in the same work day.

4. a. The underlying material shall be uniformly compacted to the Engineer's satisfaction.

b. After compaction, a tack coat shall be applied on the vertical faces and bottom surface as prescribed in Section 504. The rate of application shall be as directed by the Engineer.

5. All cut edges shall be vertical and cut in straight lines.

6. Sand or gravel satisfactory to the Engineer shall be used to replace any removed base course. Subgrade soils removed during patching shall be replaced with similar suitable soil material.

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 0.40 inch (10 mm) above the adjacent surfacing.

516.05 -- Method of Measurement

1. Patching of flexible pavement and the replacement of any subgrade material will be measured by the hour of equipment rental in accordance with Section 919. Only approved equipment needed to patch and excavate the failure is to be rented. Excluded is any equipment needed to haul asphalt to the site.

2. Concrete pavement patching will be measured by the square yard (square meter) of completed and accepted work. Concrete pavement patching with asphalt is divided into 3 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 2 or more lanes, then the continuous patch will be counted as multiple patches -- 1 patch per lane.

Table 516.02

Asphalt Patch Sizes in Rigid 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. Asphalt cement and asphaltic concrete used in patching will be measured for payment in accordance with Subsection 503.05. The Engineer may authorize additional asphaltic concrete, not to exceed 6 inches (150 mm) in depth, to replace faulty subgrade material.

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. Patching of flexible pavement will be paid per hour of equipment rental.

3. Asphalt cement and asphaltic concrete used in the work of pavement patching shall be paid for in accordance with Section 503.

4. Emulsified asphalt for tack coat will be measured and paid for in accordance with Section 504.

5. If more than one type of asphaltic concrete is required, the pay item will be subdivided so the quantities of each type are documented.

6. If sand or gravel is used to replace the base course, the pay item will be "Granular Material for Patching" measured by the cubic yard (cubic meter). Payment will be negotiated.

7. Replacement of subgrade materials will be paid per hour of equipment rental.

8. Payment is full compensation for all work prescribed in this Section.

SECTION 517 -- PRIME COAT

517.01 -- Description

This work shall consist of the application of asphaltic materials on bases, roadbeds or other surfaces as shown in the plans or as designated by the Engineer.

517.02 -- Material Requirements

Asphaltic materials for prime coat shall be the type and grade shown in the plans 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/m^2).

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

Asphaltic materials are measured by the gallon (liter) at 60°F (16°C).

517.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Prime Coat Asphaltic Oil	Gallon (Gal) [Liter (L)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 518 -- FABRIC REINFORCEMENT

518.01 -- Description

This work shall require the Contractor to furnish and place a reinforcing fabric, crack repair system on joints or cracks as shown in the plans.

518.02 -- Material Requirements

1. The woven fabric reinforcement shall be on the NDR Approved Products List.

2. The fabric shall be at least 1 foot (300 mm) wide.

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.

3. The application of the materials will be accepted by visual examination and satisfactory initial performance.

518.04 -- Method of Measurement

Fabric reinforcement crack repair will be measured by the total length in linear feet (meters) of cracks being repaired.

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 prescribed in this Section and all fabric reinforcement system manufacturer's requirements.

SECTION 519 -- CRACK SEALING BITUMINOUS SURFACING

519.01 -- Description

This work shall consist of preparing and sealing the transverse and longitudinal cracks in bituminous surfacing at the various locations shown in the plans.

519.02 -- Material Requirements

1. 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:

a. The sealant shall contain between 10% and 15% vulcanized recycled rubber by total weight of product. The sealant shall be pre-reacted blend of product. The material shall not require additional heating time after it has reached the manufacturer's recommended application temperature. New material may be added to the material that has already been heated to proper application temperature. When heated in accordance with ASTM D-5078 to the safe heating temperature, the sealant shall meet the following test parameters:

Test	Specification
Cone Penetration @ 77° F (25° C) (ASTM D-5329)	45-70
Cone Penetration @ 39.2° F (4°C) (ASTM D-5329)	30 minimum
Resilience (ASTM D-5329)	30% minimum
Softening Point (ASTM D-36)	195° F (91°C) min.
Ductility @ 77° F (25C) (ASTM D-113)	30 cm minimum
Asphalt Compatibility (ASTM D-5329)	Pass
Bitumen Content (ASTM D-4)	60% minimum
Tensile Adhesion (ASTM D-5329)	500% minimum

b. Sampling and heating shall be in accordance with ASTM D-5078.

c. The vulcanized recycled ground rubber shall be free of wire, fabric, or other contaminating materials. The gradation shall be 100% passing the Number 8 sieve (2.36 mm) and a maximum of 5% passing the Number 200 (75 μm) sieve.

d. Acceptance of the manufactured material will be based on a certificate of compliance for each lot or batch furnished by the supplier. The certificate of compliance shall state the type of rubber used, the lot number, and a copy of the test result for the lot. The date of manufacture must also be shown on the certificate.

e. One sample per lot of material shall be sent to the Nebraska Department of Roads, Materials and Research Division for specification compliance testing with ASTM D-5078 or the sample may be tested by an approved independent testing laboratory. If the test results show the sealant sample conforms to Specifications, the NDOR will absorb the cost for testing.

If the sealant sample test results do not conform to Specifications, the Contractor shall be assessed the costs for testing and shall be required to provide acceptable sealant for the project including additional samples for retesting.

f. The rubber asphalt crack sealant shall be meltable at 300° F (150°C). The use of metal staples or fasteners of any kind is prohibited for closing the lids of the containers. Tape or other like materials will be accepted.

g. Each container shall include information regarding lot number, type of product, safe heating temperature and specific gravity of crack sealing material.

519.03 -- Construction Methods

1. Preparation of Transverse and Longitudinal Cracks

a. Cracks shall be formed and prepared as follows:

(1) Cracks 3/8" (10 mm) or less in width shall be widened using a router to form a reservoir which is 1/2" (12.5 mm) wide by 3/4" (20 mm) to 1" (25 mm) deep. The formed 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" (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 incompressible 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 is at the temperature for proper pouring consistency, 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.

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. a. When sealant materials comply with the Specification requirements, crack sealing shall be paid for at the contract unit price per linear foot (meter). When sealant materials are outside of the specified property ranges, crack sealing shall be paid for at the contract unit price multiplied by the product of the pay factors determined by the following pay factor table. Pay factors shall be determined for the properties shown below.

Pay Factor	***Specified Property***	
	Upper Limit	***Lower Limit***
1.00	+1% to +10%	-1% to -10%
0.95	+11% to 15%	-11% to -15%
0.90	+16% to +20%	-16% to -20%
0.80	+21% to +25%	-21% to -25%
0.70	+26% to +30%	-26% to -30%
0.40 or Reject	+31% and Higher	-31% and Lower

b. If the resultant pay factor for the material is less than 0.70 and the material has not been used, the material shall be rejected. If incorporated in work which is judged to be unsatisfactory, the material shall also be rejected.

c. If the pay factor is less than 0.70 and the material has been incorporated in work which is allowed to remain in place, the pay factor for the material shall be 0.40.

3. Payment is full compensation for all work prescribed in this Section and all sealant manufacturer's requirements.

SECTION 520 -- BITUMINOUS PATCHING OF CONCRETE PAVEMENT

520.01 -- Description

This work shall consist of repairing certain joint and panel spalls in the concrete pavement with bituminous material. The work will be performed on the mainline roadways and interchange ramps at locations 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) Minimum
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
Residue Tests:	
AASHTO T202 or ASTM D-2171	Abs. Viscosity at 140°F (60°C): 125-425 Poises
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 Trichloroethlene: 99% Minimum

3. Aggregate - The aggregate shall consist of a crushed limestone complying with the following requirements:

English Sieve Size (Metric)	% 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: Other Deleterious Matter:	2.55-2.75
NDR T504 or ASTM C-123	Soft Pieces	3.0% Max.
NDR T504 or ASTM C-295	Coal and Lignite	1.0% Max.
NDR T504 or ASTM C-142	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 120 lbs. (54.4 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.

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 m^2), 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 15 pound (6.8 kg) maximum chipping 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 by the Engineer. 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 15 pound (6.8 kg) chipping hammer or other equipment approved by M & R.

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 cleaned of loose concrete and remaining bituminous patching material using high pressure air until further application of

air fails to remove any significant quantity of material. Care shall be taken to avoid blowing any loose material into adjacent lanes which are open to traffic.

3. After the area has been blown clean and dry, the bituminous patching material shall be placed using hand methods to assure complete filling of the spalls. The spalled 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. If the patched areas have been depressed due to traffic, they shall be filled with bituminous patching material or an Engineer approved hot mix asphaltic concrete and compacted approximately ¼ inch (6 mm) above the existing pavement surface prior to the asphaltic concrete overlay.

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 dropoff created by the repair is greater than one inch (25 mm), the dropoff 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 copy of the scale ticket to the delivery point and give it

to the NDR placement inspector.

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**	**Pay Unit**
Bituminous Patching	Ton (Tn) [Megagram (Mg)]

2. Portland cement concrete repairs of areas larger than 10 sq. ft. (0.9 m^2)] will be paid for as "Concrete Pavement Repair, Type ____". If "Concrete Pavement Repair" is not a bid item, then the PCC repairs will be extra work.

3. Payment is full compensation for all work prescribed in this Section and all sealant manufacturer's requirements.

DIVISION 600 -- PORTLAND CEMENT CONCRETE PAVEMENTS

SECTION 601 -- GENERAL REQUIREMENTS

601.01 -- General

1. The requirements in Section 601 are applicable to all concrete work unless otherwise indicated.

2. The Contractor shall protect concrete pavement from damage due to precipitation and/or freezing conditions until cured.

3. The Contractor shall always have materials readily available to protect the edges and the surface of the concrete.

4. 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.

5. 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.

6. Curing compounds shall not be placed on any surface that will be bonded to another concrete surface.

7. The NDR Materials and Research Division is responsible to core all portland cement concrete pavement. The NDR Materials and Research Division should be notified of any coring requirement the same day the pavement is laid so the coring can be done before the pavement is opened to traffic.

601.02 -- Equipment

1. a. All placing and finishing equipment shall be at the job site 1 full NDR work day before its intended use to allow the Engineer time to examine it.

b. On small urban projects, the equipment will be inspected 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. The Contractor shall calibrate equipment as prescribed in Section 1002.

4. The subgrade template blade shall be of sufficient strength and stiffness to retain its shape under all working conditions. It shall be constructed so that the cutting edge will conform to the pavement crown and grade shown in the plans.

5. The subgrade profiling equipment shall conform to the requirements of Section 302. Electronically controlled profiling equipment will not be required when subsequent construction uses formed construction methods.

6. Concrete spreaders shall be self-propelled and able to spread and strike off concrete. Hand operated or tractor-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.

7. 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.

c. All finishing machines shall finish the pavement to the required cross section and degree of consolidation.

8. All spreading and finishing equipment operating on forms shall be equipped with scrapers to keep the top of the paving form free of concrete.

9. 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.

10. a. Internal vibrating equipment shall be used ahead of the finishing machine.

b. Vibrators shall not contact the side forms 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.

11. 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 continuously check the alignment of the straightedge.

c. Sufficient straightedges shall be available to maintain continuous paving operations.

12. 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. (1) The mechanical joint saw blade shall be water-cooled with an adjustable guide to insure that a true line is cut.

(2) The initial cut can be made with either a carbide or diamond-toothed blade.

(3) The final cut shall be made with a diamond-toothed blade.

(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. 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 to a pouring consistency without damaging the joint compound.

f. A pressure type joint filling machine with a mixing unit shall be used. The nozzle shall fill the joint from bottom to top. 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 a Profile Index no greater than 20 inches per mile (315 mm/km).

2. Pavement smoothness will be evaluated as prescribed in this section when the pay item “Portland Cement Concrete Smoothness Testing” is included in the contract.

602.02 – Equipment

1. The Contractor shall furnish a 25-foot (7.6 m) California profilograph approved by the Nebraska Department of Roads.

2. The profilograph shall have multiple, non-uniformly spaced, articulated support wheels arranged such that no two wheels pass the same location on the pavement surface at the same time (ASTM Designation: E 1274, Paragraph 5.1.2).

3. The profilograph shall be equipped with a computerized system that will record, analyze, and print the test data.

4. The profilograph shall produce a printed pavement profile trace (profilogram) with a vertical scale 1:1, and a horizontal scale of 1:300 [1” paper = 25’ pavement (1 mm paper=300 mm pavement)]. The profilogram 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. Blanking (Null) band width

k. Profile counts for each test section

l. Profile Index for each test section

m. Bump locations for each test section

602.03 – Certification and Independent Assurance Testing

1. The Department shall calibrate and certify the Contractor's profilograph annually at a test site established by the Department.

a. The profilograph shall be inspected for compliance with general equipment requirements, including wheel configuration, effective length, data analysis system, guidance system, and overall condition.

b. The profilograph shall be calibrated for distance measurement by moving it over the prescribed path of a premeasured test distance at walking speed, and determining its distance calibration factor.

c. The profilograph shall be checked for vertical measurement accuracy by placing a 1-inch (25 mm) and 2-inch (50 mm) calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The vertical measurement indicated by the profilograph shall be within 4.0% tolerance of the actual premeasured block height.

d. The profilograph shall be checked for overall performance by moving it over the prescribed path of a premeasured pavement test section at walking speed.

e. Distance measurement indicated by the profilograph shall be within 0.2 percent 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 level used for calibration.

f. The Profile Index reported by the profilograph for the test section shall be within 10.0 percent tolerance of the Profile Index reported by a Nebraska Department of Roads' profilograph for the same test section.

g. A dated and signed decal will be placed on the profilograph to certify its acceptability for use on Nebraska Department of Roads' pavement construction projects.

2. The Department shall certify the Contractor's profilograph 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 Nebraska Department of Roads.

3. The Department shall schedule and perform Independence Assurance tests for the Contractor's profilographs 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.

602.04 – Profilograph 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 14, below.

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 (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 shall be combined with the preceding 528 feet (200 m) long test section for analysis.

3. The Contractor's certified profilograph 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 profilograph operator shall perform pavement smoothness measurements in the right-hand or left-hand wheel path of all driving lanes, as directed by the Engineer, including climbing and fly-by lanes. 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. All wheels of the profilograph shall be on the new pavement for which the Contractor is responsible. The wheel path to be tested shall be designated by the Engineer prior to the beginning of construction.

5. The Contractor shall remove all objects and foreign material from the pavement surface before testing.

6. The profilograph operator shall guide the profilograph along the specified wheel path of each traffic lane at walking speed. Propulsion may be by personnel pushing manually or by suitable propulsion until that does not exceed a speed of 4 miles per hour (65 km/hr). Excessive speed can produce erratic test results.

7. A lateral location indicator shall be used to keep the profilograph in the required test path during testing. Pavement edges, longitudinal joints or longitudinal pavement markings may be used as reference lines. An additional person may be required to hold the back end of the profilograph on the required path on horizontal curves.

8. Before testing, the profilograph operator shall lower the profilograph's recording wheel to the pavement surface and move the profilograph forward to the beginning location of a test section to stabilize the measurement system. To ensure consistent distance measurement, the profilograph operator shall also check and adjust the recording wheel tire pressure several times a day.

9. All station references on the profilograms and report forms shall be actual project stations. Stations shall be accurately noted on the profilogram at least every 200 feet (50 m).

10. The profilograph operator and the Engineer shall sign the profilograms immediately after completion of the tests, and the Engineer shall take immediate possession of the profilograms.

11. The Engineer shall perform or schedule verification tests on at least 10 percent of the pavement surface, using a profilograph owned by the Department.

12. 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 of the following:

a. Require the Contractor to calibrate the profilograph and re-run the tests.

b. Disqualify the Contractor's equipment and/or operator.

c. Perform the tests for part, or all, of the project with a profilograph owned by the Department, and charge the Contractor $500.00 per lane mile for all testing done by the Department.

13. The following areas of pavement shall be excluded from the Profile Index, unless otherwise specified in the special provisions.

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 or 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.

14. Excluded pavement sections shall be measured for bumps with either a profilograph or a 10-foot (3m) straight edge. If the profilograph is used, the deviation shall not exceed 0.30 inch (7.6 mm). 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 a Profile Index and number of correctable bumps for each test section, record the information on the report form, and provide a copy of the report, along with the corresponding

profilograms, to the Engineer.

a. The Profile Index shall be calculated by adding the absolute value of the vertical deviations (inches or millimeters) outside of a 0.1 inch (2.5 mm) blanking band and dividing the sum of the length of the test section [miles (kilometers)]. The resulting Profile Index is in units of inches per mile (mm/km).

b. Correctable bumps shall be separately identified on the profilograms. They appear as high points on the profilogram, 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).

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. The Contractor may also locate and perform voluntary corrective work as described in Paragraphs 4 and 5 of this Subsection.

a. Corrective work, including bump correction, 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 Contractor shall re-test all corrected test sections with the profilograph.

2. All bumps, as defined in Subsection 602.05, Paragraph 2, shall be corrected until they are at or below the 0.30 inch (7.6 mm) maximum height.

3. When the initial Profile Index of a test section is 20 in/mi (315 mm/km), or less, mandatory bump correction is the only corrective work allowed for that section.

4. When the Profile Index of a test section exceeds 20 in/mi (315 mm/km), the Contractor may perform voluntary corrective work in that section, in addition to mandatory bump correction work.

5. When the initial Profile Index of a test section exceeds 30 in/mi (473 mm/km), mandatory corrective work shall be performed to reduce the Profile Index of that section to a value of 30 in/mi (473 mm/km) or less. The Contractor may perform voluntary corrective work in that section, in addition to mandatory work.

6. 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

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	
Profile Index Inches per Lane Mile (mm per lane Kilometer)	Percent of Contract Prices
0 to 4 (0 to 63)	106
Greater than 4 to 8 (63 to 126)	104
Greater than 8 to 12 (126 to 189)	102
Greater than 12 to 20 (189 to 315)	100
Greater than 20 to 22 (315 to 347)	98
Greater than 22 to 24 (347 to 379)	96
Greater than 24 to 26 (379 to 410)	94
Greater than 26 to 28 (410 to 442)	92
Greater than 28 to 30 (442 to 473)	90
Greater than 30 (473)	Corrective work required

2. When the initial Profile Index of a test section is 20 in/mi (315 mm/km) or less, that value shall determine the percent of incentive pay for the section. Mandatory bump correction work performed in that section may increase the percent of pay.

3. When the initial Profile Index of a test section is greater than 20 in/mi (315 mm/km), mandatory bump correction and/or voluntary corrective work performed in that section may increase the percent of pay up to the 100 percent level.

4. When the initial Profile Index of a test section is greater than 30 in/mi (473 mm/km), mandatory or voluntary corrective work performed in that

section may increase the percent of pay up to the 100 percent 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 profilograph test sections shall be determined according to the formula in Table 602.02.

Table 602.02

Pay Factor Formula
$PF = \frac{A(1.06) + B(1.04) + C(1.02) + D(1.00) + E(0.98) + F(0.96) + G(0.94) + H(0.92) + I(0.90)}{A + B + C + D + E + F + G + H + I}$
Where:
A = Length of pavement with a Profile Index of 0 to 4 inches per mile (0 to 63 mm/km)
B = Length of pavement with a Profile Index greater than 4 to 8 inches per mile (63 to 126 mm/km)
C = Length of pavement with a Profile Index greater than 8 to 12 inches epr mile (126 to 189 mm/km)
D = Length of pavement with a Profile Index greater than 12 to 20 inches per mile (189 to 315 mm/km)
E = Length of pavement with a Profile Index greater than 20 to 22 inches per mile (315 to 347 mm/km)
F = Length of pavement with a Profile Index greater than 22 to 24 inches per mile (347 to 379 mm/km)
G = Length of pavement with a Profile Index greater than 24 to 26 inches per mile (379 to 410 mm/km)
H = Length of pavement with a Profile Index greater than 26 to 28 inches per mile (410 to 442 mm/km)
I = Length of pavement with a Profile Index greater than 28 to 30 inches per mile (442 to 473 mm/km)

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

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 or foundation course as prescribed in these *Specifications* and as shown in the plans.

603.02 -- Material Requirements

1. The concrete class for pavements, headers and bridge approach slabs shall be as specified in the contract bid proposal Schedule of Items.

2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 603.01.

Table 603.01

Material Requirements	
Applicable Materials	**Section**
Fly Ash	1008
Admixtures	1007
Curing Materials	1010, 1011, 1012, 1013
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. Preparation:

a. The Contractor shall prepare the subgrade as prescribed in Section 302.

b. After the subgrade template or profiler has been drawn over the subgrade or foundation course, any irregularities found in lines or grades shall be corrected before concrete is placed.

c. The foundation course shall be constructed in accordance with the requirements of Section 307.

d. (1) The forms shall have a flat or rounded top at least 1 3/4 inches (45 mm) wide. When tested as a simple 10 foot (3 m) beam under a center load of 1,650 pounds (750 kg), the maximum deflection shall not exceed 1/8 inch (3 mm). The forms shall be interlocking. Wood or metal

forms of the proper radii shall be used for curves having radii of less than 100 feet (30 m).

Outside forms shall be ferrous metal, straight, and their depth equal to the pavement thickness. Additional form height for integral curb may be obtained by attaching form extensions to the main forms.

(2) Forms shall be tightly joined and securely pinned and staked to line and grade at least 200 feet (60 m) ahead of the concrete placing operation. Forms shall withstand the concrete pressure and the weight of supported equipment. The use of earth pedestals or other materials to support the forms above grade will not be allowed.

(3) Before placing the concrete, the Contractor shall clean, oil, and check the alignment and grade of the forms. Each joint of the forms shall be tested with a 10 foot (3 m) straightedge placed on the forms so that the mid-point of the straightedge is directly over the joint. Forms that do not make full contact along the full length of the straightedge shall be reset.

(4) Finished pavement and curbs may be used as forms.

2. Placing Concrete:

a. (1) The Contractor shall mix and place the concrete.

(2) Steel reinforcement shall not be disturbed.

(3) The concrete shall not be segregated.

(4) The concrete shall be spread to the required depth, consolidated, leveled, and finished.

(5) The foundation course shall not be damaged or mixed with the concrete.

b. The concrete shall be placed in the forms to make a uniform layer approximately 1 inch (25 mm) greater than the required finished thickness.

c. Concrete shall be consolidated for its full depth and width and along all joints.

d. After being consolidated with internal mechanical vibration, the concrete shall be struck off to a uniform height approximately 0.4 inch (10 mm) above the finished surface and then finished to the final elevation by means of a vibrating mechanical or vibrating hand operated screed.

e. Finished concrete shall be of uniform density with no segregation or honeycombing.

f. Portland cement concrete is sensitive to ambient air temperature and humidity. The following are maximum limits that do not cover all situations:

(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. A set-retarding admixture conforming to Section 1007 may be incorporated into the concrete mixture.

h. Operations will not be started until the ascending ambient air temperature reaches 40°F (5°C). Mixing and placing operations shall be discontinued when the descending ambient air temperature reaches 40°F (5°C).

i. In no case shall concrete be placed upon an unstable or frozen subgrade or foundation course.

j. Placement authorized for ambient air temperatures below 40°F (5°C) shall be as prescribed in Subsection 704.03, Paragraph 14. Any concrete damaged by freezing shall be rejected.

k. If the rate of evaporation approaches .2 lb/SF/h (1.0 kg/m^2/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 at Figure 710.01.

l. To place concrete at night, the Contractor must request permission from the Engineer 24 hours in advance of placement.

m. Concrete headers extending the full depth and width of the pavement shall be constructed as shown in the plans.

n. The Contractor shall construct pavement approach slabs as shown in the plans.

3. Slip-Form Construction:

a. Slip-form equipment may be used to construct the pavement. Formed construction may be required on irregular or variable width sections which are not adaptable to slip-form construction.

b. (1) The subgrade profiler must provide trackways and a subgrade for the paver that will insure the finished surfaces will meet the specification requirements.

(2) A reference line shall be erected and maintained by the Contractor true to line and grade to assure vertical and horizontal control during the subgrade and foundation course operations. The reference line shall be maintained until passage of the paving machines.

c. The slip-form paving equipment shall be able to spread, consolidate, strike off, shape, and float-finish the freshly placed concrete to the desired line, grade, and thickness. Work shall be done in one continuous pass so that minimum hand finishing is required. All equipment shall be designed to span the full width of the lane or shoulder.

d. (1) The concrete shall be distributed uniformly into final position by the paver immediately following its placement on the prepared base.

(2) The forward speed of the paver shall be adjusted to the concrete production so that the operations are continuous and uninterrupted.

(3) All concrete shall be consolidated by internal vibration with transverse vibrating units or a series of longitudinal vibrating units.

(4) The paver extrusion plate or screed shall extrude the concrete under load, properly shaping and compacting the concrete into a dense, stable mass.

(5) Excess edge slumping resulting in profiles that do not match those in the plans will not be allowed.

e. The concrete float finisher shall be directly attached to the paver.

f. A wet burlap, carpet, or canvas drag will be drawn over the entire surface in a longitudinal direction for a final finish.

g. The straightedging operation may be required on any part of the pavement that the Engineer suspects is not smooth. This is in addition to the straightedging that is required at the beginning and end of the daily concrete placement and in those sections immediately following a breakdown or work interruption.

4. Doweled Concrete Pavement

a. Transverse Joints for doweled concrete pavement shall be constructed perpendicular to the roadway on 16'-6" (5 m) centers.

b. The dowel bars shall meet the requirements of Section 1022.

c. The dowel bars shall be placed within a tolerance of ¼ inch (6 mm) in both the horizontal and vertical planes. The Contractor shall check with a suitable template approved by the Engineer, the placement of each assembly and the position of the bars within the assembly. If the assembly is found to be placed outside any one of the tolerances, the placement shall be corrected.

d. Dowels for transverse joints furnished in approved assemblies shall be suitable for the joint layout shown in the plans. The assemblies shall be dipped in MC-70, RC-70, RC-250, CRS-1, CRS-2, CSS-1H, HFMS-2h, or HFMS-2s 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, which would restrict movement of the dowel bars, shall 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. For areas with pavement widening, the Department requires that dowel baskets be placed in all contractor joints which are 6 feet (1.8 m) or wider.

f. If normal vibration is found inadequate to thoroughly consolidate the plastic concrete within and around the dowel basket assemblies, additional hand vibration or other procedures may be required by the Engineer.

g. Precautions shall be taken to assure that the sawed contraction joint is located directly over the center of the dowel bars.

h. Transverse cracks which form in the concrete pavement panels between load transfer joints shall be secured with a minimum of 1½ inch x 18 inch (38 mm x 450 mm) epoxy coated deformed reinforcing bars as shown in the plans. The dowel bars shall be secured using a resin adhesive listed on NDOR approved products list. No payment will be made for this work.

5. Placing Reinforcing Steel:

a. The Contractor shall place reinforcement as shown in the plans.

b. All reinforcement metal must be kept clean and free from foreign material.

c. Welded steel wire fabric shall be kept in flat sheets.

d. (1) 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.

(2) (i) Welded steel wire fabric shall be lapped at least 1 foot (300 mm).

(ii) The welded steel wire fabric shall be tied together at all laps.

(iii) The spacing between the ties of longitudinal laps shall not exceed 2 feet (600 mm).

(iv) The transverse laps shall be tied with a minimum of 3 ties per lane width.

(3) The welded wire shall be covered immediately with a layer of concrete placed to the pavement's required thickness and crown. 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.

e. (1) The Contractor may use mechanical means for placing the welded steel wire fabric. The placement machine shall be specifically designed for this purpose.

(2) When the welded steel wire fabric is placed by mechanical methods, the Contractor may elect to place the concrete in one operation to the full depth and width shown in the plans.

(3) Alternate methods of installing welded steel wire fabric may be approved when paving small or irregular sections.

f. (1) The Contractor will be required to furnish and install suitable supports approved by the Engineer for all reinforcing steel and dowel bars.

(2) All steel reinforcing bars must be tied securely in place at all points where these bars cross other reinforcing bars.

(3) Epoxy coated reinforcing steel shall be tied with plastic coated ties.

g. The Contractor shall coat dowel bars with a lubricant as shown in the plans. The lubricant shall be a petroleum oil or grease that meets the following requirements:

(1) The lubricant shall adhere to the dowel to form a complete and continuous film over the portion of the dowel being coated.

(2) The coating shall be sufficient to break the bond between the dowel bars and the concrete.

(3) The lubricant shall have sufficient contrast with the bar to be easily seen.

h. 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.

i. Dowel bars may be placed by use of either baskets or mechanical inserters. Mechanical inserters must be approved before being used on a project.

j. If baskets or mechanical inserters are not used, then the free end of the dowels must be supported in a frame to keep the dowels properly aligned.

k. (1) The Contractor may use a machine to place the longitudinal tie bars in lieu of tie bar pins shown in the plans.

(2) (i) The tie bar placement machine shall be designed to place the tie bars as shown in the plans and Table 603.02.

(ii) The tie bar placement machine shall be operated only when the machine to which it is attached is moving.

(iii) Devices or jigs that call for manual placement of the tie bars will not be allowed except in emergencies to complete the day's concrete placement.

(iv) Tie bar spacing may vary ±1" (±25 mm) from the nominal spacing shown. The number of tie bars per 16'-6" (5 m) panel shall remain constant.

(v) No tie bar shall be installed closer than ½ the tie bar spacing to a transverse joint; except, tie bar spacing may vary ±1" (±25 mm) from the nominal spacing shown. The number of tie bars per 16'-6" (5 m) panel shall remain constant.

Table 603.02

TIE BARS FOR LONGITUDINAL JOINTS		
Slab Thickness	**Bar Size***	**Bar Spacing**
10" (250 mm) or Less More Than 10" (250 mm)	#5 (#16) #6 (#19)	33" (840 mm) 33" (840 mm)

*Bent bars that must be straightened shall be #5.

(3) (i) 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.

(ii) To minimize tie bar breakage, before placing the adjacent lane, the tie bars shall be bent to a position that is at least 45 degrees to the longitudinal joint. The free end of the bar shall not be within six inches (150 mm) horizontally of the location of the transverse joint to avoid corner cracking when the joint is sawed. The free end of the bar shall also be positioned so that it does not interfere with the movement of any dowel bar in the transverse joint. Bars that are loose in their socket must be replaced or secured.

(iii) All bars that crack or break off shall be replaced by installing tie bars as prescribed in Section 909.

(iv) 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.

(v) Cracked or broken bars shall be replaced at no additional cost to the Department.

6. Finishing Concrete Pavement:

a. The Contractor shall keep the concrete manipulation to a minimum when bringing the concrete to a proper finish.

b. (1) Machine finishing. After the concrete has been deposited and spread, it shall be struck off 1/4 inch (6 mm) higher than the specified crown elevation. The concrete shall then be consolidated and finished with a power-driven machine.

(2) The forward speed of the finishing machines shall be adjusted so the operations are continuous and uninterrupted.

(3) The top of the forms and the surfaces of the wheels of the finishing machine shall be kept free from concrete and earth.

(4) The addition of water to the surface of the concrete to assist in finishing operations is not allowed except as follows:

(i) Unavoidable delays or unusual drying conditions may require fogging the concrete surface to aid finishing. The fog shall be applied as a mist by means of an approved "orchard" sprayer.

(ii) 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.

(iii) An evaporization retardant may be used in addition to fogging.

(5) Laitance and surplus water shall be removed after completion of the mechanical finishing and while the concrete is still plastic.

(6) (i) The surface shall be made smooth and true to the profile of a 10 foot (3 m) straightedge.

(ii) 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.

(iii) Straightedge testing shall be continued as necessary until all irregularities have been satisfactorily corrected.

(7) (i) The concrete shall be textured by dragging a wet burlap, carpet, or canvas belt over the full width of the surface in a longitudinal direction.

(ii) The drag shall be suspended from a mandrel, or similar device, to insure a uniform texture.

(iii) 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.

(iv) Drags shall be rinsed or washed as necessary to obtain a uniform surface. Drags that cannot be cleaned shall be replaced.

(8) 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) Hand methods may be used to finish concrete already placed when equipment breakdowns occur.

c. (1) (i) Unless otherwise provided in the special provisions, hand-finishing as prescribed herein may be employed only in cases of emergency and on narrow or variable width sections where mechanical methods are impractical. After the concrete has been deposited and spread, it shall be vibrated with a tamping device or vibrator, then struck-off to a uniform height above the specified finished grade. It shall then be consolidated, shaped, and tamped with heavy templates, floats, or hand screeds until the concrete is thoroughly consolidated to the prescribed cross section.

(ii) When a non-vibrating hand screed is used, the concrete shall be consolidated with an approved tamping device or vibrator before the concrete is struck off.

(iii) Strike off shall account for consolidation and not allow the final surface elevation to be other than as shown in the plans.

(iv) Non-vibrating screeds and templates shall be at least 2 feet (600 mm) wider than the pavement.

(v) Screeds shall be of metal or metal-shod wood and shall have sufficient strength and stiffness to retain their shape under all working conditions.

(vi) The working edge shall have excess concrete in front of it to prevent voids in the concrete surface.

(2) (i) The screed or template shall be in contact with the forms. It shall be moved on the side forms.

(ii) When using non-vibrating screeds or templates, a crosswise motion shall be combined with the longitudinal advance.

(3) After the concrete has been consolidated, leveled, and tested with a straightedge, it shall be given a texture finish.

(4) (i) The concrete shall be textured by dragging a wet burlap, carpet, or canvas belt over the full width of the surface in a longitudinal direction.

(ii) The drag shall be suspended from a mandrel, or similar device, to insure a uniform texture.

(iii) Drags shall be rinsed or washed as necessary to obtain a uniform surface. Drags that cannot be cleaned shall be replaced.

(5) 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.

d. Tined Finish.

When required by the plans or Special Provisions, the Contractor shall tine texture the concrete pavement surface using the following methods:

(1) The surface of the concrete pavement shall be dragged with wet burlap, carpet, or canvas belt before tining.

(2) Mainline Tining-Longitudinal

(i) Mainline paving shall be tined with a metal device 23 feet (7 meters) in length with a single row of tines.

(ii) 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 ¾ 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.

(iii) 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.

(iv) Hand tining will be allowed on irregular areas or areas inaccessible to the tining machine as shown in the Concrete Pavement Plan. 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.

(3) When authorized, pavement texture damaged by rain and 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 in 2.(ii).

7. Protection and Curing:

The Contractor shall cure concrete pavement by one of the following methods:

a. Curing with liquid membrane-forming compounds:

(1) After the final finishing operations, the concrete pavement surface, curbs, and edges shall be covered with a continuous uniform coating of white-pigmented curing compound as prescribed in Section 1012.

(2) Curing compounds shall not be placed on any surface that will be bonded to another concrete surface.

(3) (i) The curing compound may be applied in either 1 or 2 applications in accordance with the manufacturer's directions.

(ii) If applied in 2 coatings, the second shall be applied not later than 30 minutes after the first.

(iii) 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/135 SF (0.3 L/m^2) of surface area for tined surfaces or 1 Gal/200 SF (0.2 L/m^2) of surface area for all other finishes.

(4) With form paving, the sides of the pavement slab shall be covered with the curing compound within 30 minutes after removal of the forms.

(5) (i) An approved 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.

(ii) The mechanical power sprayer shall not ride on the pavement surface.

(iii) The power sprayer shall be able to cover the entire lane width and thoroughly atomize the curing-compound.

(iv) If the mechanical power sprayer produces an unsatisfactory result, such as puddling, dripping, or non-uniform application, the paving operation shall be suspended until appropriate changes have been made.

(v) The sprayer shall be equipped with a hood to prevent uncontrolled dispersal by the wind.

(6) Damaged curing compound coatings, such as may result during the joint sawing operations, shall be recoated without delay using the same application rate originally prescribed.

(7) When concrete is being placed and the ambient air temperature is expected to drop below 35° F (2°C), straw, hay, or other suitable blanketing material shall be spread 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. The Contractor shall replace any concrete damaged by freezing at no additional cost to the Department.

b. Curing with white opaque polyethylene film or white burlap-polyethylene sheets:

(1) 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.

(2) The film or sheeting shall be placed on the concrete pavement in conformance with the following:

(i) The weight of the rolls of film or sheeting shall be kept off the concrete while placing the material.

(ii) The material shall cover all exposed horizontal and vertical pavement surfaces.

(iii) 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.

(iv) The Contractor shall secure the sheeting and/or film so that moisture is held inside the covering to facilitate curing.

(v) Any tears or holes in the film or sheeting must be repaired immediately by cementing patches over the openings.

(vi) 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.

(vii) 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.

(3) If "hair-checking" develops before the film or sheeting can be applied, initial curing with wet burlap shall be required.

(4) Any joints or seams in a roll of burlap-polyethylene sheeting shall be double sewn.

(5) 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.

(6) All joints and seams shall be sufficiently durable to prevent separation during the curing period.

c. Curing with wet burlap:

(1) Immediately after the finish is complete, burlap shall be carefully placed on the concrete and kept moist in a manner which will not damage the pavement surface.

(2) 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.

(3) 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).

(4) 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.

8. Joint Construction Procedures:

a. (1) Contraction joints in concrete pavement, with the exception of curbed sections, may be formed by any method shown in Section 601 with the approval of the Engineer. The joints shall be constructed to the dimensions shown in the plans 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) Doweled contraction joints shall not deviate more than 1 inch (25 mm) from the center of the dowel's length.

(4) Joints with or without dowels shall not deviate from their intended location by more than 5 percent of the prescribed spacing.

(5) Each transverse joint shall be cut to the prescribed depth in one continuous pass.

(6) The Contractor shall be responsible for repairing all random cracks. The cracks shall be repaired as shown in the plans or as directed by the Engineer.

(7) Joints at gutters or integral curbs must be cut to the proper depths to prevent erratic cracking.

b. Immediately after the joints have been sawed or the premature cracks routed, they shall be cleaned with water to remove all dirt and loose material.

c. (1) Any spalls over 0.25 inch (6 mm) wide and over 0.50 inch (13 mm) below the surface of the pavement or over 0.25 inch (6 mm) wide and over 2.00 inches (50 mm) in length regardless of the depth below the surface

shall be patched with epoxy mortar as prescribed in Section 1018 or the manufacturer's recommendations.

(2) Spall patching shall be done only when the air and pavement temperatures are above 50°F (10°C) and rising. The concrete shall be clean and dry at the time of placing the epoxy mortar.

(3) All loose concrete shall be removed from the spalled area using pneumatic chisels. The spalled concrete surface shall be sandblasted and blown clean with compressed air.

(4) A suitable insert shall be placed in the joint or against the pavement edge to form the face of the patch. Polyethylene, polyvinylchloride, or other material that will not bond to the epoxy shall be used.

(5) After cleaning, the spalled surface shall be primed with a brush application of freshly mixed epoxy binder.

(6) Immediately after priming, epoxy mortar of troweling consistency shall be placed in the spalled area and finished to the level of the original pavement surface.

(7) Dry sand shall be sprinkled onto the fresh epoxy mortar surface to eliminate any gloss. After the epoxy mortar has cured sufficiently to prevent damage, the plastic insert shall be carefully removed.

d. (1) The Contractor shall prepare joints for sealing or filling according to the manufacturer's recommendations.

(2) Joints shall be sealed according to the manufacturer's recommendations.

(3) If a joint is not sealed immediately, a curing membrane must be applied to the joint surfaces.

(4) 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. 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.

(5) (i) Transverse contraction joints in portland cement concrete pavements shall be sealed by inserting a backer rod in the joint so that the top of the backer rod will be at a depth of 5/8” (15 mm) to 3/4” (20 mm) below the surface of the concrete. The joint shall then be filled to approximately 1/8” (3 mm) below the top of the joint with an approved hot poured sealant. The backer rod shall be a closed cell material capable of withstanding the temperatures of the hot poured sealant without damage. The backer rod shall have a maximum absorption of 5% when immersed in water for 24 hours with the ends sealed. The backer rod shall have a diameter greater than the width of the joint such that compression is required for installation in the joint.

(ii) All overflow material shall be removed from the surface of the pavement.

(iii) If the joint is an “early-cut” type joint, and the depth of cut is 1 inch (25 mm) or less, then a backer rod is not required at a dowel joint. If the joint is an “early-cut” type joint and the depth of cut is greater than 1 inch (25 mm), then a backer rod is required at a dowel joint.

(iv) If adhesion is not satisfactory, the material shall be rejected.

(6) The Contractor shall give the Engineer one copy of the manufacturer's sealing and filling recommendations.

9. Surface Tests:

a. The Contractor shall check all concrete pavement for smoothness as prescribed in Section 602.

b. The Contractor will test the hardened concrete for surface irregularities with a 10 foot (3 m) straightedge or other device for measuring deviations from a plane. 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. The grinding shall be performed so that the cement-aggregate bond will not be broken.

10. Integral Curb:

a. Original Method:

The Contractor shall construct integral curbs as shown in the plans. This curb shall be placed within 30 minutes after the slab has been placed and finished. That part of the pavement that will be covered by the integral curb shall be cleaned of all laitance and roughened to assure a good bond.

b. Alternate Method:

(1) The Contractor may install tie bars of the size and at the spacing shown in the plans and then place the curb as a separate operation. The surface area upon which the curb is to be placed shall be finished with a rough texture.

(2) The part of the pavement that is to be covered by the integral curb shall be cleaned of all laitance and debris.

(3) A membrane curing compound shall not be used on the area where the curb will be placed.

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.

11. 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 on the compressive strength of the concrete as determined from a 6 inch (150 mm) diameter cylinder or 4 inch (100 mm) diameter 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 an age of 4 days and developed a compressive strength of 3500 psi (24 MPa) when tested in accordance with AASHTO T 22.

d. The Contractor may elect to increase the early strength of the concrete by adding cement and/or reducing the water/cement ratio, and then the pavement may be opened to traffic after 48 hours 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 required by the special provisions or when requested by the Contractor, the maturity method, as provided for in ASTM C 1074, may be used in lieu of the requirements of Subsection 603.03, Paragraph 10.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 Materials and Research Engineer. The Contractor shall be responsible for the testing and documentation required to develop the time-temperature-strength curves.

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.

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 plans unless changes are approved by the Engineer.

3. a. A pay factor will be applied to each unit based on the compressive strength of 1 core per unit tested in accordance with AASHTO T 24. Concrete in the cores must have a minimum age of 28 days before testing.

b. Units will be considered separately and are defined as 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.

c. The last unit for the width under consideration shall be 750 feet (230 m) plus any fractional part of 750 feet (230 m) remaining.

d. 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.

e. 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.

f. Bridges and approach slabs shall be considered as exceptions to the unit's length.

g. 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.

h. When the primary designated core is deficient in thickness by more than .25 inch (6 mm), an additional core will be taken within 1 foot (300 mm) of the primary core. The additional core can be used for compression testing.

i. 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 3.k of this Subsection

j. 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.

k. The Engineer will evaluate the concrete's expected use and may allow concrete with a compressive strength of less than 80 percent of the required strength (after 28 days) to be left in place and paid for at 40 percent of the bid price or may require the unit to be removed and replaced.

4. Pavement shall be constructed to the minimum thickness shown in the plans. Determination of pavement thickness shall be based on pavement cores. The method of measuring the cores shall be in accordance with NDR T 148. Determination of thickness and requirements relative to deficient thickness shall be as specified herein:

a. (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 width shall also be considered separate if two classes of concrete or separate bid items are poured at the same time as when doweled concrete pavement is placed simultaneously with undoweled concrete pavement.

(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.

(7) At the option of the Engineer cores may not be required from irregular areas, with widths less than 8 feet (2.4 m) or from an entire contract involving less than 5,000 square yards (4200 m^2) of pavement.

b. (1) At least one core shall be taken from within each unit of the pavement at random locations to be selected by the Engineer.

(2) 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.

(3) Special cores may also be taken at any locations where the Engineer thinks deficiencies in materials or work quality may exist.

c. (1) The thickness of a core shall be determined by averaging the measurement of three caliper readings taken at 3 equidistant points on the core.

(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 603.03. Cores deficient by more than 0.50 inch (12.5 mm) will be treated as prescribed in Paragraph 4.d. of this Subsection.

(5) When calculating the average thickness of the pavement unit, measurements greater than plan thickness will be considered plan thickness. Measurements less than plan thickness by more than 0.50 inch (12.5 mm) will be considered plan thickness minus .50 inch (12.5 mm).

(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 percent pay.	

d. (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 50 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 603.03 for deficiencies greater than 0.50 inch (12.5 mm).

5. 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 prescribed by ASTM C 138.

c. (1) If the average of 10 consecutive cement content tests is less than 100 percent of the specified weight, then a deduction shall be made as prescribed 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 percent or more of the specified weight and any individual test is less than 97 percent, then a deduction is made as prescribed 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 percent.

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 percent 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 percent of bid price.	

6. No additional payment over the contract unit bid price will be made for any pavement, which has an average thickness greater than shown on the plans.

7. 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.

8. Direct payment will not be made for integral curbs. They shall be considered as subsidiary to concrete pavement.

9. Furnishing and placing required reinforcement and dowel bars shall not be paid for directly but will be considered as subsidiary to concrete pavement.

10. Water incidental to the concrete placement shall be considered subsidiary to concrete pavement.

11. 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.

12. 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.

13. Payment is full compensation for all work prescribed in this Section.

SECTION 604 -- CONCRETE BASE COURSE

604.01 -- Description

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 plans.

604.02 -- Material Requirements

1. The base course concrete shall be NDR 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
Admixtures	1007
Water	1005

604.03 -- Equipment

The equipment used and the calibration responsibility shall be as prescribed in Sections 601 and 603.

604.04 -- Construction Methods

1. The Contractor shall prepare the subgrade and foundation course as prescribed in Sections 301, 302, 303, 305, and 307.

2. Section 603 provides the specifications for the following concrete base course requirements:

a. Forms.

b. Constructing approach slabs and headers.

c. Placing concrete.

d. Finishing and texturing concrete.

e. Curing concrete.

f. Placing reinforcing steel and dowels.

g. Constructing joints.

h. Slip form construction.

i. Constructing integral curb.

3. The surface of the concrete base course shall be tested in both the transverse and longitudinal directions with a 10 foot (3 m) straightedge, and the maximum allowable variation is 0.25 inch (6 mm).

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/m^2) 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 prescribed 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 AASHTO T 22.

b. The Engineer shall be given 48 hours 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.

604.05 -- Method of Measurement

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 thickness and strength deficiencies will be computed as prescribed 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 prescribed in Table 603.02.

c. (1) 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.

(2) Cores must be taken within 30 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

7. Payment is full compensation for all requirements prescribed 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 plans 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 for the repairs.

2. Concrete pavement repairs are grouped into 3 types based on the surface area of the patch (see Table 605.01). If a pavement failure extends across more than one lane, each lane will be counted as a separate repair.

Table 605.01

PCC Pavement Repair Groups	
Type	**Size Square Yards(m^2)**
A	Less than 5 (5 m^2)
B	5 to 15 (5 m^2 to 15 m^2)
C	More than 15 (15 m^2)

3. Full width pavement panels shall be a minimum of 6 feet (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).

5. Full depth pavement repair shall be constructed on a prepared subgrade or foundation course as prescribed in the plans. The thickness of the new concrete pavement will be as shown in the plans or the thickness of the adjacent pavement, as appropriate.

6. Special Prosecution:

a. When performing this operation on 2-lane roadways, the Contractor will be required to have all lanes open to traffic at 1/2 hour after sunset and at times when the Contractor is not working. Where the pavement has been removed and the Contractor will be 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, as directed 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 should normally be removed, the excavation cleaned out, and the required permanent patch placed, within 48 hours. 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 joint or pavement repair work being performed.

b. When performing this operation on multi-lane highways, the Contractor will be permitted to have one lane closed at night. Where the pavement has been removed, the Contractor will be required to have the excavated area filled with either (1) the appropriate patching concrete material for curing overnight, or (2) a commercially available cold-mix bituminous mixture or other suitable temporary patch material with a durable surface, as directed by the Engineer. The next day, the Contractor will then be required to remove any "temporary patches", thoroughly clean the repair area and complete the required permanent patch so that the lane can be opened to traffic by the end of the second day. The material, installation, removal and disposal of these temporary patches will not be measured and paid for directly, by shall be considered subsidiary to the concrete pavement repair work being performed.

605.02 -- Material Requirements

1. Repairs shall be made with Class PR1-3500 (PR1 25 MPa) or Class PR3-3500 (PR3 25 MPa) concrete when the repair work is done under traffic maintained conditions, and Class 47B-3500 (47B- 25 MPa) when traffic is detoured.

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
Curing Compounds (Without Asphalt Overlay)	1012
Curing Compounds (With Asphalt Overlay)	1013
Joint Sealing Filler	1014
Admixtures	1007
Water	1005

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. Vibrating screeds, either mechanical or hand operated, shall be used to finish the concrete.

605.04 -- Construction Methods

1. a. The Contractor shall remove the concrete pavement without damaging the adjacent concrete pavement.

b. The Contractor shall use a diamond blade to cut around the perimeter of the repair area to a depth of 2 inches (50 mm).

c. The Contractor shall use hand or pneumatic tools to remove the concrete pavement. If the patch is full depth Type C, then a drop hammer may be used to remove the pavement.

2. a. All repairs shall be cut so the edges are parallel or perpendicular to the traveled way. 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.

b. For full depth repairs, a full depth diamond blade saw cut shall be made and dowel bars and/or tie bars anchored into the faces of the existing concrete as designated in the plans. A full depth cut approximately 4 inches (100 mm) wide may be made with a wheel cutter through the repair section if the repair will be overlaid. 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.

(1) Dowel bars or tie bars shall be anchored into the faces of the existing concrete as designated in the plans. To provide proper alignment, a drill approved by the Engineer shall be used to install the dowel bars. The drill shall be capable of drilling the holes parallel to the surface of the pavement and to the centerline of the highway ± 1/8 inch. The dowel bar holes shall be drilled independently. The drilled holes shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material and moisture.

(i) For concrete pavement repairs, dowel bars shall be placed on the new transverse joint nearest the existing transverse joint. A minimum of 2 tie bars shall be placed on each side of a full depth pavement repair as designated in the plans.

(2) After cleaning and prior to dowel or tie bar insertion, an application of grout shall be made at the back of the hole. The grout 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. Grout retention disks shall be placed on the bars as designated in the plans. 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.

c. The centerline joint edge of the repair section shall be prepared with a reasonably neat vertical surface, with a 15-pound (7 kg) maximum chipping hammer, with all tie bars cut flush with the vertical surface for reinforced pavement repairs, or joint repairs, as shown in the plans. The initial removal of any concrete pavement other than that described above shall be removed by means of a jackhammer not exceeding 35 pounds (16 kg). The repair sections shall be removed to the lines designated by the Engineer, including reinforcement that interferes with the operations. The cut-away 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.

3. The Contractor shall remove and dispose of all old pavement, reinforcing steel, and all other materials that are removed and not identified for reinstallation.

4. If reinforcing fabric is encountered, it shall not be replaced.

5. When concrete 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 an approved non-shrink grout.

6. The Contractor shall compact the subgrade or foundation course under full depth patches to 100 percent of the maximum density as determined by AASHTO T 99 and NDR T 238. Water shall be sprinkled on the subgrade before placing the concrete.

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 in a manner that is approved by the project manager. Forms for concrete pavement repair shall conform to the requirements of Subsection 603.03, except that forms may be wood when the length of the patch is less than 13 feet (4 m).

8. a. The surface 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 before grouting.

b. The clean, dry surface shall be coated with bonding grout, which consists of equal parts of cement and grout sand mixed with water to a consistency of paint, just before placing the new concrete.

c. The grout shall be applied to the vertical faces and any cracks near the repair with a brush. Transverse and longitudinal joints shall not be coated with grout.

d. The grout's application rate shall be limited so the grout does not become dry before it is covered with new concrete.

e. Reestablish any transverse and longitudinal joints impacted by this work with a 1/2 inch (13 mm) wide closed cell thermo-setting polyurethane or sytrofoam bond breaker for the repair depth before placing new concrete.

9. The transverse and longitudinal joints shall be reestablished with a 1/2 inch (13 mm) wide closed cell thermo-setting polyurethane or styrofoam bond breaker for the repair depth before placing new concrete.

10. 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.

11. An internal vibrator shall be used to consolidate the concrete. Excessive vibration shall be avoided.

12. After the concrete is consolidated, it shall be struck off to a uniform height approximately 0.4 inch (10 mm) above the finished surface.

13. A vibrating screed that spans the paved surface shall be used to finish the concrete to the final elevation.

14. Immediately after finishing the concrete, it 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.

15. The Contractor shall cut joints to match the existing pavement joints. Transverse joints shall be established by sawing to a minimum of one-third the actual thickness of the slab and then creating a well as shown in the plans.

16. The Contractor shall edge the surface that abuts a transverse joint to provide a well 0.4 inch (10 mm) wide and 0.6 (15 mm) inch deep.

17. The Contractor shall use an edging tool to finish all exterior edges of the new concrete.

18. a. The Contractor shall apply curing compound to all concrete pavement repairs.

(1) When pavement and joint repairs are overlaid with asphaltic concrete, the curing method shall be with tack coat, or an approved asphalt emulsion.

b. White pigmented curing compound shall be used when surfaces are exposed to view.

c. The application rate shall be 1 Gal/200 SF (0.2 L/m²).

19. a. Class PR1-3,000 (PR1-20) or PR3-3,000 (PR3-20) concrete pavement repairs shall be covered with polyethylene film and insulation board immediately after the curing compound has been applied.

b. The insulation board shall have an R-value (thermal resistance) equal to or greater than 5 ft²-hr-°F/BTU [1.0 m²(°C/W)].

c. The insulation board shall be protected from the rain.

d. Insulation must be covered with sheeting to form a tight seal around the concrete and must have an adequate anchor placed on it to keep the insulation in place.

e. Insulation board and sheeting shall be maintained for at least 4 hours.

f. From June 1 through August 31, if the daytime temperature is 85° F (30° C) or greater, covering of the repair concrete with polyethylene film and insulation board is optional, provided the maturity method is used to measure the strength of the concrete.

g. From June 1 through August 31, if the pavement is to remain closed to traffic for at least 24 hours, covering of the repair concrete with polyethylene film and insulation board is optional.

20. a. 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 3000 psi (20 MPa). Table 605.03 is a guide to the minimum time before traffic will be allowed on new concrete.

Table 605.03

Time Until Traffic Allowed (Class PR1-3500 [24 Mpa] and PR3-3500 [24 Mpa])	
Minimum Ambient Air Temperature [°F (°C)]	**Minimum Time Before Opening (Hours)**
Below 41 (5° C)	12
41 – 60 (5°-16°C)	8
Above 60 (16°C)	4

b. Concrete shall not be placed when ambient air temperatures are expected to drop below 40 °F (4° C) during the cure period.

c. Class PR1 Concrete may be used for concrete repair if the repaired area is to remain closed to traffic for at least 24 hours.

d. Class PR3 Concrete shall be used for all concrete repair 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.

e. Strength measurements for the opening and the 24-hour pay strengths of the PR1 and PR3 Concrete may be performed using the maturity meter method. The maturity curve will be determined by the Materials and Research Division.

21. a. Class 47B-3500 (47B-25 MPa) concrete pavement repairs shall not be opened to traffic until the compressive strength reaches 3000 psi (20 MPa). Table 605.04 is a guide to the minimum time before traffic will be allowed on the new concrete.

b. 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

Time Until Traffic Allowed (Class 47B-3500 24 MPa)	
Minimum Ambient Air Temperature [°F (°C)]	**Minimum Time Before Opening (Hours)**
Below 41 (5° C)	120
41 – 60 (5°-16°C)	72
Above 60 (16°C)	48

c. The 24-hour compressive strength shall be used to determine pay factor deductions for PR concrete in accordance with Table 603.03.

22. 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. Damaged areas of the surfaced shoulders shall be removed by sawing.

23. a. The Contractor shall seal all transverse and longitudinal joints as prescribed in Section 603.

b. Random cracks which develop in the new concrete repair before traffic is allowed on the pavement shall be routed and sealed. The sealing will not be measured and paid for directly but shall be considered subsidiary to the joint or pavement repair work being performed.

24. Removal shall extend across the existing joint a minimum of 2 feet (600 mm) into the adjacent panel in reinforced (doweled) concrete.

605.05 -- Method of Measurement

The quantity of each type of concrete pavement repair and joint repair are measured in square yards (meters) of pavement replaced in each separate lane.

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.

605.06 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Concrete Pavement Repair, Type A, Partial Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair, Type B, Partial Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair, Type C, Partial Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair, Type A, Full Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair, Type B, Full Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair, Type C, Full Depth	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement Repair	Square Yard (SY) [Square Meter (m²)]
Concrete Pavement, ____ Joint Repair	Square Yard (SY) [Square Meter (m²)]

2. When the Engineer directs that partial depth concrete pavement repairs be constructed with a thickness greater than what is shown in the plans, an adjustment will be made to provide compensation for the work. The adjustment will be as follows:

$$\text{Adjusted Unit Price} = \text{Bid Price} \times \frac{\text{(Actual Thickness Placed)}}{\text{(Thickness shown in the Plans)}}$$

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 prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 30 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

4. Payment is full compensation for all work prescribed in this Section.

SECTION 606 -- CONCRETE CURB AND CONCRETE GUTTER

606.01 -- Description

The Contractor shall furnish all materials and construct concrete curb, combination concrete curb and gutter, and concrete gutter as prescribed in the plans. This Section shall not include integral curb that is covered under Section 603.

606.02 -- Material Requirements

1. The Contractor shall furnish all materials to construct the curbs and gutters.

2. The concrete Class shall be specified in the contract bid proposal Schedule of Items.

3. The concrete shall conform to the requirements of Section 1002.

4. Preformed joint filler shall conform to the requirements of Section 1015.

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 plans.

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.

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 curbs. The inside forms shall conform to the dimensions shown in the plans and shall allow secure fastening to the outside form.

d. When pavement has already been constructed, the front gutter form shall be omitted.

3. Slip-form techniques are acceptable.

4. When concrete is being placed and consolidated in the curb and gutter, the face of the curb shall be formed with fixed or movable forms and shall have dimensions that will conform to the dimensions shown in the plans.

5. a. The forms shall be neatly and tightly joined and then securely pinned and staked to line and grade.

b. The forms shall be thoroughly tamped on both sides with a special tamping tool approved by the Engineer. The tamping shall be completed at least 200 feet (61 m) ahead of the point where concrete is being placed.

6. 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.

7. a. The Contractor shall place the concrete on the prepared subgrade so that there will be no segregation of the concrete mortar and aggregate.

b. 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.

8. 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 plans.

9. a. Templet joints are to be opened with a double edger while the concrete is still plastic.

b. Preformed joint filler shall be placed at locations and in accordance with the details shown in the plans and double-edged while the concrete is plastic.

10. 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). Any surplus concrete at the edges of joints shall be cut away for the full depth of the concrete. The edges shall then be banked with moist earth to a width of at least 6 inches (150 mm) beyond neat lines.

11. The Contractor shall cure concrete by one of the methods prescribed 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. In the event that concrete curb or combination concrete curb and gutter on the project are constructed to more than one cross section, an appropriate designation will be added to the pay item to differentiate the type or dimension 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 prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 45 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

4. Payment is full compensation for all work prescribed 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 prescribed in the plans.

2. Median surfacing shall be constructed on sand fill when shown in the plans.

607.02 -- Material Requirements

1. The concrete Class shall be specified in the contract bid proposal Schedule of Items.

2. Sand fill for medians shall be granular non-plastic aggregate.

3. 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
Preformed Joint Filler	1015
Steel Bars for Concrete Reinforcement	1020

607.03 -- Construction Methods

1. a. The Contractor shall prepare the subgrade by excavating or filling to the elevation prescribed in the plans.

b. The subgrade shall be thoroughly compacted to insure stability.

c. In cuts, the excavation shall be made sufficiently wide to allow placing of forms and performing the required work.

d. In fills, the subgrade shall be made at least 1 foot (300 mm) wider on each side than required by the bikeway and/or sidewalk.

e. Concrete shall be deposited upon a thoroughly moistened subgrade.

f. Sand fill, when required, shall be uniformly compacted to facilitate placing the concrete median surfacing.

2. a. Forms shall be wood or metal and a depth equivalent to the design thickness of adjacent concrete.

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.

3. a. The Contractor shall mix the concrete as prescribed in Section 1002 and then shall deposit it 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 by tamping. Excess concrete shall be screeded off level with the forms. The edges adjacent to all forms, expansion joints, curbs, or fixtures in the surface shall be thoroughly spaded their 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.

d. (1) The surface of sidewalks shall be floated with a steel float to produce a smooth surface free from irregularities.

(2) The surface of median surfacing shall be finished with a wood float to a uniform granular texture.

(3) All edges and joints shall be rounded to a radius of 1/4 inch (6 mm) with an approved finishing tool.

(4) The surface shall then be brushed to slightly roughen the surface and remove the finishing tool marks.

e. (1) Surfaces of sidewalks shall be marked off in square areas not less than 1.0 square yard (0.8 m^2) nor more than 4.0 square yards (3.3 m^2). Bikeways will be marked off in squares equal their width. On these lines, the concrete shall be cut at least 25 percent of the slab thickness with approved tools; and it shall then be 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 plans.

(3) Holes for sign posts shall be formed in the median surfacing in accordance with the plans.

(4) Expansion joints shall be placed as shown in the plans.

4. 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.

5. The Contractor shall cure the concrete by one of the methods prescribed for curing concrete pavement in Subsection 603.03.

6. Slip-form methods described in Subsection 603.03 may also be used.

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.

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)]

2. Sand fill, when shown in the plans, 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 plans, 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 prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 45 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

6. Payment is full compensation for all work prescribed in this Section.

SECTION 608 -- CONCRETE ISLAND NOSE

608.01 – Description

The Contractor shall prepare the subgrade, furnish all materials, and construct concrete island noses as prescribed in the plans.

608.02 -- Material Requirements

1. The concrete Class shall be specified in the contract bid proposal Schedule of Items.

2. All materials shall be furnished by the Contractor and 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

Construction shall be as prescribed in Subsection 603.03.

608.04 -- Method of Measurement

1. Concrete island noses constructed on other than new pavement slabs shall be measured by the each. On new pavement, the noses are not measured.

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 are 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 shall be reduced by the amount prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 45 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 609 -- CONCRETE DRIVEWAYS

609.01 -- Description

The Contractor shall prepare the subgrade, furnish all materials, and construct a wearing course composed of portland cement concrete as prescribed in the plans.

609.02 -- Material Requirements

1. The concrete Class shall be specified in the contract bid proposal Schedule of Items.

2. All materials shall be furnished by the Contractor and 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 prescribed 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 plans.

5. Preformed joint filler shall be placed at locations and in accordance with the details shown in the plans. 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.

7. The Contractor shall dispose of any excess soil or other materials.

609.04 -- Method of Measurement

1. Preparation of the subgrade shall 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 shall 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 plans, 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 shall be reduced by the amount prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 45 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 610 -- CONCRETE MEDIAN BARRIERS

610.01 -- Description

The Contractor shall furnish all materials, construct, and install cast-in-place or precast concrete median barriers and cast-in-place concrete median barrier end and transition sections in accordance with the details shown in the plans.

610.02 -- Material Requirements

1. The Contractor shall furnish all materials to construct median barriers.

2. The concrete Class shall be specified in the contract bid proposal Schedule of Items.

3. The concrete shall conform to the requirements of Section 1002.

4. Reinforcing steel and dowel bars shall conform to Sections 1020 and 1022.

610.03 -- Construction Methods

1. The Contractor may submit revised designs for approval before building the barriers.

2. The only changes that may be authorized are to the section's casting and attachments or holes used to facilitate handling and lifting. If approved, the concrete median sections must still meet all of the test and performance requirements unless specifically released in the approval letter.

3. Construction of the concrete median barrier shall conform to the applicable provisions of Sections 704 to 707.

4. The Contractor shall take care during storage, hoisting, and handling of precast units to prevent cracking or damage. Units damaged shall be replaced by the Contractor at no additional cost to the Department. The Engineer may approve repairs for minor chipping and spalling.

5. a. The surface finish of the median barrier shall be a rubbed finish in accordance with Subsection 704.03.

b. Each individual section of concrete median barrier will have a uniform color and texture so that the completed concrete median barrier will have a uniform appearance.

6. Precast concrete median barriers shall be cured in accordance with Subsection 705.03. If steam curing is used for precast sections, the concrete will be cured until it has reached a compressive strength of 2000 psi (14 MPa).

7. All forms shall be metal except for end and transition sections.

8. a. If precast units are provided, all lift slots and dowel holes shall be grouted as shown in the plans.

b. Grout for filler and mortar joints shall consist of 1 part cement to 1 part clean, fine-grained sand mixed to flow freely.

610.04 -- Method of Measurement

"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 _____" are 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 prescribed in Table 603.03.

c. (1) 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.

(2) Cores must be taken within 45 days from the date the concrete was poured.

(3) The Engineer shall select the site where the cores will be taken.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 611 -- SEALING TRANSVERSE AND LONGITUDINAL CRACKS

611.01 -- Description

This work shall consist of preparation and sealing of transverse cracks and longitudinal cracks, which are in the portland cement concrete roadway.

611.02 -- Material Requirements

The transverse and longitudinal 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 Transverse and Longitudinal Cracks:

a. Transverse and longitudinal cracks from 1/4 inch to 1/2 inch (6 mm to 12.5 mm) in width shall be prepared with a crack reservoir of a nominal 1/2 inch (13 mm) in width at the surface of the pavement and to a depth of at least 5/8 inch (16 mm). The crack reservoir shall be prepared by removing old crack sealing filler, if previously filled. The crack reservoir may be formed with routers, diamond blade sawing or other procedures which will provide the appropriate dimensions for the well. After the crack has been prepared to the proper width and depth, the crack shall be flushed with water to remove any slurry that has been created. After the cracks have been dried, they shall be given a sandblast cleaning to remove loose crack sealing filler or other foreign material prior to applying the crack sealing filler.

b. Transverse and longitudinal cracks 1/2 inch (12.5 mm) and over in width shall have the crack interfaces prepared by removing old crack sealing filler, if previously sealed. All loose crack sealing filler or other foreign material shall be removed by sandblasting to a depth of at least 1.5 inches (38.1 mm). Backer rods may be used in the transverse cracks and longitudinal cracks at the option of the Contractor. The backer rod shall be of a size which will fit tightly in the crack and of a material which will not melt when subjected to hot poured type joint sealing filler. The backer rod shall be of such diameter to be seated properly that will allow for a depth of approximately 1/2 inch to 1 inch (13 mm to 25 mm) of crack sealing filler.

c. The location of the transverse and longitudinal cracks to be sealed will be designated by the Engineer.

2. Sealing Transverse and Longitudinal Cracks:

a. The crack sealing filler shall be melted uniformly and with constant stirring in an asphalt kettle of such design that direct flames are not applied to the immediate surfaces of the kettle which are in contact with the joint sealing filler.

b. The material shall be furnished or prepared in pieces of such size and shape that the material can be melted readily to the proper pouring consistency.

c. The Contractor shall obtain from the supplier or from the manufacturer and furnish to the project manager the manufacturer's recommendations for mixing application and temperature restrictions. These recommendations shall be strictly followed. In no case shall the temperature exceed the maximum recommended by the manufacturer.

d. When proper pouring consistency is attained, the cracks shall be filled to 1/8 inch (3 mm) below the pavement surface through the use of a pressure type applicator approved by the Engineer, and equipped with a nozzle which will fit into the joints.

e. 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.

611.04 -- Method of Measurement

Sealing transverse and longitudinal cracks will be measured for payment by the linear foot (meter) of transverse and longitudinal 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. Payment is full compensation for all work prescribed in this Section and all sealant manufacturer’s requirements.

SECTION 612 -- SEALING TRANSVERSE AND LONGITUDINAL JOINTS

612.01 -- Description

This work shall consist of the preparation and sealing of all joints in the concrete roadway.

612.02 -- Material Requirements

The joints shall be sealed with hot-poured type joint sealing filler which conforms to the requirements of Section 1014 in the 1997 English Edition of the Standard Specifications.

612.03 -- Construction Methods

1. Preparation of Transverse Joints

a. All joints shall be prepared by removing old joint sealing filler and other foreign material by diamond-blade sawing or other suitable method which will produce similar results. Details of the joints are shown in the plans. 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 and 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.

c. Backer rods may be used in the transverse joints at the option of the Contractor. The backer rod shall be of a size which will fit tightly in the joint and of a material which will not melt when subjected to hot-poured type joint sealing filler. The backer rod shall be of such diameter to be seated properly that will allow for a depth of approximately 5/8 inch (16 mm) of crack sealing filler.

2. Sealing Joints

a. The joint sealing filler shall be melted uniformly and with constant stirring in a kettle of such design that direct flames are not applied to the immediate surfaces of the kettle which are in contact with the joint sealing filler.

b. The material shall be furnished or prepared in place of such size and shape that it can be melted readily to the proper pouring consistency.

c. The Contractor shall obtain, from the supplier or manufacturer and furnish to the project manager, the manufacturer's recommendations for mixing, application and temperature restrictions. These recommendations shall be strictly followed. In no case shall the sealing filler temperature exceed the maximum recommended by the manufacturer.

d. When proper pouring consistency is attained, the joints shall be filled through the use of a pressure type applicator, approved by the Engineer, and equipped with a nozzle which will fit into the joints.

e. 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.

612.04 -- Method of Measurement

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.

612.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Sealing Joints	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for all work prescribed in this Section.

(This page was intentionally left blank.)

DIVISION 700 -- BRIDGES, CULVERTS, AND RELATED CONSTRUCTION

SECTION 701 -- GENERAL REQUIREMENTS

701.01 -- Description

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. a. 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.

b. 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. a. The method used to place concrete shall not allow the concrete materials to segregate or displace reinforcing steel.

b. The impact of any free fall must be kept to the lowest levels consistent with efficient placement.

c. The maximum free fall placement distance shall be 5 feet (1.5 m).

7. The Contractor shall backfill bridge abutments, wingwalls, and retaining walls concurrently on all sides.

8. Cofferdams shall be substantially watertight. The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and for the inspection of their exteriors.

9. a. Cofferdams shall be constructed so as to protect recently placed concrete from damage from a sudden rising of the stream and to prevent damage to the foundation by erosion.

b. No timber bracing shall be left in cofferdams or cribs and incorporated into the structure's concrete.

10. Cofferdams shall be removed by the Contractor after the completion of the substructure.

11. Any steel bracing left inside a concrete structure and exposed at the structure's surface shall be treated so that the metal is corrosion resistant and will not stain the concrete surface.

12. Water jetting is not authorized for excavating or backfilling around structures.

13. Culvert excavation volumes are computed based on Figure 701.01.

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.

Figure 701.01

EXCAVATION PAYMENT LIMITS

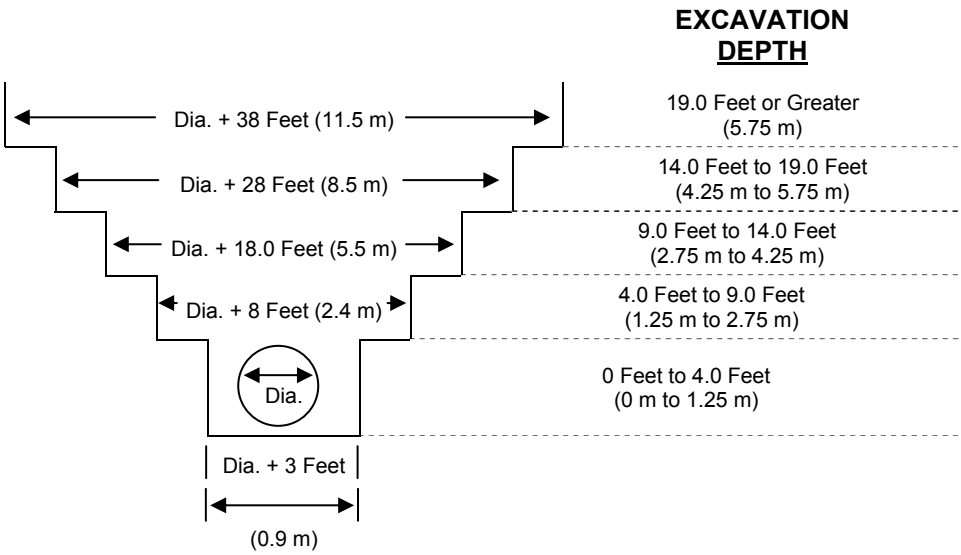


Figure 701.01

SECTION 702 -- EXCAVATION FOR STRUCTURES

702.01 -- Description

1. a. 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.

b. This work shall consist of all excavation for the following:

(1) Bridge foundations:

(i) Abutments.

(ii) Piers.

(iii) Bents.

(2) Concrete seals.

(3) All culverts

(4) Structural plate pipe.

(5) Headwalls and wingwalls.

(6) Retaining walls.

(7) Steps.

(8) Other miscellaneous structures described in Division 700.

2. This work shall include the removal of any obstructions within the excavation limits shown in the plans. 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.

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. and 2. and 3. or 6. and the requirements in Tables 1033.02A or 1033.06 is 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. (1) If water is encountered, the Contractor shall dewater the excavation.

(2) If unsuitable soil is encountered at the elevation established for the bottom of the excavation and if the soil does not become stable within a

reasonable time after attempting dewatering, the excavation shall be continued to a width and depth designated by the Engineer and the additional volumes excavated shall be replaced with compacted granular material.

(3) 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.

(4) 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.

(ii) This will be considered extra work.

(5) 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.c.(3) of this Subsection.

c. (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) (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 plans, the work shall be suspended.

(iii) The Department will reevaluate the design before work resumes.

2. Excavating for Pipe and Pipe-Arch Culverts:

a. (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 prescribed in Paragraph 3. of this Subsection.

(3) Bedding is shaping the trench to the pipe's diameter, including recesses for connections. It is required for all pipe with a diameter greater than 2 feet (600 mm). Bedding shall include shaping the trench to not less than 10 percent of the total culvert height.

b. (1) When rock is 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 suitable, preferably granular, 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 and replaced with approved granular material or crushed

concrete meeting the gradation requirements of Subsection 702.02 paragraph 2.; the material shall be compacted to 95 percent of maximum density as determined by NDR T 99.

3. Backfilling:

a. All structures shall be backfilled in accordance with the following requirements:

(1) "Granular Backfill" limits are identified in the plans.

(2) Backfilling shall not damage any part of the structure.

(3) Approved materials shall be compacted to 95 percent of maximum density as determined by AASHTO T 99, or flowable fill may be used.

(4) 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				
	Depth Below	**Percent**		**Moisture Requirements**
Soil Type	**Finish Grade**	**Density**	**Minimum**	**Maximum**
Silt-Clay	Upper 40 in (1 m)	96±3	Opt. -3%	Opt. +3%
Silt-Clay	Depths > 40 in (1 m)	95 min.	**	Opt. +2%
Granular	All Depths	100 min.	**	**
** Moisture content as necessary to obtain density.				

(5) (i) Soil shall be placed in layers approximately 6 inches (150 mm) thick.

(ii) Materials such as frozen soil, logs, stumps, sod, weeds, or other perishable matter shall not be used.

(iii) 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.

(iv) Shales and other materials that break down during compaction shall not be used.

(6) Backfilling shall not be started against any structure until the concrete develops a compressive strength of at least 2,000 psi (14 MPa) in compression.

(7) Backfilling of retaining walls and abutments is limited to the top of berm elevation until the superstructure is in place.

(8) Backfilling culverts, abutments, wingwalls, and piers shall progress concurrently on all sides.

(9) All form boards or other obstructions shall be removed from drain or weep holes and any other structure before backfilling.

(10)(i) 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.

(ii) Granular backfill shall be compacted in accordance with Paragraphs 3. a. and 3. b. of this Subsection.

(iii) When tie rods are required, the abutment/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.

(iv) 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/wing face.

(v) 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.

(11)When the area to be backfilled has standing water, the area shall be drained or pumped until dry. If a suitable draining or pumping procedure cannot produce a dry area, an approved granular material may be deposited to an elevation above the water level.

(12)The Contractor shall use all available suitable backfill material before obtaining borrow.

b. (1) The Contractor shall complete the backfill at bridges to the elevation shown in the plans. 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 plans.

(3) Tie rods shall be left in place during backfill operations.

(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.

c. (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 plans.

(2) The area beneath and adjacent to pipe and pipe-arch culverts shall be backfilled carefully to insure the specified density is achieved.

(3) When the full embankment over a pipe culvert is not immediately placed, the embankment shall be constructed 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 may be required for this work.

(4) (i) When 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 10 feet (3 m) outside of and parallel to the neat lines of the pipe or barrel at its maximum horizontal dimension. Compacted soil shall be placed to a depth at least 1 foot (300 mm) above the top of the box or pipe.

(ii) The volume of embankment needed to meet this requirement, less any separately placed to meet the requirements of Paragraph 702.03, 3.c.(3) shall be considered as ordinary embankment and included in the appropriate roadway grading quantities.

d. The Contractor shall protect backfill from washing away or other erosion until the contract is complete and accepted by the Engineer.

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 plans.

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.

2. 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.

3. a. Excavation for pipe culverts, headwalls, and box culverts is measured by the cubic yard (cubic meter).

b. The quantity of excavation is computed by the Department using the following limits described below:

(1) The upper limits will be the new channel section elevations, when shown in the plans, or the ground elevations, when a new channel section is not shown in the plans.

(2) The horizontal limits to be used in computing the quantity of excavation will be as follows:

(i) Concrete Footings. Vertical planes 18 inches (450 mm) outside of and parallel to the limits of the footings.

(ii) Headwalls. Vertical planes 18 inches (450 mm) outside of and parallel to the limits of the headwalls.

(iii) 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.

(iv) 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.

(3) 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 to 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.

(4) 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.

(5) (i) Overlapping excavation volumes will be measured and deducted from the pay volumes so that a volume is only paid for once.

(ii) 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.

(6) 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.

(7) 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 m^2) within the limits of culvert excavation.

(8) (i) When excavation depths exceed 4 feet (1.2 m) , an additional horizontal allowance will be computed on the basis of Figure 701.01.

(ii) The slope of trench walls shall be approximately 1.0 foot (300 mm) rise to 1.0 foot (300 mm) run.

c. The excavation limits may vary due to the bedding requirements shown in the plans, however, the quantity of excavation will be computed on the basis of Figure 701.01.

4. When the plans or special provisions require a culvert to be built with shoring or sheet piling, then figure 701.01 will be superseded by the location of the shoring and the sheet piling when determining the authorized volume of excavation for culverts and pipes.

5. a. When additional material is required for backfilling or for the construction of embankments as prescribed 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.

6. a. "Granular Backfill" for bridges shall be the quantity shown in the plans.

b. The quantity for "Granular Backfill" shown in the plans 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 plans or with a change in the location, the payment may be redetermined.

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.

d. When it is necessary to remove unsuitable material or 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."

7. a. Backfill required by paragraph 3.c.(3) of Subsection 702.03 to build the berm and the 1 vertical to 2 horizontal slopes 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.c.(3) of Subsection 702.03 is paid for under the pay item for the remainder of the surrounding embankment.

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 (m3)]

a. 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.

b. Additional work required due to unforeseen obstacles which are essentially man-made in character, 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.

c. Removal of obstacles or obstructions that are unforeseen shall be paid for as "extra work", except as noted in Subsection 104.06.

d. 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) Backfilling or compacting.

(4) Water used to facilitate compaction.

(5) Drainage provisions at drains or weep holes.

(6) The work involved in "bedding" pipes in trenches.

(7) Sheeting and shoring.

(8) Gravel, crushed rock, or other fill material (except as allowed in Paragraph 6. of this Subsection).

3. a. Box and pipe culvert excavation shall be the quantity shown in the plans.

b. The quantity will be recomputed when the completed structure differs from the plans because of one or more of the following changed conditions:

(1) An increase or decrease in length of more than 10 feet (3 m).

(2) A change in location, measured along the centerline of the

project, of more than 10 feet (3 m).

(3) A change in flow line elevation, at one or both ends of the structure, of more than 1 foot (300 mm).

(4) An addition or deletion of any horizontal or vertical bend.

(5) A change in the skew angle of more than 10 degrees.

c. If the Engineer and the Contractor agree, in writing, that no significant change in excavation has resulted from the occurrence of one or more of the conditions listed in Paragraph 2.b. of this Subsection, then the quantity of excavation need not be recomputed.

4. Direct payment will not be made for any excavation required in connection with the construction of pipe culverts, median inlets, and flared-end sections or other appurtenances which are a part of the median culvert items shown in the plans. This work shall be considered subsidiary to the items for which the contract provides that direct payment will be made.

5. a. Additional excavation for backfill and embankment for pipe culverts, headwalls, and box culverts will be paid at the item's contract unit price -- "Excavation for Pipe or Pipe-Arch Culverts and Headwalls" and "Excavation for Box Culverts".

b. Embankment placed above the limits specified in Subsection 702.03, Paragraph 3.c.(4) shall be included with appropriate earthwork pay item ["Excavation", "Excavation Borrow", "Excavation (Established Quantities)", or "Earthwork Measured in Embankment"].

c. When "Earthwork Measured in Embankment" is the appropriate pay item, the volume of an "Additional Excavation for Backfill" shall be deducted from the "Earthwork Measured in Embankment" quantity.

6. a. When gravel or crushed rock is placed for a structure foundation as "extra work" at the direction of the Engineer, payment will be in cubic yards (cubic meters) based on 10 percent of the contract unit price for "Box Culvert Concrete".

b. If "Box Culvert Concrete" is not a pay item, then the NDR average unit price for "Box Culvert Concrete" will be used.

c. 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.

7. a. When it is necessary to lower the elevations of bridge foundation beds, the additional excavation will be measured for payment as "extra work".

b. The quantities of unsuitable material excavated beyond the excavation limits shown in the plans and removed at the direction of the Engineer will be paid as "extra work."

8. 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 plans; 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".

9. Payment is full compensation for all work prescribed 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 and/or placed in accordance with the requirements of these *Specifications* at the locations, elevation, penetration, and bearing shown in the plans.

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. 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. a. The Contractor shall furnish piles for each structure in accordance with the itemized list in the plans showing the number and lengths of all piles required.

b. The lengths included in the plans shall be based on the lengths which are to remain in the completed structure.

c. The Contractor shall, without additional compensation, increase the lengths given to provide for removal of piles damaged while driving and for additional lengths as may be necessary to suit the Contractor's method of operation.

d. Heat numbers shall be stamped on each pile.

e. Approved manufacturers of prefabricated pile points are shown on the NDR Approved Products List.

4. Downgraded or salvaged piles are not to be used.

5. Storing and Handling Steel Piling:

a. Piles shall be stored on suitable skids or platforms. Steel piles shall be kept free from accumulations of dirt, oil, or other foreign matter.

b. If the Contractor uses steel bearing piles or sheet piles for falsework, trackways, or any other purpose than shown in the plans, such use will be at his/her own risk and any damaged piles shall be rejected for use as material in the permanent structure.

6. Manufacture of Cast-In-Place Concrete Piles:

a. Piles shall be constructed in accordance with the details shown in the plans.

b. (1) The class of concrete used in cast-in-place concrete piles shall be as shown in the plans. Maximum slump for concrete used in cast-in-place piling shall be 6 inches (150 mm).

(2) (i) When the plans allow 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 before the date of beginning the concrete work.

(ii) No change shall be made in the concrete class without written permission of the Engineer.

c. Pile shells for cast-in-place concrete bearing piles shall be metal shells of the type, size, and gauge indicated in the plans.

d. 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.

e. Reinforcement shall be furnished, handled, stored, and placed in accordance with the requirements of Section 707.

f. (1) 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.

(2) Water inside the shells shall be removed before the concrete is placed.

g. (1) Concrete shall be placed continuously and shall be vibrated only in the areas which contain reinforcing steel.

(2) The shells shall be overfilled, the surplus concrete struck-off, and the top surface finished to a uniform, even texture.

h. Concrete shall be placed in accordance with the requirements of Section 705.

703.03 -- Construction Methods

1. Preparation for Driving Piles:

a. 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.

b. The Hammer Data sheet is 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 NDR Construction Engineer, at least 21 days before its use. The NDR Construction 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.

c. Wood or steel cable shall not be allowed for use as a hammer cushion.

d. Wood can be used as a pile cushion.

e. 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 Construction Engineer. The new data shall 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.

f. Hammers will not be replaced or changed unless authorized by the Engineer. The Contractor shall submit a new Hammer Data sheet if hammers are changed.

g. (1) 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 1 inch (25 mm) increments and shall be readable from the ground.

(2) The Contractor may provide a saximeter for the Department's use.

h. 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.

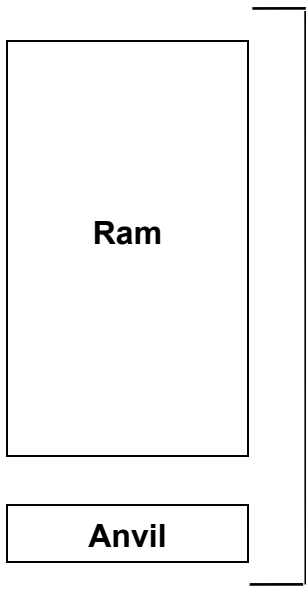
i. If fresh cushioning material has been inserted over the head of the pile, the penetration measurements for the purpose of determining the final bearing values shall not be made until at least 10 blows are struck.

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.

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:

Figure 703.01

HAMMER DATA



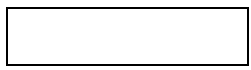
Hammer

Manufacturer: .....

Model: .....

Type: .....

Serial No.: .....

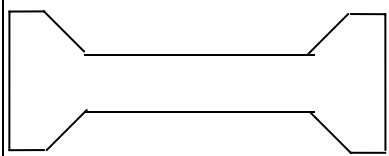


Hammer Cushion

Material: .....

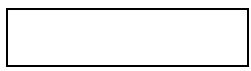
Thickness: .....

Area:.....



Pile Cap

Weight: .....



Pile Cushion
(For Concrete Piles Only)

Material: .....

Thickness: .....

Area: .....

NOTE: Proposed pile cushion thickness and/or area may be modified by the engineer after wave equation analysis.

(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 plans.

(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. (1) All welding to be done on steel piles shall be in accordance with the plans and pertinent requirements of Section 708, except that proof of the welder's qualifications will not be required.

(2) Welders shall be experienced in pile welding.

2. Pile Driving Methods:

a. (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" (safe load in tons) shall be not less than 125 percent 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. (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 Tons (kN)	**Gravity Hammer Weight in Pounds (kg)**
8 – 12 (70-105)	2,000 (900)
More than 12 – 15 (105-135)	2,500 (1100)
More than 15 – 22 (135-195)	2,800 (1250)
More than 22 – 28 (195-250)	3,000 (1350)
More than 28 – 37 (250-330)	3,500 (1600)
More than 37 – 50 (330-445)	4,000 (1800)

(2) The weight of the gravity hammer for driving precast concrete bearing piles shall not be less than 30 percent of the weight of the pile and never less than 2,000 pounds (900 kg).

d. The fall of gravity hammers shall be regulated so as to avoid damage to the piles.

e. (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.

f. 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.

g. (1) The Contractor has the option of starting piling in augured holes.

(2) Augured hole length shall not exceed 30 percent 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. Driving of Bearing and Sheet Piles:

a. Piles shall be driven to the depth and bearing shown in the plans

or to "practical refusal", whichever occurs first.

b. (1) Piles not driven plumb or to the batter indicated in the plans shall be rejected.

(2) No variation greater than 1/4 inch per foot (6mm per 300 mm) (2 percent) from vertical or the batter line indicated shall be allowed.

(3) In no case shall the top of a bearing pile be out of line more than 3 inches (75 mm).

(4) The tops of sheet piles shall not be out of position by more than 2 inches (50 mm).

(5) 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 prescribed elevations.

4. Determination of Bearing Capacity:

a. (1) The Engineer shall compute the bearing capacity of every pile. The bearing capacity of at least 1 pile in each substructure (i.e., bent, abutment, or pier) shall be determined at 5 foot (1.5 m) penetration intervals.

(2) 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.

(3) 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.

(4) 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.

(5) The purpose of 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.

b. To insure accurate bearing capacity:

(1) The head of the pile shall not have any broomed or crushed fibers.

(2) The pile penetration shall be quick and at uniform rate.

(3) Deviations or problems shall be noted by the Engineer on the driving report.

c. The bearing capacity of piles shall be computed from one of the following formulas:

Dynamic Formulas (English)

$$P = \frac{3.5\ WH}{S+0.35} \times \frac{W}{W+M}$$ For gravity hammers.

$$P = \frac{3.5\ E}{S+0.1} \times \frac{W}{W+M}$$ For steam hammers.

$$P = \frac{3.0\ E}{S+0.1} \times \frac{W}{W+M}$$ 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.

$$P = \frac{7.0\ E}{S+0.1} \times \frac{W}{W+M}$$ For driving concrete bearing pile with diesel hammers.

Where:

P = the safe load, in tons.

W = the mass of the ram, in tons.

M = the mass of the pile and driving cap, in tons.

S = the average penetration, in inches, of the pile per blow for the last 5 blows for gravity hammers or the last 10 blows for steam and diesel hammers.

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, the value of E shall be taken from the manufacturer's published values. For single-acting steam hammers, E = W x H.

For diesel hammers, the value of E in kilojoules shall be in accordance with Table 703.03 and Table 703.04.

Dynamic Formulas (Metric)

$$P = \frac{2.9\,WH}{S+9.0} \times \frac{W}{W+M}$$ For gravity hammers.

$$P = \frac{290\,E}{S+2.5} \times \frac{W}{W+M}$$ For steam hammers.

$$P = \frac{250\,E}{S+2.5} \times \frac{W}{W+M}$$ For driving steel, steel shell, and pipe piles with diesel hammers.

$$P = \frac{130\,E}{S+2.5}$$ For driving mandrel driven pile shells.

$$P = \frac{580\,E}{S+2.5} \times \frac{W}{W+M}$$ For driving concrete bearing pile with diesel hammers.

Where:

P = the safe load, in kilonewtons.

W = the mass of the ram, in kilograms.

M = the mass of the pile and driving cap, in kilograms.

S = the average penetration, in millimeters, of the pile per blow for the last 5 blows for gravity hammers or the last 10 blows for steam and diesel hammers.

H = the height of fall of the ram, in meters (less twice the height of bounce for gravity and steam hammers).

E = the energy per blow in kilojoules. For double-acting steam hammers, hammers, the value of E shall be taken from the manufacturer's published values. For single-acting steam hammers, E = 0.01 x W x H..

For diesel hammers, the value of E in kilojoules shall be in accordance with Table 703.03 and Table 703.04.

Table 703.03

Energy (Foot-Tons) for Single-Acting Diesel Hammers

Hammer Designation	Manuf. Energy Rating (Ft-Tons)	Ram Weight (Tons)	Hammer Fall (feet) 4	5	6	7	8	9	10	11
McKiernan-Terry										
DE-30 & DE-30B	**11.900**	1.400	5.6	6.9	8.1	9.2	10.3			
DE-33	**14.025**	1.650	6.6	8.1	9.5	10.9	12.2			
DA-35B	**11.900**	1.400	5.6	6.9	8.1	9.2	10.3			
DE-40	**17.000**	2.000	8.0	9.8	11.5	13.2	14.7			
DE-50B	**21.250**	2.500	10.0	12.3	14.4	16.5	18.4			
DE-70B	**29.750**	3.500	14.0	17.2	20.2	22.5	25.8			
DE-33-30-20	**16.480**	1.650	6.6	8.1	9.5	10.9	12.2	13.5	14.7	15.9
Delmag										
D-12	**11.250**	1.375	5.5	6.7	7.9	9.0	10.1			
D-15	**13.550**	1.650	6.6	8.1	9.5	10.9	12.2			
D-16-32	**19.670**	1.760	7.0	8.6	10.1	11.6	13.0	14.4	15.7	17.0
D-22	**19.890**	2.420	9.7	11.9	14.0	16.0	17.9			
D-19-32	**21.400**	2.095	8.4	10.3	12.1	13.8	15.4	19.0	18.4	
D-30	**27.100**	3.300	13.2	16.2	19.0	21.8	24.4			
D-25-32	**29.130**	2.757	11.0	13.5	15.9	18.1	20.3	22.3	24.3	
Kobe										
K-13	**12.600**	1.435	5.7	7.0	8.3	9.5	10.6			
K-22	**20.650**	2.425	9.7	11.9	14.0	16.0	17.8			
K-25	**25.350**	2.755	11.0	13.5	15.9	18.2	20.4	22.5		
K-35	**35.400**	3.860	15.4	18.9	22.2	25.5	28.6	31.6		
Mitsubishi										
M-14-S	**13.000**	1.485	5.9	7.3	8.6	9.8	11.0			
M-23	**22.500**	2.530	10.1	12.4	14.6	16.7	18.7			
Ice										
40S	**20.000**	2.000	8.0	9.8	11.5	13.2	14.8	16.4	17.9	
42S	**21.000**	2.044	8.2	10.0	11.8	13.5	15.1	16.7	18.3	
30S	**11.25**	1.500	6.0	7.4	8.7	9.9				

Table 703.03A

Energy (kilojoules) for Single-Acting Diesel Hammers

Hammer Designation	Manuf. Energy Rating (kilojoules)	Ram Weight (kilograms)	Hammer Fall (feet)							
			1.5	1.75	2.00	2.25	2.50	2.75	3.00	3.25
McKiernan-Terry										
DE-30 & DE-30B	**32.3**	1270	18.3	21.0	23.6	26.1	28.5			
DE-33	**38.0**	1500	21.6	24.8	27.9	30.8	33.6			
DA-35B	**32.2**	1270	18.3	21.0	23.6	26.1	28.5			
DE-40	**43.4**	1800	26.2	30.1	33.8	37.3	40.7			
DE-50B	**57.6**	2270	32.7	37.6	42.2	46.7	50.9			
DE-70B	**80.7**	3180	45.8	52.6	59.1	65.3	71.3			
DE-33-30-20	**44.7**	1500	21.6	24.8	27.9	30.8	33.6	36.3	38.9	41.4
Delmag										
D-12	**32.0**	1250	18.0	20.7	23.2	25.7	28.0			
D-15	**38.4**	1500	21.6	24.8	27.9	30.8	33.6			
D-16-32	**53.2**	1600	23.1	26.4	29.7	32.8	35.9	38.7	41.5	44.1
D-22	**55.1**	2200	31.7	36.4	40.9	45.2	49.3			
D-19-32	**57.5**	1900	27.4	31.5	35.4	39.1	42.7	46.1	49.4	52.5
D-30	**80.8**	3000	43.2	49.6	55.7	61.6	67.2			
D-25-32	**83.4**	2500	36.1	41.4	46.5	51.5	56.2	60.7	65.0	69.0
Kobe										
K-13	**34.5**	1300	18.8	21.6	24.2	26.8	29.2	31.6		
K-22	**61.5**	2200	31.8	36.4	40.9	45.3	49.4	53.4	57.2	
K-25	**69.9**	2500	36.1	41.4	46.5	51.4	56.1	60.6	64.9	
K-35	**97.9**	3500	50.4	57.9	65.0	71.9	78.4	84.7	90.8	
Mitsubishi										
M-14-S	**34.2**	1350	19.5	22.3	25.1	27.7	30.3	32.7		
M-23	**58.3**	2300	33.1	38.0	42.7	47.2	51.5	55.7		
Ice										
40S	**54.2**	1800	26.2	30.1	33.8	37.3	40.7	44.0	47.1	
42S	**56.9**	1850	26.8	30.7	34.5	38.2	41.7	45.0	48.2	
30S	**30.3**	1360	19.7	22.6	25.4	28.1	30.8	33.3		

Table 703.04

Double-Acting Diesel Hammers			
Hammer Designation	Manuf. Energy Rating (Ft-Tons)	Ram Weight (Tons)	Ram Fall (Feet)
Link-Belt Hammers			
440	9.10	2.000	4.5
520	13.13	2.535	5.0
McKiernan-Terry Hammers			
DA-35B	10.50	1.400	7.5
DA-55B	18.75	2.500	7.6

Table 703.04A

Double-Acting Diesel Hammers			
Hammer Designation	Manuf. Energy Rating (kilojoules)	Ram Mass (kilograms)	Ram Fall (meters)
Link-Belt Hammers			
440	24.68	1814	1.37
520	35.60	2300	1.55
McKiernan-Terry Hammers			
DA-35B	28.47	1270	2.29
DA-55B	50.84	2268	2.32

d. 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.

e. (1) If piling driven to the prescribed depth fail to obtain the required bearing capacity, the Engineer shall temporarily suspend driving.

(2) The Engineer will reevaluate pile requirements and notify the Contractor of proposed revisions within 2 NDR work days from the time driving was suspended.

f. 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 ultimate bearing capacity of the pile. In such cases, the Engineer will request data to calculate soil-setup factors.

(2) (i) Whenever a setup factor is to be established for a group (i.e., abutment, bent, or pier), 2 representative piles shall be driven to within 2 feet (600 mm) of the cutoff elevation shown in the plans and allowed to rest undisturbed for 36 hours.

(ii) In the case of twin bridges, each shall be considered a separate bridge for the determination of soil setup factors.

(3) (i) After 36 hours have elapsed, the hammer shall be warmed up on Pile #1 and this pile driven to cutoff elevation. The bearing of

Pile #1 is not reliable if the hammer is not warmed up.

(ii) The hammer shall then be placed on Pile #2 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 NDR 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 ten (10) blows after a piling that has rested undisturbed for a minimum of 36 hours is Bearing initial (B) as determined in paragraph (3) (ii). The bearing computed on the basis of the average penetration of the last 10 blows required to bring the pile to cutoff elevation is known as Bearing achieved (B_a), as determined in paragraph (3) (ii). The soil-setup factor is the ratio of Bearing initial (B) divided by Bearing achieved (B_a).

(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. Static Pile Load Test:

a. The Contractor shall perform static pile load tests according to ASTM D 1143 test methods when required in the plans. A minimum of 2 weeks before any pile installation, the Contractor shall submit a proposal for a test apparatus.

b. All test results shall be documented in a report and submitted to the Engineer within 3 NDR work days following completion of the test.

c. The Contractor shall furnish all testing equipment and personnel to conduct the test. The Engineer may approve, disapprove, or modify the Contractor's proposal.

d. The integrity of the test frame during the test operation will be the Contractor's responsibility.

6. Test Piles:

a. Test Piles shall be driven at the locations shown on the plans. The Contractor shall give the Engineer a 7-day notice as to when he/she proposes to drive each test pile. The Engineer shall monitor each test pile with a Pile Driving Analyzer.

b. When the pile order lengths are indicated as "tentative" on the plans, the final order lengths shall 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. The restrike will be monitored with the Pile Driving Analyzer.

e. The Contractor shall bolt 2 accelerometers and 2 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 NDR 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.

7. Practical Refusal:

a. "Practical refusal" occurs when the actual bearing capacity is 2.0 times design bearing capacity and exceeds 75 tons (68 Mg) for timber piles or 100 tons (91 Mg) for precast concrete, steel, pipe, or steel pile shells.

b. (1) 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.

(2) The Engineer may require predrilling through the material that is causing premature refusal for subsequent piling.

8. Elevation of Piles and Cutoff:

a. Piles shall be driven to the specified depth and cut off at the elevation shown in the plans, or the entire order length may be driven if the pile top is not damaged.

b. (1) (i) Prestressed concrete piling shall be cut off to the shape specified.

(ii) A saw cut, to the depth of the prestressing strands, shall be made at cutoff elevation around the perimeter of the pile.

(iii) After the saw cut is completed, a chipping tool shall be used to expose the prestressing strands for burning.

(iv) The Contractor shall remove the excess portion of the concrete pile after cutting the prestressing strands.

(2) The Contractor shall remove and replace piles that have broken or damaged.

9. Extensions, Splices, Build-Ups, and Overdriving:

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. Care shall be taken 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.

10. Prefabricated Cast Steel Pile Points:

a. Piles requiring prefabricated pile point protection are shown in the plans.

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.

11. 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. a. 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. a. 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.

b. The quantity paid will be the authorized square feet (square meter) of sheet piling in the completed structure.

3. "Test Pile" and "Static Pile Load Test" 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. Authorized "cutoff" of bearing and sheet piling shall be paid for at 60 percent of the piling's contract unit price. No payment is made for "cutoff" beyond the order length.

3. Splices ordered by the Engineer shall be paid for at 5 times the unit bid price for HP steel piling, pipe piling, and cast-in-place piling; and at 20 times the unit bid price 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 to cutoff elevation, bearing capacity, and/or practical refusal.

5. 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. a. Overdriving length is paid for at 40 percent of the contract unit price of the piling. 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. 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.

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 have broken or damaged butts 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 prescribed 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 plans.

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 plans or specified in the special provisions.

2. When the plans 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 Method

1. The Contractor shall construct concrete structures as prescribed in the plans.

2. Foundation Preparation:

a. Foundation excavations shall be as dry as practicable before concrete is placed.

b. The Contractor shall place concrete in one continuous operation.

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. In the event that the Contractor is required to excavate for spread footings to depths greater than those shown in the plans, the Engineer shall 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 plans.

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 plans.

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 an approved 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. 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 plans. 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 templets.

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.

5. Concrete Seal Course:

a. When shown in the plans 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 will 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 prescribed in Paragraph 13. 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.

6. Reinforcement:

Reinforcing steel shall be placed as prescribed in Subsection 707.03.

7. Falsework:

a. The Contractor is responsible for the falsework and its design. The falsework shall be designed by a Professional Engineer registered in Nebraska.

b. The Contractor shall submit falsework plans when they are required by plans or special provisions and 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) Unusual or complicated work indicated in the plans.

(4) Support of girders over or under active railroad tracks.

(5) Support of girders carrying traffic or extending over highways or streets carrying traffic.

c. Falsework plans will not be required for the deck forming of girder-type bridges, but will be required when the concrete deck cantilevers more than 6 feet (1.8 m) beyond the exterior girder.

d. (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.

e. All falsework shall be designed and constructed to support the loads without appreciable settlement or deformation. The Contractor shall use approved jacks, wedges, or other means to take up any settlement in the formwork falsework before and during the placing of concrete.

f. (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.

(3) Highway grade separation structure falsework may be supported by mudsills if they are large enough to provide necessary support of the load.

g. Falsework construction shall not begin until authorization to proceed is given by the Engineer. The Engineer will check completed falsework for conformity with the plans and for their general condition. Special attention will be given to lateral stability, bracing, fasteners, wedges, connections, and jacks.

h. Falsework shall be set up to produce a finished structure at the elevations and grades indicated in the plans. The Contractor shall consider and compensate for deflections that the method of construction creates.

i. 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. When a material item is a proprietary accessory or commercially available form unit, the manufacturer, proprietary name, and rated capacity of the item shall be shown on the falsework plans.

j. 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.

k. All falsework piles in the stream channel shall be pulled when no longer needed.

8. Forms:

a. Formwork shall be constructed in accordance with the AASHTO *Guide Design Specification for Bridge Temporary Works*.

b. (1) Forms for concrete shall conform to the dimensions, lines, and grades shown in the plans. 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.

(2) Aluminum or other materials that react adversely with the concrete shall not be used in the forms.

(3) (i) Forms for concrete floor slabs on steel or precast concrete girders or beams shall be hung from adequate metal hangers.

(ii) Metal hangers shall be certified to carry the expected loads.

(iii) They shall be adjustable to vary the slab thickness.

(iv) They shall be of such substantial design that no measurable settlement of forms occurs when the concrete deck is placed.

(v) Tack welding of form hangers or other miscellaneous hardware to the flanges of girders is prohibited.

c. (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.

d. 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.

e. Forms shall be filleted or chamfered approximately 3/4 inch (19 mm) at all exposed corners.

f. (1) 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.

(2) Tie and anchorage cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in color.

(3) Protruding ends of plastic ties shall be removed flush with the concrete surface.

g. Forms shall be set and maintained true to the line designated without the use of temporary internal bracing.

h. 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.

i. (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) Typical items which may be constructed in this manner

include box culvert walls on floors, pier columns on footings, bridge curbs, and concrete rails on bridge slabs.

j. 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 ½ inch (12 mm) clearance between the form support and the bridge deck reinforcing steel. Removable forms must be used outside of the exterior girders.

The form corrugations shall be filled with polystyrene strips to prevent excess slab dead load.

The Contractor must 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.

Steel stay-in-place form material shall conform to the requirements of ASTM A 653/A 653M Coating Designation G615/Z500.

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.

k. Construction equipment will be allowed on bridge floors 5 days after placing concrete provided the compressive strength is at least 3500 psi (24 MPa).

9. Removal of Forms and Falsework:

a. Care shall be taken in the removal of all forms. Steel prying tools shall not bear directly on fresh concrete.

b. Falsework or bracing supporting concrete structures and forms supporting concrete floor slabs on girder bridges shall remain in place until tests show that the concrete has attained a compressive strength of at least 2,000 psi (14 Mg). In the absence of such tests, the requirements in Table 704.02 shall govern the length of time the falsework shall remain in place, exclusive of the time during which the air temperature is below 40°F (4°C) and the concrete is not protected.

Table 704.02

Minimum Formed Time	
Floor slabs	7 Days
Walls	14 Days
Columns	7 Days
Box Culvert Slabs	7 Days

c. (1) Supports shall be removed gradually so as to allow the concrete to support its own weight uniformly.

(2) Falsework supports shall be released near the center of the span and progress toward the end supports.

d. All falsework piles shall be removed in accordance with the requirements of Subsection 203.02, Paragraph 21.

10. Placing Concrete:

a. (1) The Contractor shall give the Engineer 1 NDR 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.

b. (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.

c. The maximum allowable interval for placing successive concrete batches into forms shall be 30 minutes.

d. The sequence of placing concrete shall be as shown in the plans.

e. 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.

f. (1) 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.

(2) Material segregation and displacement of the reinforcement shall be avoided.

(3) Concrete in girders shall be deposited uniformly for the full length of the girder and brought up in horizontal layers.

(4) Concrete placement shall be regulated to control fluid pressures.

(5) 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.

(6) 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.

g. (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.

h. (1) After placing concrete in the forms, the concrete shall not be moved laterally more than 6 feet (1.8 m).

(2) The forms shall be filled uniformly.

i. (1) All chutes and pipe shall be metal, metal lined plastic, rubber, or other nonreactive material.

(2) Chutes shall be kept clean and free from concrete coatings.

(3) Aluminum or aluminum alloys that react with the concrete shall not be used for chutes.

j. (1) Concrete free fall distance shall not exceed 5 feet (1.5 m). This includes free fall in a discharge pipe.

(2) The concrete shall be discharged in a continuous stream free of air pockets so that a constant pressure head is maintained.

k. (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.

(3) When a monolithic layer cannot be completed in one operation, it shall be terminated in a vertical bulkhead.

l. (1) 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.

(2) To avoid visible joints at exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.

(3) 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).

m. (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.

n. Cast-in-place concrete railings shall not be placed on concrete slab bridges until the falsework supporting the roadway slab has been removed.

o. 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).

11. 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.

12. 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 prescribed in this Subsection.

b. Internal vibration shall be used.

c. (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. (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.

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 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.

13. Placing Concrete Under Water:

a. The Engineer shall approve all concrete placed under water.

b. (1) 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 percent.

(2) Concrete shall be tremied in place forming a compact mass. It shall not be disturbed after being deposited.

(3) Still water shall be maintained at the point of deposit, and the forms shall be watertight.

c. (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.

(4) 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.

(5) 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.

(6) The flow shall be continuous until work is completed.

(7) 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.

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.

14. 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 must 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. (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 Contractor shall provide 4 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.

c. The Contractor shall assume all risk connected with the placing of concrete during freezing 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 freezing shall be rejected.

15. 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 plans or indicated in the placing diagram unless otherwise provided in these *Specifications* and approved by the Engineer.

c. (1) Open, expansion, and fixed joints; water stops; and bearing seats shall be constructed according to the details shown in the plans.

(2) Open joint templets 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) Positive methods shall be employed in placing steel joints to keep them in correct position when placing the concrete.

d. (1) 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.

(2) 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.

16. Curing Concrete:

a. Exposed, unformed concrete surfaces which do not require a rubbed finish shall be wet-cured or membrane-cured.

b. (1) Surfaces from which forms have not been removed 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. (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. Details of application shall be as specified in Subsection 603.03, Paragraph 6.

(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.

17. Concrete Surface Finish:

a. (1) The Contractor shall finish all concrete surfaces, except bridge decks, in accordance with the requirements of this Section.

(2) All formed concrete surfaces shall first be given an ordinary surface finish.

(3) Surfaces requiring a rubbed finish are shown in the plans.

(4) 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.

(5) Concrete surfaces which are not to receive a rubbed finish shall be float-finished.

b. 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 prescribed 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.

c. Rubbed Finish:

(1) 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.

(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 carborundum 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 carborundum 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.

d. 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.

e. 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.

18. 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.

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. 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.

19. a. When the plans 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 plans. 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 plans.

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 Project Manager 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’ long x 4’ 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.

20. The Contractor shall paint all exposed metal, except weathering grade steel, as prescribed in Section 709.

21. a. Concrete barrier curbs and bridge rails shall present a smooth, uniform appearance conforming to the horizontal and vertical lines shown in the plans or as directed by the Engineer, and shall be free of lumps, sags, or other irregularities.

b. The top and exposed surfaces 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 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.

22. 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. a. 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 plans. No field measurement is required. Pay quantities are those shown in the plans.

b. 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.

c. 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.

2. The volume involved in fillets, scorings, and chamfers 1 square inch (645 mm^2) or less in cross sectional area shall be neglected.

3. The volume of precast or cast-in-place concrete piles or pipe piles encased in the concrete shall be deducted from the concrete plan quantity.

4. No deductions shall be made for the volume of concrete displaced by steel reinforcement, floor drains, or expansion joint material.

5. a. 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.

b. (1) An additional allowance is made for concrete box culverts constructed with either a horizontal or vertical break in barrel alignment.

(2) 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).

6. "Preparation of Bridge at Station _____" is measured by the each.

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 at Station _____	Each (ea)

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. a. Payment deductions shall be taken when the measured 28-day compressive strength of cores or cylinders is less than the design compressive strength.

b. The pay deduction percentage is calculated as shown below:

$$\frac{2 \times (\text{Design Compressive Strength} - \text{Actual 28-day Compressive Strength})}{\text{Design Compressive Strength}} = \text{Percent Deduction}$$

c. (1) The actual 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.

(2) If a cylinder's compressive strength is more than 5 percent below the design compressive strength, then the average of 3 core samples taken 28-30 days after the concrete was poured will be used to determine the compressive strength.

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 prescribed in this Section.

SECTION 705 –
PRECAST/PRESTRESSED CONCRETE STRUCTURAL UNITS

705.01 -- Description

1. This work consists of all labor, materials, and equipment required in the production of precast/prestressed structural units.

2. Contract plans 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 prescribed 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. Precast/prestressed concrete structural units whose compressive strength does not achieve design strength shall be rejected.

3. The concrete class used in the manufacture of precast/prestressed structural units shall be shown in the plans.

4. The Contractor is responsible for the concrete mix design and may use other concrete mixes which are proportioned in accordance with ACI Standard 318 and the following additional requirements:

a. The mix designs shall be submitted to the Engineer 4 weeks before beginning any concrete work.

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 and ASTM C 494 approved Type A, Type B, Type D, and Type F admixtures.

c. The minimum cement content shall be 565 lb/CY (335 kg/m^3).

d. Coarse aggregate shall have a minimum limestone content of 30 percent of the total aggregate by weight.

e. Fly ash cannot exceed 15 percent of cement by weight.

f. Data from at least 15 individual batches shall be collected and given to the Engineer. The data collected shall include the following:

(1) The 28-day compressive and flexural strength test results.

(2) The water/cement ratio.

(3) The air content (between 2.0 percent and 6.0 percent inclusive).

(4) The cement and fly ash content.

(5) The amount of fine aggregate, coarse aggregate, and sand and gravel.

5. Gradation requirements for fine and course aggregate may be waived by the NDR Materials and Research Engineer.

6. No change shall be made in the concrete mix design during the progress of the work without the prior written permission of the Engineer.

7. Reinforcement shall be furnished, handled, stored, and placed in accordance with the requirements of Section 707.

8. Welding of reinforcing steel is prohibited unless specifically authorized by the Engineer.

9. Prestressing steel other than that specified in the plans or special provisions 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.

10. The area of broken wires shall not exceed 2 percent of the cross sectional area of the stressing strands when the number of strands is 14 or less.

11. The area of broken wire shall not exceed 1 percent of the cross sectional area of the stressing strands when the number of strands exceeds 14.

12. No more than 1 broken wire will be allowed in a single strand.

13. 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)

14. 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.

15. 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.

16. Any defective material shall be rejected.

17. Concrete quality control shall be the responsibility of the Contractor. Concrete shall be sampled and tested as shown in Table 705.03.

Table 705.03

Required Concrete Sampling and Testing		
Test	**Contractor Test Samples***	**Department Correlation Text Samples**
Yield ASTM C138 Air meter measuring bowl.	One per day	One per 10 Contractor tests *(for each mix)*
Air content ASTM C 231 (0.8% variation allowed)	One per load	One every 5 production days *(for each mix)*
Concrete Temperature ASTM C 1064	One per load	One every5 production days *(for each mix)*
Concrete Compressive Strength		
28-day strength ASTM C 31 Section 9.3 Cure	Two cylinders – each from a different load; and one from the last load	One set of two cylinders every 5 productionn days *(for each mix)*
56-day strength *(used only if 28-day strength is less than specified.)* ASTM C 31 Section 9.3 Cure	Two cylinders – each from a different load and from same load as 28-day break.	N/A

* At least 6 cylinders shall be made each production day and at least 2 cylinders are required from each load.
* Cylinders shall be 4 inches *(100 mm)* by 8 inches *(200 mm).*
* Contractor test samples and Department correlation test samples shall be taken independently.

18. Plant Approval Requirements:

a. (1) All precast/prestressed concrete structural units shall be produced in a Precast/Prestressed Concrete Institute (PCI) certified plant.

(2) The method of manufacture and quality of concrete are also subject to Department approval/inspection.

b. A Contractor proposing to furnish 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.

c. The use of portable pretensioning beds for the manufacture of concrete structural units or piles will not be allowed.

19. The static elastic modulus of the concrete used in prestressed bridge girders shall be determined in accordance with ASTM C469.

a. A data base of thirty tests for each trial and production mix shall be included in the data collected and given to the Engineer. A test result shall be the average result of testing two cylinders made from the same concrete mix.

b. Trial mix test cylinders shall be cast from the minimum number of trial batches required by the Standard Specifications and tested at age 28 days. For the purpose of this specification, trial mix shall mean a mix in which the ingredient proportions have been modified or the aggregate source has changed. A change of cement source is excluded if the new source is on the Department of Roads' approved product list as a level one producer.

c. The thirty production tests shall be performed by the Contractor. A production test shall consist of testing two cylinders at release and two cylinders at 28 days. Up to four cylinders may be cast from each production batch provided they are taken from different locations within the batch.

d. Once the database has been established, only the minimum testing frequency for the modulus of elasticity shall be required. The following criterion establishes the required minimum testing frequency for each production mix of concrete.

e. Four cylinders each day a given mix is poured, but not less than four cylinders for each 150 cubic yards (115 m^3) of each mix poured each day.

f. Two cylinders for each week's production for each mix used shall be delivered to the Materials and Tests Laboratory in Lincoln for assurance testing.

g. All tests for elastic modulus and compressive strength will be conducted using 4"x8" (100 mm x 200 mm) cylinders.

705.03 -- Construction Methods

1. The Contractor shall construct precast structures and piles as shown in the plans.

2. The Contractor shall erect precast concrete structures and drive precast concrete piles as prescribed in the plans.

3. The Contractor shall provide the Engineer a 4-week production schedule that is updated as necessary. If the Engineer is given less than 1 NDR work day's 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 and note them in the plant diary.

4. 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 NDR T 506 for each half day.

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 completed.

5.a. (1) (i) 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 percent tolerance.

(ii) Means shall be provided for measuring the elongation of reinforcement to at least the nearest 1/8 inch (3 mm).

(iii) 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.

(iv) All devices shall be calibrated and, if necessary, recalibrated so as to allow the stress in the prestressing steel to be computed at all times.

(v) A certified calibration curve shall accompany each device.

(vi) 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.

(2) (i) 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 percent tolerance.

(ii) Such equipment shall be calibrated by an approved testing laboratory.

(iii) The Contractor's laboratory shall furnish calibration curves for each device and shall certify the curves as being accurate and verifiable.

(iv) The calibration of tensioning devices shall be accomplished in place.

(v) The configuration of jacks, gauges, and other components during calibration shall be exactly the same as during the actual stressing operation.

(vi) The method of calibration shall be as approved by the Engineer.

(vii) 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.

(3) If the strand tension indicated by the gauge pressure and by elongation methods fail to agree within 5 percent, the operation shall be carefully checked and the source of error determined before proceeding further.

b. (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.

c. In all stressing operations, the Contractor shall keep stressing force symmetrical about the member's vertical axis.

6. Stressing Procedure:

a. Prestressing methods are shown in the plans. When the Contractor elects to use a method other than that shown in the plans, 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 plans.

(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 percent tolerance.

(4) With the strand stressed in accordance with the plan requirements and these *Specifications*, 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 plans.

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 plans.

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.

7. Forms:

a. Forms for precast/prestressed concrete structural units shall conform to the requirements for concrete formwork as provided in Subsection 704.03.

b. Forms shall be accessible for the vibration and consolidation of concrete.

8. 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 when the Department elects not to reschedule inspectors.

b. 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 and note them in the plant diary.

c. Concrete shall not be placed before completing the forming and placing of reinforcement.

d. (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. (1) 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) The concrete shall be consolidated by vibrating or other means approved by the Engineer.

f. The forms shall be overfilled, the excess concrete screeded off, and the top surfaces finished to a uniform, even texture.

g. Each precast/prestressed concrete structural unit shall be stamped or marked with an identification number and its manufacture date.

h. (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) nor fall below 50°F (10°C).

(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.

9. 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 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 NDR 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) between the enclosure and restricting portions of the forms in order to insure adequate circulation of heat. The relative humidity within the curing enclosure shall be maintained between 70 and 100 percent.

(2) (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 direct that automatic controls which can be activated by the recording thermometers or by separate temperature switches be installed. These automatic controls are to control the rate of temperature change and maximum curing temperature according to a preset plan.

(3) (i) Temperature of the curing concrete shall be 50°F to 90°F (10°C to 32°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".

(ii) The temperature rate of rise shall not exceed 60°F (15.5°C) per hour.

(iii) 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) When the heat has been applied for a minimum of 3 hours and the desired concrete temperature has been reached (not to exceed 175°F [79°C]), the heat source may be turned off. Should the temperature within the concrete rise 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 soaking period until the release strength has been reached.

(9) Detensioning shall be accomplished before the temperatures of the units drop below 100°F (38°C) and while they are still moist.

(10)An automatic master slave heat curing system may be used for curing quality control cylinders.

c. Prior to detensioning prestressed concrete girders, they shall be inspected by the Engineer for cracking. If any cracks are discovered, the Contractor shall wet burlap cure the entire girder for 7 days immediately after detensioning. If cracks are discovered in the bottom flange, the girder shall be rejected.

10. 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 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 in the following manner:

(1) All unsound concrete shall be removed.

(2) The affected area shall be coated with epoxy resin binder meeting the requirements of Section 1018 for epoxy resin binder. Care shall be taken to prevent getting epoxy on the exposed surface.

(3) The formwork shall be placed and secured.

(4) The prepared areas shall be filled with Class 47B-5,000 (47B-35) concrete mix (Aggregate with a diameter larger than 0.4 inch (10 mm) is not allowed) using the type of cement in the unit. Where the unit is exposed to view, white cement shall be added to give a uniform appearance with the concrete surrounding the patch.

(5) The work shall be cured 24 hours with wet burlap. Steam curing at 80°F (27°C) will be allowed.

(6) The patch shall be ground smooth to remove all joint seams.

(7) The units shall be finished as required in Subsection 704.03.

11. 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, other methods approved by the Engineer shall be employed.

(2) The interior face of an exterior girder or beam and all interior girders or beams shall be finished from the lower flange to the fillet of the web in accordance with Paragraphs 13.a.(1)(iii), (iv), (v), (vi), and (vii) of this Subsection.

b. All other structures shall receive an Ordinary Finish as described in Subsection 704.03, Paragraph 17.b.

c. On bearing and sheet piles, the Ordinary Finish described in Subsection 704.03 will not be required except that all honeycombed areas shall be repaired after removal of all unsound concrete.

12. 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 admixture (Interplast B), 1 pound (0.5 kg).

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. The Contractor shall paint all exposed metal, except weathering grade steel, as prescribed in Section 709.

14. Handling, Transporting, and Storing:

a. (1) After precast structural units have attained a compressive strength of 3000 psi (20 MPa), the Engineer shall approve the method used to remove the units from the casting beds.

(2) Prestressed concrete structural units shall attain the "release" strength specified in the plans before being delivered to the site. Prestressed concrete structural units will not be incorporated in the final product until the minimum age and strength specified in the plans is attained.

(3) All precast/prestressed concrete structural units shall be supported at or within 6 inches (150 mm) of all lifting or bearing devices. 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 lifting or bearing devices to prevent settlement into the ground.

(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 or store the precast girders in some other position, the Contractor shall be prepared to prove 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 plans.

15. Inspection Facilities:

The Contractor shall arrange with the producer of 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 shall be installed in the office, and the installation charges shall be paid by the Contractor. The monthly service charges shall 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.

k. The minimum lab area is 230 square feet (21 m^2).

l. The minimum toilet area is 20 square feet (2 m^2).

m. The minimum office area is 160 square feet (15 m^2).

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 m^2) 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/prestressed concrete piles shall be measured in accordance with the requirements of Section 703.

2. Precast/prestressed concrete superstructures will be measured for payment by the lump sum.

705.05 -- Basis of Payment

1. Prestressed and/or precast concrete piles shall be measured and paid for as prescribed in Section 703.

2.

Pay Item	**Pay Unit**
Precast/Prestressed Concrete _____ Superstructure at Station _____*	Lump Sum (LS)

* Reinforcing steel, prestressing tendons, and all other components of the precast/prestressed concrete superstructure are subsidiary to this pay item.

3. 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 _____".

4. If a precast or 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 percent will be taken if the 56-day compressive strength is less than 95 percent of the design strength.

5. All equipment calibrations and tests are subsidiary to "Precast/Prestressed Concrete _____ Superstructure at Station _____".

6. Payment is considered full compensation for all work prescribed in this Section, including the cost of prestressing and precasting.

SECTION 706 -- CONCRETE BRIDGE FLOORS

706.01 -- Description

This work shall consist of providing all necessary materials and construction of concrete bridge floors in accordance with the plans 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. 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 plans 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. 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. a. The Contractor's sequence of placing shall be as shown in the plans.

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. 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. When the plans require a construction joint between concrete curbs or railings and the concrete floors, the curbs or railings shall not be placed until the concrete floor has cured for at least 3 days.

6. 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. (1) The machine shall be supported on adjustable rails or tracks of sufficient strength to prevent deflection between rail supports.

(2) Preferably, the rails shall 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. a. For finishing concrete slab widenings or other small or irregular deck areas, hand-finishing methods will be allowed.

b. (1) 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 plans and to accurately match adjacent existing concrete surfaces.

(2) 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.

(3) Excess concrete shall be maintained in front of the cutting edge to avoid creation of surface low spots.

c. 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.

d. 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. a. Before the concrete obtains initial set, the Contractor shall give all finished 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. (1) All concrete bridge floors and approach slabs except those which are to receive a subsequent concrete overlay surface course shall also be tine textured. 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. 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. Environmental conditions during placement are critical to the quality of concrete in bridge decks. Of particular importance is the evaporation rate. The Contractor shall predict the evaporation rate for the duration of the deck casting based on the Contractor's estimate of the start and completion times. Local weather forecasts can be used to predict the wind speed, air temperature and relative humidity. The Contractor may estimate the concrete temperatures from those actually measured during the previous day's placement, from test batches, or from estimates of aggregate, cement and water temperatures. The Contractor shall use the predicted weather conditions and the Evaporation Nomograph, Figure 2.1.5 from the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2 or Figure 710.01 in the Nebraska *Standard Specifications for Highway Construction* 1997 English Edition, to estimate the evaporation rate. The Contractor shall record the wind velocity, air temperature, concrete temperature, and relative humidity immediately before and after casting the deck and provide the Project Manager a copy of this data. The attached data sheet or similar Contractor record may be used to record the data.

c. When the evaporation rate is estimated to exceed 0.15lb/sf/hr (0.75 kg/m^2/hr), the Contractor will only be allowed to cast the bridge deck when additional measures are implemented to create and maintain environmental conditions on the bridge deck which are satisfactory for concrete placement and have been approved by the Project Manager. These measures may consist of:

- Fogging,
- Placing clean, saturated wet burlap on the finished concrete no later than 1 1/2 hours after the concrete leaves the truck/pump chute and is on the deck,
- Erecting wind breaks, and/or
- Cooling the concrete.

(1) Fogging is only a temporary measure that allows the Contractor to delay placing the saturated wet burlap. Saturated wet burlap must be applied before the Contractor stops the fogging operation. Saturated wet burlap must always be applied and be maintained saturated wet until 96 hours after casting. The Contractor must use extreme caution when applying saturated wet burlap 90 minutes after placement to avoid damage to the deck. Any damage, except partial removal of tining imprints, caused by dragging the saturated wet burlap over the surface of the newly cast concrete, shall be repaired by the Contractor at no additional cost to the Department. (Partial removal of tining imprints is defined as less than 25% of the total deck surface.) Any smoothness damage as defined by applicable contract smoothness requirements shall be repaired by the Contractor at no additional cost to the Department.

(2) Fogging shall be accomplished using pressurized equipment that distributes at least 0.10 gallon of water/ hour/square foot (4 l/h/m^2) of bridge deck placed. As an example, on a 36-foot (11 m) wide deck, the system must be able to distribute at least 3.6 gallons of water/hour/linear foot

(44.7 l/h/m). The fog spray must be produced from nozzles, which atomize the water and which are capable of keeping the finished deck surface area saturated without depositing noticeable standing water. (Atomized water should have an average droplet diameter of approximately 80 microns (0.08 mm or 0.003 inch) or less.) Water that drips from nozzles must not be allowed to fall onto the concrete that is being cured.

(i) Fogging must begin progressively along the length of the deck immediately after tining the concrete (approximately 30 minutes after casting), and the fog must be applied over the entire placement width until saturated wet burlap is in place.

(ii) The Contractor must submit a letter certifying that their fogging equipment will meet the requirements of this Special Provision.

(iii) Use of white, clear, or black polyethylene film (plastic sheeting) is prohibited.

d. If environmental conditions are such that the evaporation rate is less than 0.15 lb/sf/hr (0.75kg/m^2/h) and the forecast temperature is predicted to be above 40°F (4.5°C), then the Contractor has the option to use the following curing procedures instead of those in Paragraph 9c. above:

(1) The Contractor shall incrementally apply white-pigmented curing compound within 45 minutes after the finish machine passes over the concrete. The application rate shall be in accordance with the manufacturer's application procedures and Subsection 603.03, Paragraph 6, Protection and Curing in the Nebraska *Standard Specifications For Highway Construction.*

(2) The Contractor shall place uniformly saturated wet burlap on the finished concrete within 3 hours after applying white-pigmented curing compound. The Contractor must keep the burlap uniformly saturated for at least 96 hours. If the temperature at the time of casting and for the next 96 hours is not expected to exceed 75°F (24°C), then the Contractor has the option to limit the application of water to the burlap after 24 hours and cover the saturated wet burlap with opaque polyethylene film sheets for the remaining 72 hours.

e. When placing concrete in cold weather, the following alternate curing is authorized (Cold weather is defined as air temperature expected to be 40°F (4°C) or less.).

(1) The finished concrete surface shall be covered with a layer of saturated and clean burlap approximately 90 minutes after the concrete is placed on the deck. The saturated wet burlap shall be immediately covered with a layer of white opaque polyethylene film.

(2) The curing system shall remain in place for at least 72 hours.

(3) All other requirements for cold weather concreting, as defined in Subsection 704.03, shall apply.

f. 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.

g. The Contractor is 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.

h. The Department will determine the method for repairing any cracked concrete.

i. Concrete Bridge curbs and rails shall be cured in accordance with Subsection 704.03.

Bridge Deck Environment

Project: _____ Date: _____

Location: _____ Project No.: _____

Control No.: _____ Station No.: _____

	Time Measured	Air Temp.	Relative Humidity (%)	Concrete Temp.	Wind Velocity (MPH/KPH)	Evaporation Rate
Prior to Casting						
After Casting						

_____
Signature

10. a. The Contractor shall test the cured concrete for surface irregularities with either a 10 foot (3 m) straightedge placed or operated parallel to the centerline of the roadway or some other device for measuring deviations from a plane. Variations greater than 1/8 inch (3 mm) shall be plainly marked for removal, except that for decks which are to receive a subsequent concrete overlay course, where 1/4 inch (6 mm) variations are allowed.

b. The Contractor shall grind or cut irregularities that exceed the above limits. Grinding or cutting shall not be done until the concrete is at least 7 days old, and bush hammering or other impact methods are not allowed.

c. Concrete barrier curb, bridge rail, and median barrier curb:

(1) The barrier curbs and bridge rail shall present a smooth, uniform appearance conforming to the horizontal and vertical lines shown in the plans or ordered by the Engineer, and shall be free of lumps, sags, or other irregularities. The top and exposed faces of the barrier and bridge rail shall conform to the following requirements when tested with a 10 foot (3 m) straightedge laid on the surfaces.

(2) The top of the barriers shall not vary more than 1/4 inch (6 mm) from the edge of the straightedge, and the faces shall not vary more

than 1/2 inch (13 mm) from the edge of the straightedge. Areas not conforming to the requirements in Paragraph 10.c.(1) of the Subsection shall be removed and replaced at no additional cost to the Department.

11. 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 60ºF (15ºC) or higher.

(1) Type B – Retarding Admixture or Type D – Water Reducing and Retarding Admixtures, as shown on the NDR Approved Products List, shall be used.

(2) Type A – Water Reducing Admixtures, as shown on the NDR Approved Products List, shall not be used as retarders.

c. Retarders are intended to keep the concrete from setting up 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. 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. Here, 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 plans. 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 prescribed 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 7 days and developed a minimum compressive strength as prescribed in the plans.

b. Construction equipment meeting legal load limits will be allowed on bridge floors after 5 days have elapsed from the time of placement provided a test specimen made during the progress of the work develops a compressive strength of at least 3500-psi (24-MPa) as prescribed in the plans.

706.04 -- Method of Measurement

1. No field measurements are required when items are constructed according to the plan geometrics.

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)

2. Finishing, curing, texturing, set retarders, and test wells are subsidiary to the concrete floor.

3. Miscellaneous items that are listed in the plans 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. Payment is full compensation for all work prescribed in this Section.

SECTION 707 -- REINFORCEMENT

707.01 -- Description

This work shall consist of furnishing and placing reinforcing steel as required by these *Specifications* and as shown in the plans.

707.02 -- Material Requirements

1. Reinforcing steel shall conform to the requirements as prescribed 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 Tests Division for testing. The length of each sample shall be 6 linear feet (1.8 m).

707.03 -- Construction Methods

1. 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. Tightly adhering, powdery rust on steel is not harmful to concrete bond and will not normally require removal. However, 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.

2. Fabrication:

a. The Contractor shall bend reinforcing bars without the use of heat to the dimensions and shapes shown in the plans, and bars having cracks or splits at the bends shall be rejected.

b. (1) 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.

(4) Epoxy coated bars shall not be welded or flame cut.

c. Plain 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.

d. All reinforcing steel shall be identified and tagged as required in Subsection 1021.03, Paragraph 9.

3. Placing and Fastening:

a. The Contractor shall place all reinforcement in the position shown in the plans, and it shall be held securely in position with plastic clips and blocking. Reinforcing bars shall be tied at all intersections, except when the spacing is less than 1 foot (300 mm) in each direction, in which case alternate intersections shall be tied. 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.

b. (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 slabs shall be positioned on plastic coated supports or chairs to accurately maintain the specified clearance to the surface of the concrete. Supports shall not be spaced at distances greater than 4 feet (1.2 m). See details A, B, & C as shown in Figure 707.01.

(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) Tie wire for epoxy coated bars shall be plastic coated. Plastic clips suitable for the purpose may be used.

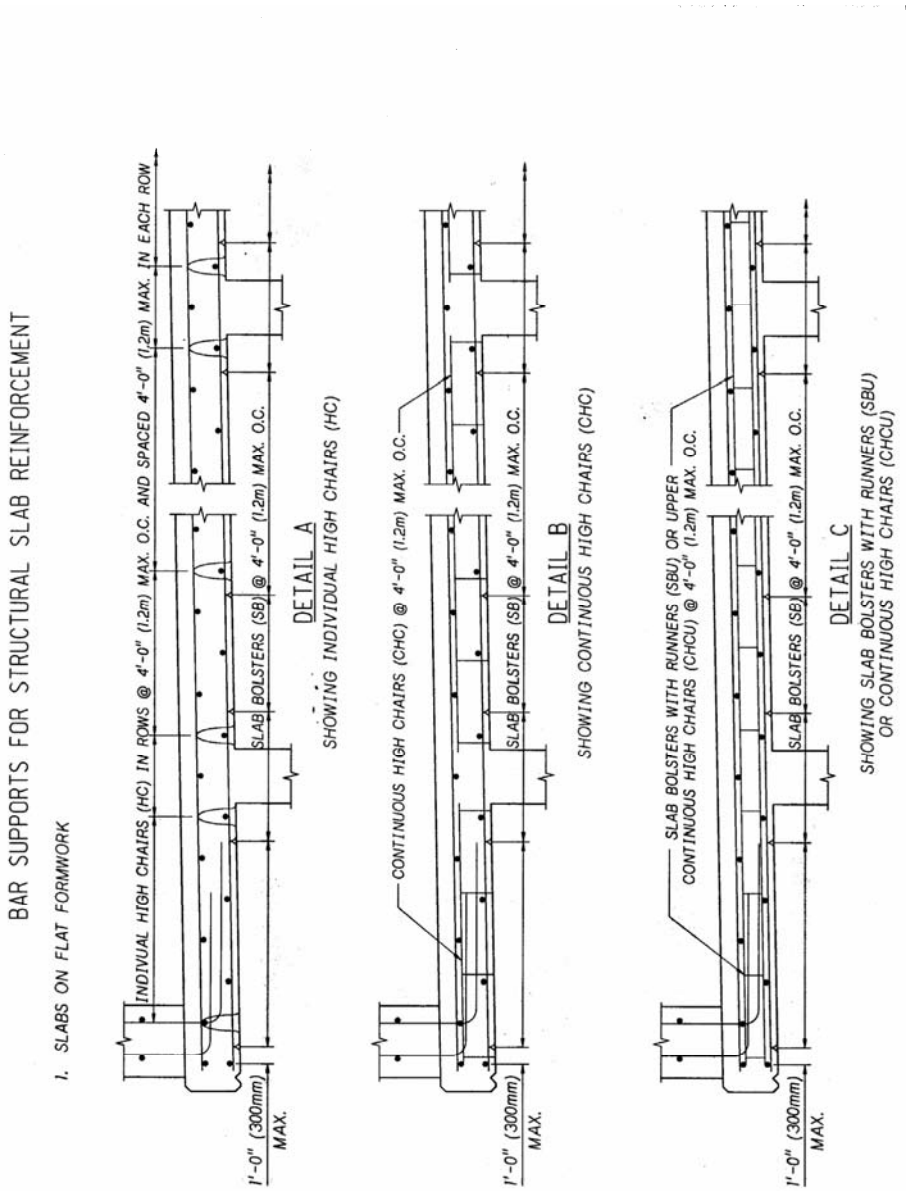
(7) Bar supports which are at exposed concrete surfaces shall be corrosion resistant as prescribed in the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*.

c. The Contractor shall position all vertical steel reinforcement used in the construction of sidewalls or wingwalls of reinforced concrete culverts as shown in the plans.

d. Welding on reinforcing steel is prohibited unless specifically authorized by the Engineer.

e. Fiber reinforced concrete support spacers must have at least 4 percent Polyamid 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.

Acceptance of the support spacers will be based on a certificate of compliance furnished by the supplier.



4. Splicing:

a. The Contractor shall furnish all reinforcing steel in full lengths, except where splices are indicated in the plan. 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 plans. 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

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 plans.

707.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Reinforcing Steel for _____	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 prescribed in this Section.

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 plans 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 plans to describe what steel item(s) 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 NDR 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 "MBr" certification is required to fabricate main members of Major Steel Bridges (other than rolled beam structures).

c. Secondary member fabrication is allowed without AISC certification.

3. Welding and weld qualification tests shall conform to the provisions of the ANSI/AASHTO/AWS D1.5 Bridge Welding Code, herein referred to as *AWS Standard Specifications*.

4. 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 prescribed 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 NDR Bridge 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.

5. Field welding is prohibited unless specifically shown in the plans.

6. a. Field welding does not require welder qualification certification.

b. Field welding shall be done in accordance with all other requirements of this Section.

c. Welders shall be experienced in the process, detail, and position to be employed; and the quality of the resulting work will be subject to the Engineer's approval.

d. Welders producing unsatisfactory work will not be allowed to make field welds.

708.02 -- Material Requirements

1. Materials shall conform to the requirements in Table 708.01.

Table 708.01

Material Requirements	
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. a. The Contractor shall furnish to the Engineer 2 copies of all mill orders or 2 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 NDR 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 deterioration by rust or loss of minor parts. 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 A 325/A 325M Type 3.

9. a. This specification covers swedged anchor bolts, nuts and washers for use on bridge bearing devices.

b. Requirements

(1) Anchor Bolts

(i) Unless specified otherwise on the plans or in the contract, anchor bolts shall conform to the requirements of ASTM A307, Grade A.

(ii) Coating. The anchor bolts shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(iii) Threads. Anchor bolts shall be threaded to the length shown on the plans. 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).

(iv) 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.

(2) Nuts

(i) Dimension. Nuts for anchor bolts shall be Heavy Hex nuts as specified in ANSI B18.2.2.

(ii) Strength. Nuts shall comply with the proof load or Brinell hardness requirements of ASTM A307.

(iii) Threads. Threads shall be the Coarse Thread series as specified in ANSI B1.1.

(iv) Coating. The nuts and washers shall be hot-dipped galvanized after fabrication. The galvanizing shall comply with the requirements of ASTM A153.

(v) 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.

(3) Washers

(i) 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:

1.	Inside diameter	± 1/16 inch (1.6 mm)
2.	Outside diameter	± 1/18 inch (1.4 mm)
3.	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 may 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 NDR Materials and Research Division for testing.

12. a. For prestressed concrete girder structures, all structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A 709/A 709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A 123.

b. Bolts, nuts, and washers used to install and assemble steel diaphragms shall conform to ASTM A 325M or ASTM A 325 and shall be galvanized in accordance with ASTM A 153.

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 plans.

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. (1) The work quality and finish shall equal or exceed ANSI, AASHTO, and AWS Standards.

(2) Shearing, thermal cutting, and chipping shall be done accurately; and all portions of the work shall be finished neatly.

2. Plans and Working Drawings:

NDR 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 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 percent 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 percent 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.

d. Except where restoration by welding is necessary for structural or other reasons, mislocated holes shall be left open or filled with bolts.

e. (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. (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. 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)
¼ (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 plans.

b. Unless otherwise specified, approved lockwashers 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 plans, 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. (1) The rotational capacity test described in Section 1058 will also be performed by the NDR 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 M 164 (ASTM A 325) by State personnel, they must be sampled by State personnel and submitted to the NDR 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. (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 8.

f. (1) Heavy hex structural bolts and heavy hex nuts shall be required unless other dimensional requirements are stipulated in the plans or special provisions.

(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 percent (but no more than 50 percent) 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 A 325 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 percent of the specified tensile load as shown in ASTM A 325 specifications (tested full size with UNC threads loaded in axial tension), rounded to the nearest kip (kN).

Table 708.03B

Bolt Tension ASTM A 325M 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 percent of the specified tensile load as shown in ASTM A 325 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 or Direct Tension Indicators (DTI).

(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 percent 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).

(2.) Direct Tension Indicators (DTIs)

(i) Self-indicating type DTIs that meet the requirements of ASTM F959/F959M shall be used.

(ii) DTIs shall be installed in accordance with Division II, Article 11.5.6.4.7 of the AASHTO Standard Specifications, 16th edition.

(iii) The Contractor shall provide to the Engineer a detailed inspection instructions prepared by the manufacturer for approval.

(iv) At the start of work, representative samples shall be submitted to the NDOR Materials and Research Division for testing in the tension calibration device to demonstrate that the DTIs supplied are within the compression load ranges in Table 3 of ASTM F959/F959M.

(v) Installation and tightening of individual bolts with DTIs shall be in accordance with manufacturer instructions.

(vi) The Direct Tension Indicators shall be stored in an environment that preserves the surface condition supplied by the manufacturer.

(vii) Reuse of Direct Tension Indicators is not allowed.

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 handled in this manner 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 NDR Materials and Research Division. Such devices must be submitted to the Department about 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, however, 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 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:

[1] Bolts represented by the sample prescribed 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 percent of the bolts, but not less than 2 bolts, selected at random in each connection.

[2] If no nut is turned by this application of the job inspecting 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 inspecting 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 plans 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 plan 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.

b. Cuts shall not go beyond the prescribed 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, except members carrying no calculated stress shall meet a rating of 2,000.

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. Steel Girders:

a. (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 NDR 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.

(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). 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 plans or allowed in the specifications.

f. (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.

(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 plans or in the special provisions.

b. (1) (i) 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 percent 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 prescribed above may be made with the approval of the Engineer.

(2) 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, nor shall the velocity of the air exceed 5 mph (8 km/h) throughout the cooling period.

d. (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. (1) 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.

(2) However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat curving.

(3) If longitudinal stiffeners are required, they shall be heat-curved or thermal-cut separately and then welded to the curved girder.

(4) 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).

(5) 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 prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat curving.

g. (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.

17. Welding:

a. The Contractor shall perform all welding using the shielded metal-arc, submerged arc, gas metal-arc, or flux cored arc process.

b. (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. 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 plans. 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. (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 Standard Specifications.

19. Steel Diaphragms:

a. 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 plans.

b. For prestressed concrete girder structures, all structural steel used in steel diaphragms shall conform to the minimum requirements of ASTM A 709/A 709M, Grade 36 steel, and shall be galvanized in accordance with ASTM A 123.

c. Bolts, nuts, and washers shall conform to ASTM A 325/A 325M and shall be galvanized in accordance with ASTM A 153.

20. Shop and Field Inspection:

a. (1) The Contractor shall give the Engineer 30 days advanced notice of shop work and provide a copy of the anticipated 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.

(2) The Contractor shall perform inspection and testing at least to the extent specified in the AWS Standard Specifications and additionally as necessary to assure conformance with the requirements of the contract documents.

b. (1) 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.

(2) 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.

(3) The office facility shall have a floor area of approximately 110 square feet (10 m^2). It shall be weatherproof, insulated, lighted, and secured. An office key shall be furnished to each assigned inspector.

(4) 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).

(5) 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.

c. 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.

21. 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. (1) When the weight of a member exceeds 3 tons (3 Mg), then the weight shall be marked on the member.

(2) Bolts of one length and diameter and loose nuts and washers of each size shall be packed separately.

(3) 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.

c. The loading, transporting, unloading, and storing of all material shall be conducted so that the material is kept clean and is not damaged.

22. Field Assembly:

a. (1) The Contractor shall request the Engineer's approval of the proposed assembly methods at least 2 NDR 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 plans and specifications.

b. The Contractor's preparation of bearing areas shall include:

(1) 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.

(2) The bearing devices and the bases of columns shall be rigidly and permanently located to the correct alignment and elevations.

(3) 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.

(4) Anchor bolts shall be cast in the concrete as shown in the plans.

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 not likely to 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. (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.

23. Falsework:

Falsework shall be designed, constructed, and removed as prescribed in Subsection 704.03, Paragraphs 7. and 9.

24. 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 plans.

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 plans.

b. The weight of structural steel shall be computed by the Department on the basis of the dimensions shown in the plans.

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 prescribed in this Section.

SECTION 709 -- PAINTING

709.01 -- Description

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. Paint systems and paint materials shall be on the NDR Approved Products List or as specified in the special provisions.

2. The Contractor shall furnish the paint manufacturer's certification that the paint complies with the paint system specified.

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 specifications and the special provisions.

(2) All new structural steel work, unless otherwise specified, shall be painted with a prime coat and a final coat.

(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, 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 Steel Structures Painting Council Specifications (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. The normal profile height shall be 1 to 2 1/2 mils (25 to 63 µm).

(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 percent 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 and painted 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 solvent.

(6) The cleaning shall be approved 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) (i) 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.

(ii) 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 specifications.

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 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 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) (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 these *Specifications*.

(iii) Written documentation of measurements taken shall be provided to the Engineer.

(5) The Contractor shall thoroughly blast clean and repaint all metal coated with unacceptable paint at no additional cost to the Department.

(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.

e. Shop Painting:

(1) When all fabrication work is completed and has been accepted, 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, measured over the peaks of any blast profile or surface projections, shall be 3 mils (75 µm). The maximum dry-film thickness shall not exceed 6 mils (150 µm).

(3) The dry-film thickness of the prime coat shall be 1 to 4 mils (25 to 100 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).

(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 approved 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 3 mils (75 µm).

(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, allay 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.

g. Protection of Property:

(1) The Contractor shall take all necessary precautions during cleaning, surface preparation, and painting to protect people, vehicles, and all property in the vicinity from damage or disfigurement by paint or paint materials.

(2) Any damage or injury to people, vehicles, or property, public or private, and all damage claims which arise shall be the sole responsibility of the Contractor.

2. The Contractor shall overcoat existing structural steel as follows:

a. General:

(1) All painting shall be done in strict compliance with the paint manufacturer's specifications and the special provisions.

(2) All existing steel structures, unless otherwise specified, shall be painted with a three coat system.

(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; and all debris or waste shall be contained, collected, and disposed of in accordance with the special provisions for "Environmental Protection".

(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".

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.

(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 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) (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 these *Specifications*.

(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) Concrete at all junction points of concrete and steel shall be adequately shielded or otherwise protected so that the application of paint on the steel is full and complete without spraying on the concrete.

(7) If, in the judgement of the Engineer, traffic produces an objectionable quantity of dust, the Contractor shall allay 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.

e. Protection of Property:

(1) The Contractor shall take all necessary precautions during cleaning, surface preparation, and painting to protect people, vehicles, and all property in the vicinity from damage or disfigurement by paint or paint materials.

(2) Any damage or injury to people, vehicles, or property, public or private, and all damage claims which arise shall be the sole responsibility of the Contractor.

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 battens 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.

f. All shipping and job site storage and handling details shall be presented to the Engineer and must be approved before shipping any steel.

4. Cleaning Weathering Steel:

a. All surfaces of the girders, including all splice plates and the contact surfaces of all bolted splices, shall be blast cleaned by the Contractor in accordance with Steel Structures Painting Council Specification SSPC-SP6, Commercial Blast Cleaning. The cleaning 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

"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 prescribed in this Section.

SECTION 710 -- CONCRETE BRIDGE DECK REPAIR WITH SILICA FUME CONCRETE

710.01 -- Description

1. This work shall consist of the removal of the existing deck surfacing, resurfacing with silicia fume (SF) concrete, and other incidental work as shown in the plans.

2. A pre-placement conference at a time mutually agreed upon shall be held before the initial placement of SF concrete. Representatives of the admixture manufacturers, the concrete producer, the Contractor, and the NDR Concrete Materials Section shall meet with the project manager 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.

710.02 -- Material Requirements

1. a. 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
Silica Fume	1009

b. Coarse aggregate for use in SF concrete shall be at a moisture greater than or equal to saturated surface dry for the 24 hour period before it is used.

2. Grout for bonding plastic concrete to cured concrete shall be SF concrete without coarse aggregates. The grout shall be applied to the old concrete surface in a thin, even coating using a stiff broom. The aggregate in the concrete shall be broomed into piles and removed from the deck before the placement of the new concrete. For sealing vertical joints, this concrete may be thinned to a consistency similar to common house paint.

710.03 -- 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 with a weight 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 with a weight 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. a. The placing and finishing equipment shall include adequate hand tools for brooming in the grout and 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.

b. (1) An approved finishing machine shall be used. It shall comply with the requirements of Section 603 and the following additional requirements. The machine shall be inspected and approved in advance of the start of concrete placement.

(2) The finishing machine shall be self-propelled, capable of forward and reverse movement under positive control.

(3) The finishing machine shall be equipped to travel on rails. Rails shall be sufficiently rigid that they will not deflect under the weight of the

machine. 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.

(4) 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.

(5) 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 (150 mm) 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 (25 mm).

4. a. The Contractor shall proportion, mix, place, and finish at least 2 1/2 CY/h (1.9 m^3/h).

b. The finishing machine shall be operated so that the time between depositing the concrete on the deck and finishing shall not exceed 10 minutes.

710.04 -- Construction Methods

1. Concrete Removal Requirements:

a. (1) The Contractor shall remove, scarify, and/or chip the old concrete deck to the depths indicated in the plans and until all unsound concrete is removed. Where scarify equipment cannot be used, hand chipping will be required.

(2) (i) At points where removal of unsound concrete is adjacent to reinforcing bars or the removal of active corrosion leaves over two-thirds of the bar diameter exposed, the removal shall be continued to a depth that will allow new concrete to bond to the entire periphery of the exposed bar.

(ii) At least 3/4 inch (19 mm) clearance shall be required around the bar.

(iii) Care shall be exercised to prevent cutting or otherwise damaging any exposed reinforcing bars.

(3) 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.

(4) The Contractor shall take the necessary precautions to prevent damage to persons or property beneath the structure from falling rubble.

b. 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 plans (varies with each project).

(2) Class II Repair - covers concrete removal from the lower limit shown in the plans for Class I Repair to the mid-depth of the slab.

(3) Class III Repair - covers concrete removal depths from the mid-depth of the slab through the entire remaining deck.

c. 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 percent 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 shall be repaired by the Contractor at no additional cost to the Department.

d. (1) Wherever removal of unsound concrete extends to a depth exceeding 50 percent 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.

e. 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. 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.

c. All debris and rubble resulting from deck removal shall be thoroughly swept up and disposed of in a manner satisfactory to the Engineer.

d. 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.

3. Proportioning and Mixing:

a. Measuring and handling materials shall meet the requirements of National Ready Mixed Concrete Association's *Quality Control Manual*, Section 3.

b. (1) The suggested batching sequence is as follows:

(i) Put in 75 percent of the water with the air entrainer and water reducer.

(ii) Add in silica fume and mix for 50 revolutions.

(iii) Batch aggregates and cement.

(iv) Add remaining water and mix for 20 revolutions.

(v) The high range water reducer may be added on the project site during Step (ii), if necessary. Air entraining admixture may be added at the project site if the supplier has approval from the NDR Materials and Research Division.

(2) The Contractor must demonstrate to the Engineer the procedure for adding air entraining high range water reducing admixtures. 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 5 inches (125 mm). There shall not be more than 2 inches (50 mm) 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 proportioning report.

e. (1) A 2.5 cubic yard (2 cubic meter) trial placement is required if either the Contractor or production facility have not used silica fume concrete in the past year. If a new batching sequence is being used, a trial batch shall be produced to ensure proper mixing. Trial batches shall not be paid for directly by the Department of Roads.

(2) Removal of the trial batches is the responsibility of the Contractor.

4. Placing and Finishing Requirements:

a. (1) The Contractor shall thoroughly clean the deck, then saturate it with water 2 hours before concrete placement. Immediately before applying the grout, the deck shall be in a damp condition. Any excess water shall be removed.

(2) Immediately ahead of concrete placement, the entire surface shall be thoroughly covered with a thin layer of grout. Grout shall be thoroughly scrubbed into the wet surface with a stiff broom. The rate of progress shall be limited so that the broomed grout does not dry out before it is covered with the concrete. Grout that is allowed to become dry and chalky shall be blast cleaned and replaced at no additional cost to the Department.

(3) (i) Concrete placement shall be continuous.

(ii) Fresh concrete 3 inches (75 mm) or more in thickness shall be internally vibrated in addition to surface screeding.

(iii) 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.

(iv) The addition of water directly to the surface during the finishing operations will not be allowed. Humidity shall be maintained above the surface of the concrete by an approved fogging system capable of maintaining a constant fog over the entire surface of the fresh concrete until the curing cover is applied. Sprinklers are not allowed.

(4) The elapsed time between depositing the concrete on the deck and screeding shall not exceed ten minutes.

(5) Use of approved admixture finishing aids is allowed but shall not be used in place of fogging.

(6) (i) During delays of 30 minutes or less, the placement shall be protected from drying by fogging.

(ii) If the concrete placement is delayed more than 30 minutes, further placement shall be discontinued and may be resumed only after 48 hours of cure have elapsed. This restriction does not prohibit continuation of the placement provided a gap is left in the placement. This gap shall be sufficient in length to allow the finishing machine to clear the previously placed concrete.

b. (1) The floor surface shall be tested for smoothness with a 10 foot (3 m) straightedge while the concrete is still plastic.

(2) The straightedge shall be held in successive positions parallel to the road centerline and in contact with the surface.

(3) The whole area shall be tested from one side of the floor to the other as necessary. The straightedge shall be advanced along the deck in successive stages of not more than one half its length.

(4) Any depressions found shall be immediately filled with freshly mixed concrete, struck off, and refinished. High areas shall be cut down and refinished.

(5) The straightedge testing and refloating shall continue until the entire surface has no deviations from the straightedge that are greater than 1/8 inch (3 mm) and the floor has the required grade and contour.

(6) When the surface area is so small it will not allow use of a 10 foot (3 m) 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 (3 mm) in 10 feet (3 m).

c. 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 47BD concrete in compliance with the pertinent provisions of these *Specifications*.

d. Partial placements shall be given a 72-hour wet-burlap cure and shall be sandblasted and cleaned before proceeding with the general concrete overlay.

e. (1) Longitudinal construction joints shall be provided as shown in the plans. 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) (i) A transverse construction joint shall be constructed in case of a delay in the placement operations exceeding 30 minutes.

(ii) Transverse construction joints shall be minimized.

(iii) These joints shall be made against a bulkhead.

(iv) These joints must be sawed back as described in this Subsection.

(3) Bulkheads or steel dam plates to be used at roadway joints shall be installed to accurate grade and crown.

(4) 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.

(5) 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.

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. Forms shall be provided in areas of Class III 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.

h. 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.

i. (1) The Contractor shall finish concrete bridge decks with an approved mechanical, self-propelled finishing machine.

(2) 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.

(3) (i) The machine shall be supported on adjustable rails or tracks of sufficient strength to prevent deflection between rail supports.

(ii) Preferably, the rails shall 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 (50 mm) 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.

(4) 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.

(5) 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.

j. (1) (i) 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.

(ii) The texturing requires 1/8 inch (3 mm) deep transverse grooves approximately 1/8 inch (3 mm) wide and spaced at 1/2 to 3/4 inch (13 to 19 mm) on center.

(iii) 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.

(iv) The textured surface shall be discontinued 2 feet (600 mm) from the bridge curb.

k. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout.

l. (1) (i) The surface shall be covered with wet burlap as soon as it will support a single layer of wet burlap without deformation.

(ii) Care shall be exercised to ensure that the burlap is well drained and that the surface is not damaged.

(iii) The surface shall be fogged until burlap can be supported.

(2) The Contractor shall cure the concrete with wet burlap for at least 120 hours. The burlap shall be kept continuously wet by means of a sprinkling or wetting system. However, after 96 hours, the Contractor may

cover the wet burlap with a layer of 4 mils (minimum) polyethylene film for a minimum of 24 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.

(3) Hours during which the temperature is below 50°F (10°C) will not be counted as acceptable curing hours, and the curing period shall be extended accordingly.

m. 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 (3625 kg) wheel load or a 16,000 pound (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.

n. 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.

o. The bridge deck may be opened to traffic after 120 hours of acceptable cure time.

p. (1) Class SF concrete for bridge deck overlays shall be placed when the rate of evaporation will not exceed 0.15 lb/SF/h (0.75 kg/m^2/h).

(2) The rate of evaporation will be obtained by measuring the relative humidity near the deck, the wind velocity, the air temperature, and the deck temperature.

(3) The concrete mix temperature will be used in place of the deck temperature once placement has begun.

(4) If the rate of evaporation exceeds 0.15 lb/SF/h (.75 kg/m^2/h), fogging shall be required and the Contractor must notify the Engineer regarding additional actions that will be taken to prevent plastic shrinkage cracking. One such action may be covering the surface of the fresh concrete with white pigmented curing compound; this shall not be used in place of fogging.

(5) The rate of evaporation shall be obtained by using the nomograph shown in Figures 710.01a and 710.01b.

q. (1) Furthermore, Class SF concrete for bridge deck overlays shall not be placed when the ambient air temperature is above 77°F (25°C).

(2) Unsuitable climatic conditions may require that the concrete be placed at night.

(3) The Contractor shall provide adequate lighting for any night work.

5. The Contractor shall paint all exposed metal, except weathering grade steel, as prescribed in Section 709.

6. Acceptance:

a. Compressive strength tests shall be made in accordance with AASHTO T 22. The 7-day compressive strength shall be 5,000 psi (35 MPa).

b. (1) Before opening for traffic, the new overlay will be examined by the Engineer using visual and sounding techniques. All areas that either display cracks or that are not bonded to the underlying deck will be removed and repaired as specified for Class II Repair.

(2) All small cracks that are not significant enough to require removal of the overlay shall be filled completely with an approved crack filler in accordance with the manufacturer's recommendations.

c. (1) The Contractor shall take every reasonable precaution to produce a smooth-riding concrete surface.

(2) Immediately after the curing period is completed, the deck surface shall be tested for surface irregularities with a 10 foot (3 m) straightedge or other device for measuring deviations from a plane. High spots in excess of 1/8 inch (3 mm) in 10 feet (3 m) shall be plainly marked. The Contractor shall eliminate such high spots by the use of approved grinding tools or other approved methods.

(3) The surfaces adjacent to longitudinal construction joints shall also match within 1/8 inch (3 mm). Irregularities greater than 1/8 inch (3 mm) shall be removed by grinding to provide a smooth transition over the joint.

d. Surface defects shall be corrected by the Contractor at no additional cost to the Department.

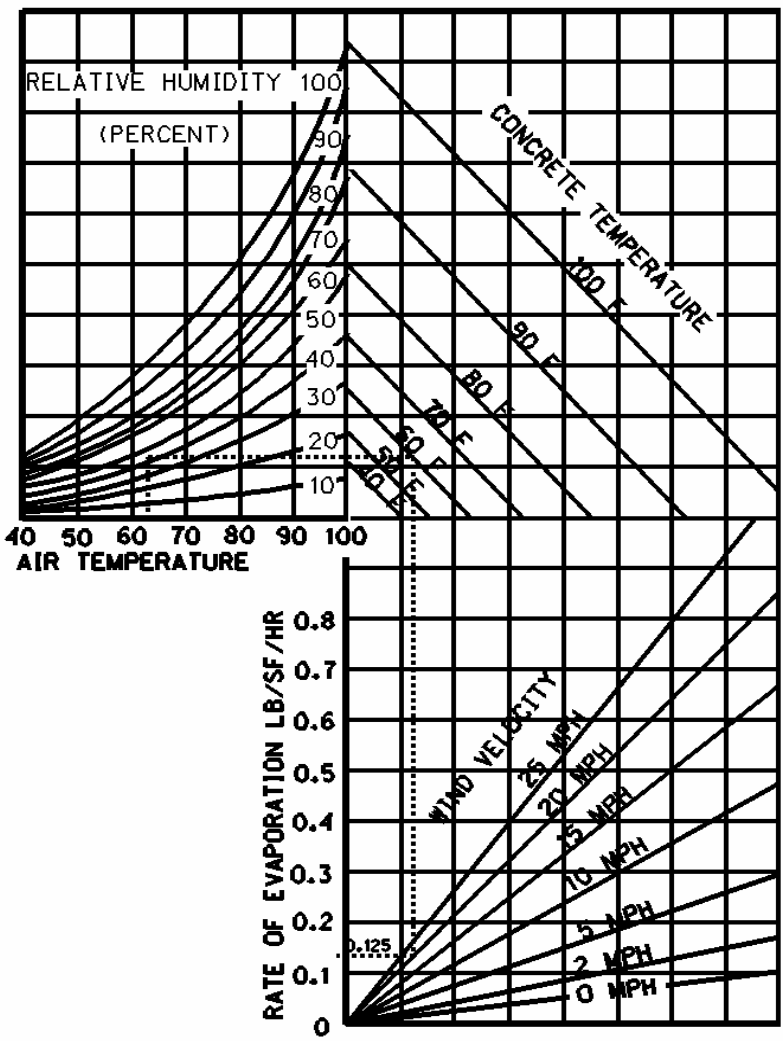
710.05 -- Method of Measurement

1. "Class I Repair", "Class II Repair", and "Class III Repair" 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.

2. "Placing, Finishing, and Curing Concrete Overlay - SF" will be measured for payment by the square yards (square meters) of deck surface overlayed as determined by field measurement.

Figure 710.01a

EVAPORATION NOMOGRAPH



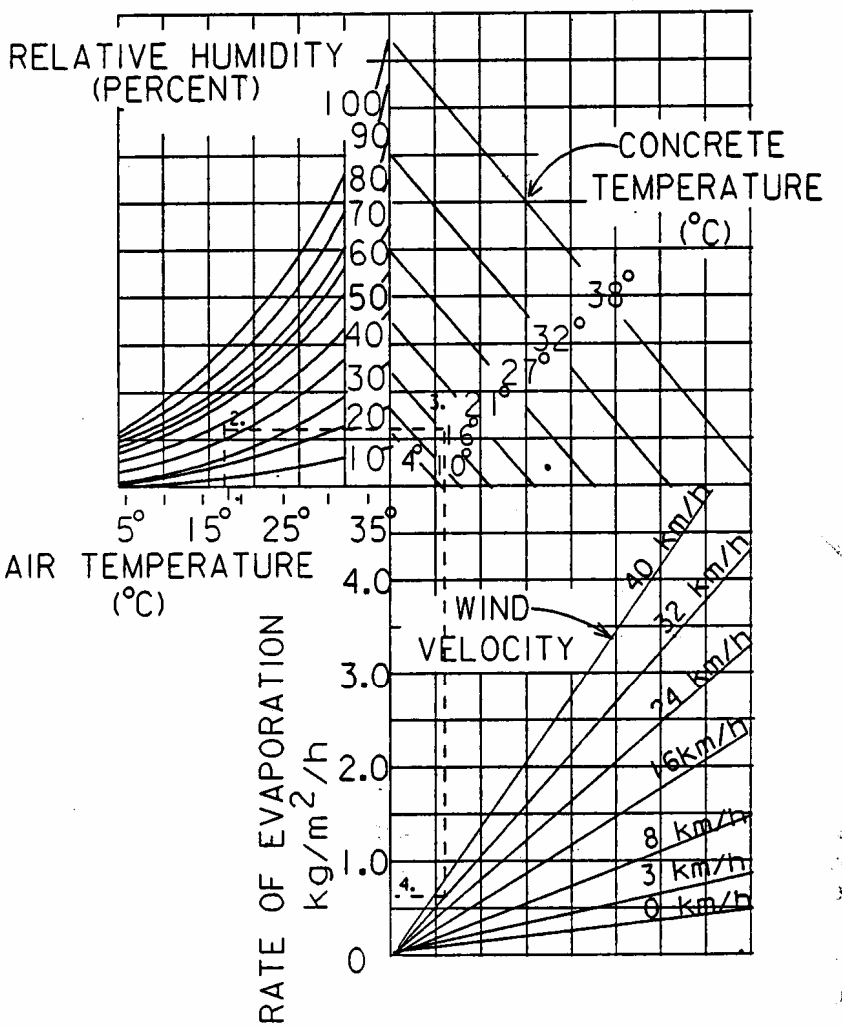
TO USE THIS CHART:

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 710.01b

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 approximate rate of evaporation.

IF THE EVAPORATION RATE EXCEEDS 0.75 kg/m^2/h, THEN THE CONTRACTOR SHALL TAKE ACTIONS TO PREVENT PLASTIC SHRINKAGE CRACKING.

3. "Concrete for Overlay - SF" shall be measured for payment by the cubic yards (cubic meters) 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. "Trial Placement" is measured by the each. A trial placement shall include the 2.6 cubic yards (2 m^3) of concrete and all work for forming, placing, finishing, and curing the placement sample.

710.06 -- Basis of Payment

1. **Pay Item** **Pay Unit**

Class I Repair	Square Yard (SY) [Square Meter (m^2)]
Class II Repair	Square Yard (SY) [Square Meter (m^2)]
Class III Repair	Square Yard (SY) [Square Meter (m^2)]
Placing, Finishing, and Curing Concrete Overlay - SF	Square Yard (SY) [Square Meter (m^2)]
Concrete for Overlays - SF	Cubic Yard (CY) [Cubic Meter (m^2)]
Trial Placement	Lump Sum (LS)

2. See Sections 602 and 603 for smoothness, quality, and thickness pay factors.

3. a. "Trial Placement" is only paid for once no matter how many trial placements are necessary to demonstrate that the system works.

b. When the trial placement must be removed, the removal is subsidiary to "Trial Placement".

4. The Contractor shall make arrangements for the admixture manufacturer and the concrete producer representatives to attend the pre-placement conference at no additional cost to the Department.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 711 -- CONCRETE BRIDGE DECK REPAIR WITH HIGH DENSITY-LOW SLUMP CONCRETE

711.01 -- Description

1. This work shall consist of repairing the existing concrete bridge deck, resurfacing with high density-low slump concrete, and other incidental work shown in the plans.

2. A pre-placement conference at a time mutually agreed upon shall be held before the initial placement.

711.02 -- Material Requirements

1. All 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
Fine Aggregate for Concrete Bridge Deck Overlays	1033
Coarse Aggregate for Concrete Bridge Deck Overlays	1033
Water for Concrete	1005

2. The concrete for bridge deck repair and resurfacing shall be High Density-Low Slump Concrete, and it shall be proportioned and mixed at the job site.

3. a. Grout for bonding new concrete to existing concrete shall consist of equal parts by weight of portland cement and sand, mixed with sufficient water to form a stiff slurry. The consistency of this slurry shall be such that it can be applied using a broom or brush in a thin, even coating that will not run or puddle in low spots.

b. For sealing vertical joints, this slurry may be thinned to a consistency similar to common house paint.

c. Sand used for grout shall meet the following gradation requirements in Table 711.02.

Table 711.02

Grout Sand Gradation		
Percent Passing		
Sieve Size	**Target Value**	**Tolerance**
No. 4 (4.75 mm)	100	None
No. 10 (2.00 mm)	85	± 5
No. 30 (600 µm)	57	±18
No. 200 (75 µm)	3	± 3

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 or fractured particles from the prepared concrete surface.

d. Power-driven hand tools will be allowed with the following restrictions:

(1) Jackhammers weighing more than a 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 weighing more 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 proportioning and mixing equipment shall be a self-contained, mobile, continuous-type mixer complying with the requirements of Section 1002.

4. a. The placing and finishing equipment shall include adequate hand tools for brooming in the grout and for distributing the stiff, 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.

b. (1) An approved finishing machine equipped with at least one screed shall be used. It shall comply with the requirements of Subsection 603.03 and the following additional requirements. The machine shall be inspected and approved in advance of the start of concrete placement.

(2) 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.

(3) The finishing machine shall be equipped to travel on rails. Rails shall be sufficiently rigid that they will not deflect under the weight of the machine. 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.

(4) 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.

(5) At least 1 oscillating screed shall be designed to consolidate the concrete by vibration to 98 percent of the maximum unit weight determined in accordance with NDR T 121. The degree of consolidation shall be measured by nuclear density methods in accordance with NDR T 525.

(6) A sufficient number of identical vibrators shall be installed such that at least 1 vibrator is provided for each 5 feet (1.5 m) of screed length. The bottom face of this screed shall be at least 5 inches (125 mm) wide with a rounded or turned-up leading edge to minimize tearing the surface of the plastic concrete.

(7) Each screed shall weigh at least 75 pounds for each square foot (370 kg for each square meter) of bottom face area and shall have positive control of the vertical position, angle of tilt, and the shape of the crown.

(8) Design of the finishing machine and associated equipment shall be such that positive machine screeding of the plastic concrete will be obtained within 1 inch (25 mm) of the face of existing curbs. The length of the screed shall be sufficient to extend at least 6 inches (150 mm) 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 (25 mm).

5. a. The Contractor shall proportion, mix, place, and finish at least 2.5 CY/h (1.9 m^3/h).

b. The finishing machine shall be operated so that the time between depositing the concrete on the deck and screeding shall not exceed 5 minutes.

711.04 -- Construction Methods

1. Concrete Removal Requirements:

a. (1) The Contractor shall remove, scarify, and/or chip the old concrete deck to the depths indicated in the plans and until all unsound concrete is removed. Where scarifying equipment cannot be used, hand chipping will be required.

(2) (i) At points where removal of unsound concrete is adjacent to reinforcing bars or the removal of active corrosion leaves over 67 percent of the bar diameter exposed, the removal shall be continued to a depth that will allow new concrete to bond to the entire periphery of the exposed bar.

(ii) At least 3/4 inch (19 mm) clearance shall be required around the bar.

(iii) Care shall be exercised to prevent cutting or otherwise damaging any exposed reinforcing bars.

(3) 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.

(4) The Contractor shall take the necessary precautions to prevent damage to persons or property beneath the structure from falling rubble.

b. 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 plans (varies with each project).

(2) Class II Repair - covers concrete removal from the lower limit shown in the plans for Class I Repair to the mid-depth of the slab.

(3) Class III Repair - covers concrete removal depths from the mid-depth of the slab through the entire remaining deck.

c. 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 percent 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 at no additional cost to the Department.

d. (1) Wherever removal of unsound concrete extends to a depth exceeding 50 percent 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 judgement, the concrete quality and structural integrity of the remaining thickness requires full depth removal.

e. 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. 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.

c. All debris and rubble resulting from deck removal shall be thoroughly swept up and disposed of in a manner satisfactory to the Engineer.

d. Any areas of the prepared deck surface contaminated by oil leaks or substances detrimental to the good bond shall be thoroughly cleaned by an approved detergent method or shall be removed to such a depth as may be necessary.

3. Proportioning and Mixing:

a. (1) The Contractor shall keep aggregate moisture content of successive batches within 0.5 percent.

(2) Continuous mixers shall be charged at the site or may be charged at other locations subject to the approval of the Engineer.

b. (1) The concrete, as discharged from the mixer, shall be uniform in composition and consistency. Mixing capability shall be such that finishing operations can proceed at a steady pace with final finishing completed within 10 minutes after depositing the concrete.

(2) Testing for slump from a continuous mixer shall commence within 2 to 4 minutes after the concrete is discharged and shall be performed as frequently as necessary to maintain control. The slump shall conform to the requirements of Section 1002.

(3) If required by the Engineer, uniformity tests shall be made according to ASTM C 685 and shall meet the requirements of ASTM C 685 Table A1.

4. Placing and Finishing Requirements:

a. (1) Longitudinal construction joints shall be located as shown in the plans. If not shown, locations will be subject to the Engineer's approval. Joints shall not be located in the traffic wheel paths.

(2) Transverse construction joints shall be avoided. If required, such joints shall be made against a bulkhead equal to the overlay thickness and installed to accurate grade and crown.

(3) Bulkheads or steel dam plates to be used at roadway joints shall be installed to accurate grade and crown.

(4) 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.

(5) 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.

(6) At transverse and longitudinal construction joints, the edge of the previously placed lane shall be sawed back to a straight and vertical edge before the abutting lane is placed. Slurry from wet sawing shall be thoroughly removed from the prepared deck surface.

(7) Forms shall be provided in areas of Class III Repair requiring full depth slab replacement. Forms for small areas (1 square yard (0.8 m^2) or less) may be wired to the reinforcing bars for support. Forms for larger areas shall be supported by blocking from the beams.

b. The mixer may be positioned on the prepared deck to discharge the concrete directly in front of the finishing machine or may be located off of 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.

c. (1) Immediately before applying grout in preparation for placing new concrete, the surface shall be cleaned with air blast. To promote absorption of the grout, the surface shall be dry and not prewetted.

(2) Immediately ahead of concrete placement, the dry surface shall be thoroughly covered with a thin layer of grout. Grout shall be scrubbed into the surface with a stiff broom. The rate of progress in applying grout shall be limited so that grout does not become dry before being covered by the new concrete. Grout that is allowed to become dry and chalky shall be blast cleaned and replaced at no additional cost to the Department.

(3) The Contractor shall place concrete in a continuous operation throughout the pour. Fresh concrete 3 inches (75 mm) or more in thickness shall be internally vibrated in addition to surface screeding. The concrete shall be manipulated and mechanically struck off slightly above grade. It shall then be mechanically consolidated to the specified density and screeded to final grade. Hand finishing with a wood float may be required for producing a tight uniform surface. The provisions of Subsection 603.03, Paragraph 5. shall be strictly observed. The addition of water directly to the surface during the finishing operations will not be allowed. Use of approved admixture finishing aids is allowed.

(4) The Contractor shall test the floor surface for smoothness with a straightedge while the concrete is still plastic. For this purpose, the Contractor shall furnish and use an accurate straightedge 10 feet (3 m) long, swung from handles 3 feet (0.9 m) longer than one half the width of the floor.

(5) (i) The straightedge shall be held in successive positions parallel to the road centerline and in contact with the surface and the whole area gone over from one side of the floor to the other as necessary.

(ii) The straightedge shall be advanced along the deck in successive stages of not more than one half its length.

(iii) Any depressions found shall be immediately filled with freshly mixed concrete, struck off, and refinished.

(iv) High areas shall be cut down and refinished.

(v) The straightedge testing and refloating shall continue until the entire surface has no deviations from the straightedge that are greater than 1/8 inch (3 mm) and the floor has the required grade and contour.

(vi) When the required grade or contour of the floor is such that the use of a 10 foot (3 m) straightedge is not feasible for testing the trueness of the surface, 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 (3 mm) in 10 feet (3 m).

(6) (i) A construction dam or bulkhead shall be installed when there is a 60 minute delay in placing concrete. The Contractor shall saw the end of the concrete to remove back to good concrete. Placement in this lane shall resume only after a period of 12 hours or may resume sooner provided a gap is left in the lane or strip being placed that is large enough for the finishing machine to clear the previously placed concrete.

(ii) During delays from 20 to 60 minutes, the end of the concrete shall be kept under wet burlap.

(7) (i) Individual areas of Class III Repair requiring full depth slab placement shall be poured on forms. Any areas exceeding 1 square yard (0.8 m^2) will require 2-stage concrete placement. The first stage shall be poured up to the lower limit of Class I Repair area or to match adjacent areas of Class II Repair. This partial placement shall be made with Class 47BD-5,075 concrete in compliance with the pertinent provisions of these *Specifications*.

(ii) Partial placements shall be given a 72-hour wet-burlap cure and shall be surface dried, sandblasted, and cleaned before proceeding with the general concrete overlay.

d. The surface shall be textured with a tining rake as prescribed in Subsection 706.03, Paragraph 8.b.(1-4).

e. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout.

f. The surface shall be promptly covered with a single layer of clean, wet burlap. Care shall be exercised to ensure that the burlap is well drained and that it is placed as soon as the surface will support it without deformation.

g. The Contractor shall cure the concrete with wet burlap for at least 72 hours. The burlap shall be kept continuously wet by means of a sprinkling or wetting system. However, after 24 hours, the Contractor may cover the wet burlap with a layer of 4 mils (minimum) polyethylene film for a minimum of 48 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.

h. Hours during which the temperature is below 45°F (7°C) will not be counted as acceptable curing hours, and the curing period shall be extended accordingly.

i. Failure to apply the wet burlap within 30 minutes after concrete has been deposited on the surface shall be cause for rejecting the work. If the concrete is revibrated due to failure to meet density requirements with initial vibration, this time limit may be extended 15 minutes. Surface concrete in a rejected area shall be removed and replaced by the Contractor at no additional cost to the Department.

5. Limitations of Operations:

a. The Contractor shall take every reasonable precaution to produce a smooth-riding concrete surface.

b. (1) Immediately after the curing period is completed, the Contractor shall test the deck surface for surface irregularities with a 10 foot (3 m) straightedge or other device for measuring deviations from a plane. High spots in excess of 1/8 inch (3 mm) in 10 feet (3 m) shall be marked.

(2) The Contractor shall eliminate such high spots by the use of approved grinding tools or other approved methods.

(3) The cause of such irregularities shall be determined and eliminated.

c. The surfaces adjacent to longitudinal construction joints shall match within 1/8 inch (3 mm). Irregularities greater than 1/8 inch (3 mm) shall be removed by grinding to provide a smooth transition over the joint.

d. 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 a 8,000 pound (3625 kg) wheel load or a 16,000 pound (7250 kg) axle load. Any combination of axles closer than 4 feet (1.2 m) center-to-center will be considered to be 1 axle.

e. The bridge deck may be opened to traffic after the conclusion of the 72-hour curing period or the extended curing time, if necessary, due to low temperatures.

f. 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.

g. Concrete shall not be placed at temperatures lower than 45°F (7°C). Placement may begin at that temperature if the temperature is predicted to rise and remain at least 45°F (7°C) for the first 8 hours of the curing period.

h. High density-low slump concrete for bridge deck overlays shall not be placed when the anticipated wind velocity during the concrete placement period is expected to exceed the requirements shown in Table 711.03.

Table 711.03

Maximum Wind Velocity and Temperature	
Air Temperature In the Shade	**Maximum Wind Velocity**
86°F (30°C)	10 mph (16 km/h)
75°F (24°C)	15 mph (24 km/h)
65°F (18°C)	20 mph (32 km/h)

i. (1) The high density-low slump concrete for bridge deck overlays shall not be placed when the ambient air temperature is above 86°F (30°C) or the concrete temperature is above 86°F (30°C).

(2) Climatic conditions may require that concrete placements be made in the early morning hours or at night.

(3) The Contractor shall provide adequate lighting for all night work.

j. Concrete shall not be placed adjacent to a previously placed lane or strip which is less than 36 hours old. This restriction shall not apply to continuation of a lane or strip beyond a joint in the same lane or strip.

k. (1) Deck preparation work may be started in a lane adjacent to a newly overlaid lane on the day following the concrete placement provided no power-driven tools weighing more than 15 pounds (7 kg) shall be used.

(2) Power scarifying and all other preparatory operations may commence only when the previously placed concrete is at least 48 hours old.

(3) Curing shall be resumed promptly.

(4) The exposed surface shall be kept wet during the time it is uncovered.

6. The Contractor shall paint all exposed metal except weathering grade steel as prescribed in Section 709.

7. Density Tests:

a. The finished, in-place concrete overlay shall have a minimum density of 98 percent as determined by NDR T 525. The density tests will be made by the Engineer in "test wells" immediately after passage of the finishing machine.

b. (1) Test wells of sufficient size and depth are necessary for conducting density tests with the nuclear gauge. Test wells shall be approximately 10 inches x 10 inches (250 mm x 250 mm) and of sufficient depth that there will be at least 3 inches (75 mm) of concrete fill at these locations.

(2) The Contractor shall construct the wells. In each lane or strip of overlay placed, test wells shall be located at 5 foot (1.5 m) intervals through the first 3 well locations, beginning at the start of the placement, and then at intervals not exceeding 50 feet (15 m) through the remainder of the placement.

Repair areas at these locations which will provide the sufficient depth of concrete may be substituted for test wells.

(3) The Contractor shall provide a suitable work bridge spanning the concrete placement area to facilitate the testing.

c. (1) Whenever a density test indicates a density less than 98 percent, the Contractor shall reverse the finishing machine to a point equidistant between the test well which produced the unacceptable density test and the nearest location at which an acceptable result was obtained.

(2) The Contractor shall then revibrate the overlay forward to the location at which the unacceptable test result was obtained, at which point a second density test will be made.

(3) Any revibration of previously placed concrete shall be completed before the concrete is 30 minutes old.

(4) Before resuming concrete placement, the cause of the unacceptable results shall be determined and corrected.

711.05 -- Method of Measurement

1. "Class I Repair", "Class II Repair", and "Class III Repair" will be measured for payment by the square yard (square meter) of deck area repaired in accordance with each classification, as determined by field measurements.

2. "Placing, Finishing, and Curing HD Concrete Overlay" will be measured for payment by the square yard (square meter) of deck surface overlayed as determined by field measurements.

3. "Concrete for Overlay - HD" shall be measured for payment by the cubic yard (cubic meter) of concrete placed in the structure. This quantity will be determined from the established relation of concrete yield to the cement meter ticket printout of the properly calibrated continuous mixer. Unacceptable concrete and any waste shall be deducted from the volume for which payment is based.

711.06 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Concrete for Overlay - HD	Cubic Yard (CY) [Cubic Meter (m^3)]
Placing, Finishing, and Curing HD Concrete Overlay	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. See Sections 602 and 603 for smoothness, quality, and thickness pay factors.

3. a. Payment shall be reduced when in-place density is less than the design density as determined by NDR T 525.

b. Payment shall be made as prescribed in Table 711.04.

Table 711.04

Density Pay Factor	
In-Place Density (Percent)	**Authorized Payment as Percent of Unit Cost**
100 to 98	100
Less than 98 to 97.00	50
Less than 97.00	0 (Reject)

c. For purposes of determining the quantity of deficient or unacceptable concrete, it will be considered that the density at any test well is representative of the material contained within a length of deck, for each individual width of placement, equal to the sum of one-half the distance to each adjacent test well.

4. a. Whenever a density test indicates a density less than 98 percent, a second test will be taken after reversing the finishing machine.

b. If the second density test indicates a density of 97.5 percent or greater has been obtained, the concrete can remain in place without a penalty to the Contractor.

c. If the second density test indicates a density between 97.00 percent and 97.49 percent has been obtained, that portion of the overlay can remain in place subject to the pay reductions described in this Subsection.

d. If the second density test indicates a density of less than 97.00 percent has been obtained, the work shall be discontinued and the concrete overlay removed back to a point equidistant between the test well having produced the density of less than 97.00 percent and the nearest location at which an acceptable density test was obtained.

5. Class 47BD-5,000 (47BD-35) concrete used in partial placements is measured for payment by the cubic yard (cubic meter) and included in the quantity "Concrete for Overlay - HD".

6. Payment is full compensation for all work prescribed in this Section.

SECTION 712 -- FIXED BEARINGS AND EXPANSION BEARINGS, TFE TYPE

712.01 -- Description

1. The Contractor shall furnish and install fixed bearings and TFE type expansion bearings at the locations shown in the plans.

2. The fixed bearings and expansion bearings, TFE type, shall consist of the upper and lower assemblies shown in the plans. Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for review.

712.02 -- Material Requirements

1. Fixed Bearings:

a. The upper assembly shall consist of a sole plate conforming to the requirements of ASTM A709/A709M grade 50W (*345W)* weathering steel. As an alternate, the sole plate may be grade 36 (250) steel, metallized. If the grade 36 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 plain steel 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 elastmeric pad (CDP) conforming to the requirements of the current AASHTO *Standard Specifications for Highway Bridges* and the Department of Defense Specification MIL-C-882.

2. Expansion Bearings, TFE Type:

a. (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 (minimum .070 inch (1.78 mm) to maximum .08 inch (2.00 mm) thickness) attached to the lower surface. As an alternate, the sole plate may be grade 36 (250) steel, metallized. If the grade 36 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 plain steel 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.

(2) The face of the stainless steel plate in contact with the TFE sheet shall be polished or rolled as necessary to provide a number 8 mirror finish.

(3) The stainless steel plate shall be attached by welding around its full perimeter.

(4) 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.

(5) The weld shall not extend into the area of contact between the upper and lower assemblies.

b. (1) The lower assembly shall consist of a CDP pad with a 94 mil (2.38 mm) thick, low friction, virgin, unfilled, polytetraflourethylene (TFE) sheet bonded to the upper surface.

(2) Bonding of the TFE 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 TFE sheet to seal out moisture and provide a smooth, flat, slide surface.

(4) The TFE sheet shall conform to the requirements of the AASHTO *Standard Specifications for Highway Bridges* and these *Specifications*.

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 TFE sheet and the stainless steel plate shall be 0.0005 x "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. 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.

6. Shop plans for bridge bearings must include the following notes when applicable.

a. All manufacturing, testing and certification of these materials shall be in accordance with the NDR Standard Specifications, Section 712, “Fixed Bearings and Expansion Bearings, TFE Type”.

b. 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 NDR Specifications.

c. Testing shall be in accordance with the AASHTO Standard Specifications for Highway Bridges.

d. The assemblies shall be suitably packaged to prevent damage during shipment and storage.

e. The stainless steel plate shall be attached to the sole plate by welding around its full perimeter. The weld shall not extend into the area of contact between the upper and lower assemblies.

f. Bonding of the TFE sheet must be complete, without air gaps under the TFE sheet, to seal out moisture and provide a smooth, flat, slide surface.

g. The flatness tolerance for the TFE sheet and the stainless steel plate shall be 0.0005 x “Nominal Dimension”.

712.03 -- Construction Methods

The Contractor shall provide and install the bearing assemblies as prescribed in the plans.

712.04 -- Method of Measurement

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, TFE Type	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 713 -- CONFINED ELASTOMERIC BEARING DEVICES (POT BEARINGS)

713.01 -- Description

This work shall consist of furnishing and installing confined elastomeric bearing devices at the locations shown in the plans. 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 plans or special provisions, the pot bearings shall be designed in accordance with the applicable requirements of the AASHTO *Standard 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. a. Confined elastomeric bearing devices shall be supplied as fixed bearings, guided expansion bearings, and non-guided expansion bearings as shown in the plans.

b. 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.

c. 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 percent 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 PTFE (may be filled or unfilled as per

AASHTO specifications) and stainless steel.

d. 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 percent 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.

c. 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.

d. Inside diameters shall be the same as the elastomeric disc.

e. (1) The pot shall be seated in a machined recess of 0.000125 inch (3.175 µm) 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.

f. 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.

g. Lead sheet used under the masonry plate shall be of the shape and thickness shown in the plans, 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. (1) 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).

(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 piston or top plate.

b. 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.

c. 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.

d. Pistons for round cross section sealing rings shall have the lower outside edge bevelled to accept and retain the ring and allow full design rotation.

e. 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 Fu (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 percent 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 µm) 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 percent.

(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 bevelled edge shall be less than 5/8 inch (16 mm) thick.

g. Guide bar tolerances shall be as follows:

(1) Length: ± 1/8 inch (±3 mm).

(2) Section dimensions: ± 1/16 inch (±1.5 mm).

(3) Flatness, where it bears on another plate: Class "A" tolerance.

(4) Bar-to-Bar tolerance: "Nominal Dimension" ± 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 x "Nominal Dimension".

(2) Class "B": 0.001 x "Nominal Dimension".

(3) Class "C": 0.002 x "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 NDR Materials and Research Division at least 10 NDR 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 percent 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 percent of the minimum vertical design load in combination with 150 percent 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 these *Specifications* to be demonstrated, an additional elastomeric seal test shall be made.

(2) This test shall be conducted by a recognized testing laboratory.

(3) It 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 NDR Materials and Research Division for review and approval.

b. In addition, the manufacturer or their representative must contact the NDR 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

The Contractor shall install elastomeric bearing devices in accordance with the manufacturer's recommendation and as prescribed in the plans.

713.04 -- Method of Measurement

"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 prescribed 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, 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 plans.

2. 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.*

3. The approved proprietary mechanically stabilized earth retaining wall systems are shown on the NDR “Approved Products List”.

4. 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 plans, shall be accounted for in the stability design of the wall.

5. The MSE wall design shall follow the general dimensions of the wall envelope shown in the plans. The plans 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 plans. The top of the face panels shall be at or above the top of the panel elevation shown in the plans. 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. 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.

6. Where walls or wall sections intersect with 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. Corner elements shall not be formed by connecting standard facing panels that abut the acute corner.

7. 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 1.0 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 plans, or determined by the MSE wall supplier, vertical joints to accommodate excessive differential settlement shall be included.

8. Working Drawings and Shop Drawings:

a. The Contractor shall submit to the Engineer for review:

(1) 6 sets of working drawings and shop drawings.

(2) 6 sets of design calculations.

(3) Explanatory notes.

(4) Specifications.

(5) Proposed component materials for the wall system.

b. The shop 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 plans.

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 plans.

f. Leveling pad elevations may vary from footing elevations shown in the plans. However, the leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown in the plans and shall provide 2 foot (600 mm) minimum cover from the top of the leveling pad to finish grade.

g. (1) The Contractor shall not start work on any earth retaining system until the shop drawings and working drawings are reviewed and returned by the Engineer.

(2) 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 plans and specifications.

(3) The Contractor shall allow 30 calendar days for the review of the drawings by the Engineer.

9. Design Requirements:

a. (1) 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:

(i) *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* FHWA-NHI-00-043;

(ii) AASHTO's *Standard Specifications for Highway Bridges,* (Division 1, Section 5 and Division II, Section 7);

(iii) *Design Manual for Segmental Retaining Walls National Concrete Masonry Association,* Washington, D.C.

(2) 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 certification that the wall is designed in accordance with the current AASHTO Standard Specifications for Highway Bridges.

b. The Engineer shall indicate in the contract plans 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.

c. The theoretical failure plane within the reinforced soil mass shall be analyzed so that the soil stabilizing components extend sufficiently beyond the failure plane to stabilize the material. At a minimum, the theoretical failure plane, the structure's mechanical height, and the effective reinforcement pullout length shall be at least as conservative as shown in Figure 5.8.4.1A of AASHTO's *Standard Specifications for Highway Bridges*, (Division I, Section 5). External loads which affect the internal stability, such as those applied through piling, bridge footings, traffic, slope surcharge, and hydrostatic and seismic loads, shall be accounted for in the design.

d. When a highwater surface elevation is shown in the plans 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. This buoyant force from the saturated soil shall be used to calculate internal stability, including pullout resistance.

e. 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 plans. 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 percent maximum density as determined by AASHTO 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 30 degrees unless otherwise shown in the plans.

(1) The optimum moisture content shall be determined in accordance with AASHTO T 99 based on a minimum of 4 percent moisture content.

f. The safety factors for external stability are:

(1) 1.5 for pullout based in pullout resistance at 3/4 inch (19 mm) deformation for a representative backfill.

(2) 1.5 for sliding.

(3) 2.0 for overturning.

(4) 2.0 for panel connection pullout or rupture at the design life for the maximum allowable reinforcement tension.

g. All structural connections shall be subject to the same metal loss rates and allowable tension requirements as outlined in Paragraph 9.j. of this Subsection.

h. 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 $0.7H_1$ for walls with a sloped surcharge or supporting an abutment. The mechanical height, H_1, 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.

i. State of Stress and Pullout Resistance:

(1) The lateral earth pressure to be resisted by the reinforcements shall be calculated using the appropriate coefficient of earth pressure, K, based on the type of reinforcement used, multiplied by the vertical soil stress at each reinforcement layer.

(2) The soil reinforcement length shall be sufficient to satisfy the above requirements, sliding, overturning and pullout factors of safety, and the minimum lengths required for external stability.

(3) For ribbed reinforcing strips, the maximum apparent coefficient of friction, f*, shall be as shown in Table 714.01.

Table 714.01

Maximum Coefficient of Friction	
Uniformity Coefficient (C_u) of Select Granular Backfill	**Maximum f***
Less than 2	1.2
2 to 7	1.5
More than 7	2.0

(4) The maximum values shown in Table 714.01 will be used at the top of the structure and will vary to a value of the tangent of ø at a depth of 20 feet (6 m), and it will remain constant (at tangent of ø) below a depth of 20 feet (6 m). A maximum f* value of 2.0 is justified when using crushed stone backfill with a uniformity coefficient below 7.

(5) For wire mesh or bar mat reinforcement, the maximum anchorage factor, A_c, shall be 30 at the top of the structure and vary to 15 at a depth of 20 feet (6 m), and it will remain constant at 15 below a depth of 20 feet (6 m). The calculation of pullout resistance for wire mesh reinforcement shall be calculated using the diameter of transverse bars remaining at the end of the service life after applying the corrosion rates given in Paragraph 9.j. of this Subsection.

(6) The top of the structure is established as the elevation at the upper limit of the mechanical height, H_1.

(7) Passive pressure in front of the wall mass shall be assumed to be zero for design purposes. Calculations for stresses and factors of safety shall be based on assumed conditions at the end of the design life. Design life shall be 75 years unless otherwise indicated in the plans.

j. (1) For steel reinforcements, including tie strips and loop inserts, the metal loss rates shown in Table 714.02 shall be assumed.

Table 714.02

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):

[1] $F^t = 0.55\ F_y$ at the reduced gross section (minimum cross section).

[2] $F^t = 0.50\ F_u$ at the net section at a bolt hole (applicable to bolted connections only).

(ii) Systems with bar mats or welded wire mesh:

$F^t = 0.47\ F_y$ 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 percent of pullout capacity of the connection devices embedded in facing panels.

714.02 -- 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 which the Contractor based his/her bid on. The supplier shall furnish the Engineer a Certificate of Compliance certifying that the applicable materials comply with Section 714 of the *Specifications*. Materials not conforming to Section 714 of the *Specifications* shall not be used.

2. 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 prescribed 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 shop plans 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 percent of the 28-day strength (4,350 psi) (30 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 plans 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 0.25 inch (6 mm).

g. Tolerances: All units shall be manufactured within the following tolerances with respect to the dimensions shown in the shop plans:

(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 0.25 inch (6 mm) and -.050 inch (-0.12 mm). Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 0.0625 inch (1.5 mm).

(2) Panel Dimensions -- All panel dimensions shall be within 0.25 inch (6 mm). All hardware embedded in the panel, with the exception of attachment devices, shall be within 0.25 inch (6 mm).

(3) Panel Squareness -- Squareness, as determined by the difference between the 2 diagonals, shall not exceed 0.50 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 0.25 inch (6 mm). Surface defects on textured-finished surfaces, measured on a length of 5 feet (1.5 m), shall not exceed 0.3125 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 80 panels or a single day's production, whichever is less.

i. Compressive strength tests shall be performed on 6 inch (150 mm) diameter by 12 inch (300 mm) cylinders prepared 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 4,350 psi (30 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 4,350 psi (30 MPa). If the 28-day compressive strength test result is less than 4,350 psi (30 MPa), the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

(1) 90 percent of the compressive strength test results for all of the production lots shall exceed 4,150 psi (28.6 MPa).

(2) The average of any 6 consecutive compressive strength test results, including the one in question, shall exceed 4,250 psi (29.3 MPa).

(3) No individual compressive strength test result shall fall below 3,900 psi (27 MPa).

m. The date of manufacture, the production lot number, and the structure component shall be clearly indicated on each cylinder.

n. (1) 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.

(2) Panels shall be stored and shipped in stacks, front face down.

(3) Firm blocking of sufficient thickness to prevent damage to the stacked panels shall be provided.

(4) Lifting inserts shall be installed on the top edge of the precast panels to allow lifting at the project site.

(5) 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. (1) The Engineer shall determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection.

(2) Repair of concrete, if allowed, shall be done in a manner satisfactory to the Engineer.

(3) Repair to concrete surfaces which will be exposed to view after completion of construction must be approved by the Engineer.

3. 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 either ASTM A 36/A 36M or ASTM A 572/A 572M Grade 65 or equal. Galvanization shall conform to the minimum requirements of ASTM A 123.

c. Reinforcing mesh and bar mats shall be shop fabricated from cold drawn steel wire conforming to the minimum requirements of ASTM A 82 and welded into the finished mesh fabric in accordance with ASTM A 185. Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of ASTM A 153 or ASTM A 123.

d. The tie strips shall be shop fabricated from hot rolled steel conforming to the minimum requirements of ASTM A 570/A 570M, Grade 50 or equivalent. Galvanization shall conform to ASTM A 123.

e. Fasteners shall consist of hexagonal cap screw bolts and nuts which are galvanized and conform to the requirements of ASTM A 325M (AASHTO M 164) or equivalent.

f. Connector bars and pins shall be fabricated from cold drawn steel wire conforming to the requirements of ASTM A 82 and be galvanized in accordance with ASTM A 123.

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. and 3.d. of this Subsection.

4. a. Joint materials shall be installed to the dimensions and thicknesses shown and in accordance with the plans or reviewed shop plans.

b. Bearing pads shall have a durometer hardness of 80 ± 5.

c. Where required, as shown in the plans, horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile as approved by the wall supplier. 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.

5. a. The select granular backfill material used in the MSE structure shall be reasonably free from organic and otherwise deleterious materials and shall conform to the gradation limits as determined by AASHTO T 27 and shown in Table 714.03.

Table 714.03

Facing Panel Select Granular Backfill Gradation	
Sieve Size	**Percent Passing**
3/4 inch (19 mm)	100
No. 200 (75 µm)	0 to 15

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 sodium sulfate soundness loss of less than 30 percent after 5 cycles, as determined by AASHTO T 104.

(3) The backfill material shall conform to the electrochemical requirements in Table 714.04.

Table 714.04

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

(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 percent of maximum density, as determined by AASHTO T 99, at optimum moisture content, based on a minimum of 4 percent 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).

c. The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be 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*.

d. A copy of all test results performed by the Contractor, which includes: AASHTO T 27, AASHTO T 90, AASHTO 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.

e. Backfill material not conforming to this *Specification* shall not be used without the written consent of both the Engineer and the wall supplier.

714.03 -- Construction Methods

1. Excavation shall be in accordance with the requirements of the plans and specifications.

2. The foundation for the structure shall be graded level for a width equal to or exceeding the length of the soil reinforcement, or as shown in the plans. 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. At each panel foundation level, an unreinforced concrete leveling pad shall be provided as shown in the plans. 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 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 + 0.125 inch (+3 mm) and - 0.25 inch (-6 mm) from the design elevation. The leveling pad shall be cured a minimum of 24 hours before placement of wall panels.

3. Precast concrete panels shall be placed in the vertical orientation as shown in the working drawings. For erection, 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 plans 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 placed in the joint at the junction of the 2 adjacent panels on the external side of the wall. External bracing is required for the initial lift. Vertical tolerances (plumbness) and horizontal alignment tolerances for any one panel shall not exceed 0.75 inch (19 mm). The allowable panel joint gap shall not exceed 0.75 inch (19 mm). The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 0.75 inch per 10 feet (19 mm per 3 m) of wall height.

4. 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 plans 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.

5. a. Backfill placement shall closely follow erection of each course of panels.

b. 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.

c. Any wall elements which become damaged or disturbed during backfill placement shall be either removed and/or replaced by the Contractor at no additional cost to the Department.

d. Any backfill material placed within the reinforced soil mass which does not meet these *Specifications* shall be either removed and/or replaced by the Contractor at no additional cost to the Department.

e. Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO 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 AASHTO T 99 based on a minimum of 4 percent moisture content.

j. The frequency of sampling of the backfill material necessary to assure gradation control throughout construction shall be as directed by the Engineer.

k. 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.

l. 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 plans.

m. 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.

n. Care shall be exercised in the compaction process to avoid misalignment of the panels or damage to the attachment devices. Heavy compaction equipment shall not be used to compact backfill within 40 inches (1 m) of the wall face.

o. 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 plans, 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 NDR Construction Division 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.

714.04 -- Method of Measurement

1. 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 plan quantity. The wall surface area, as shown on the plans, includes the surface area of nominal panel joint openings and wall penetrations such as pipes and other utilities.

2. The quantity of concrete leveling pads shall be measured by the foot (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 plan quantity.

3. a. The quantity of “Select Granular Backfill for MSE Walls" is measured by the cubic yard (cubic meter) and 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 plan quantity. The quantity shown in the plans is based on a volume equal to the height of the wall times the length of the wall times a width equal to 70 percent of the height.

b. The Random Backfill shown in the plans will not be measured for payment, but shall be considered subsidiary to th item “Select Granular Backfill for MSE Walls”.

4. The quantity of "Coping" is measured by the linear foot (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 plan quantity. The coping quantity shall be based on the coping cross-section shown in the plans.

5. "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.

714.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
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 on the plans at the top of wall is subsidiary to the pay item “Coping”.

4. Payment is full compensation for all work prescribed 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 plans.

2. 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*.

3. The approved proprietary mechanically stabilized earth retaining wall systems are shown on the NDR “Approved Products List”.

4. 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 plans, shall be accounted for in the stability design of the wall.

5. The MSE wall design shall follow the general dimensions of the wall envelope shown in the plans. The plans 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 plans. The top of the block units shall be at or above the top of the wall elevation shown in the plans. 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 + ø/2 from the intersection of the back face of the wall with the leveling pad.

6. 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 plans or determined by the MSE wall supplier, vertical joints to accommodate excessive differential settlement shall be included.

7. Working Drawings and Shop Drawings:

a. The Contractor shall submit to the Engineer for review:

(1) 6 sets of working drawings and shop drawings.

(2) 6 sets of design calculations.

(3) Explanatory notes.

(4) Specifications.

(5) Proposed component materials for the wall system.

b. The shop 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 plans.

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) Any additional details pertaining to coping, railing, drainage, or electrical conduit required by the plans.

f. Leveling pad elevations may vary from footing elevations shown in the plans. However, the leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown in the plans and shall provide 2 feet (600 mm) minimum cover from the top of the leveling pad to finish grade.

g. (1) The Contractor shall not start work on any earth retaining system until the shop drawings and working drawings are reviewed and returned by the Engineer.

(2) 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 plans and specifications.

(3) The Contractor shall allow 30 calendar days for the review of the drawings by the Engineer.

8. Design Requirements:

a. (1) 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:

(i) *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines* FHWA-NHI-00-043;

(ii) AASHTO's *Standard Specifications for Highway Bridges,* (Division I, Section 5 and Division II, Section 7);

(iii) *Design Manual for Segmental Retaining Walls National Concrete Masonry Association,* Washington, D.C.

(2) 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 certification that the wall is designed in accordance with the current AASHTO Standard Specifications for Highway Bridges.

b. The Engineer shall indicate on the contract plans 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.

c. 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.

d. 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 percent of the design height as measured from the front face of the wall to the end of the soil reinforcements.

e. Inclination of Failure Surface:

(1) Metallic reinforcements: In design, a bilinear failure surface shall be assumed to pass through the base of the wall behind the facing units to a point 0.3H behind and 0.5H above the base of the wall and shall be assumed vertical above this point to the ground surface.

(2) Polymeric reinforcements: In design, a linear failure surface at an angle of 45 degrees + ø/2 from the horizontal shall be assumed to pass

through the base of the wall behind the facing units to the ground surface at or above the top of the wall.

f. Design Parameters: The following soil parameters shall be assumed for the design unless otherwise shown in the plans or specified by the Engineer.

Reinforced fill: unit weight = 125 lb/CF (2000 kg/m^2), ø = 34 degrees, C = 0

Random backfill: unit weight = 125 lb/CF (2000 kg/m^3), ø = 30 degrees, C = 0

g. Minimum Factors of Safety for Internal Stability:

(1) Reinforcement yield or reinforcement rupture: FS = 1.5 at end of service life.

(2) Reinforcement pullout: FS = 1.5 at 0.5 inch (12.5 mm) deformation.

(3) Connection of inextensible reinforcements to facing units: FS = 1.5 at 0.5 inch (12.5 mm) deformation. The maximum allowable reinforcement tension shall not exceed two-thirds of the connection strength determined at 0.5 inch (12.5 mm) deformation or less.

(4) Connection of extensible reinforcements to facing units: FS = 1.0 at 0.75 inch (19 mm) deformation.

h. The safety factors for external stability are:

(1) Sliding: FS = 1.5.

(2) Bearing Capacity: FS = 2.0.

(3) Overturning: FS = 2.0.

(4) Slip Circle: FS = 1.5.

i. Allowable Reinforcement Tension:

(1) Metallic reinforcements: The reinforcement tensile stress at the end of the service life shall not exceed 67 percent of the yield strength of the steel (i.e., FS = 1.5 against yield of the steel at the end of the service life). A sacrificial thickness of 0.056 inch (1.5 mm) shall be considered in the analysis of the allowable reinforcement tension.

(2) Polymeric reinforcements: The allowable reinforcement tension shall conform to AASHTO *Standard Specifications for Highway Bridges*, Section 5.8.7.2 and shall be the lesser of limit state determination or the serviceability state determination.

j. State of Stress:

(1) The lateral earth pressure to be resisted by the reinforcements at each reinforcement layer shall be calculated using the appropriate coefficient of earth pressure, K, times the vertical stress at each reinforcement layer.

(2) The vertical soil stress at each reinforcement layer shall consider the local equilibrium of all the forces acting above the layer under investigation and shall be computed using the Meyerhof bearing pressure equation.

k. Metallic reinforcements - the coefficient of earth pressure, K, shall vary from an at rest earth pressure coefficient, K, at the ground surface and shall decrease linearly to an active earth pressure coefficient, Ka, at a depth of 20 feet (6 m). The coefficients of earth pressure shall be based on level top conditions and shall be independent of surcharge slope.

l. Polymeric reinforcements - a coefficient of active earth pressure, Ka, shall be used from top to bottom of the wall. The coefficient of active earth pressure, Ka, shall include the effects of sloping surcharges.

715.02 -- Material Requirements

1. The Contractor shall provide all materials necessary to construct the specified walls.

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. All units shall be sound and free of cracks or other defects that may interfere with proper placement of units or that may impair their strength or durability. Units shall be tested for compressive strength in accordance with ASTM C 140. Concrete modular blocks shall be accepted for use in wall construction provided the block's compressive strength exceeds 4,350 psi (30 MPa).

3. Soil Reinforcements and Attachment Devices:

a. Ladder reinforcing strips shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A 82 and welded into the finished strip configuration in accordance with ASTM A 185. Galvanizing shall conform to the minimum requirements of ASTM A 123.

b. Geostrap 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 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. Polyoleofin 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 ASTM A 82 and shall be galvanized in accordance with ASTM A 123.

e. U-shape reinforcement connectors used as yokes to connect geostrap reinforcements to modular blocks shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A 82. Geostrap connector plates shall be shop fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 570/A 570M, Grade 50, or equivalent. Galvanizing shall conform to the minimum requirements of ASTM A 123.

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. a. Reinforced backfill and modular block/drainage fill shall be select granular backfill materials reasonably free from organic and otherwise deleterious materials and shall conform to the gradation limits as determined by AASHTO T 27 and shown in Table 715.01.

Table 715.01

Modular Block Select Granular Backfill Gradations			
Reinforced Backfill		**Modular Block/Drainage Fill**	
Sieve Size	**Percent Passing**	**Sieve Size**	**Percent Passing**
3/4 inch (19 mm)	100	3/4 inch (19 mm)	100
No. 200 (75 µm)	0 - 15	No. 200 (75 µm)	0 - 5

b. 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 percent of maximum density as determined by AASHTO T 99 at optimum moisture content, based on a minimum of 4 percent moisture, shall exhibit an angle of internal friction of not less than 34 degrees as determined in a standard direct shear test (AASHTO T 236).

c. Select granular backfill shall also conform to the following criteria:

(1) Soundness -- The materials shall be substantially free of shale or other soft, poor durability particles, and shall have a sodium sulfate soundness loss of less than 30 percent after 5 cycles, as determined by AASHTO T 104.

(2) Electrochemical Requirements -- The backfill material shall have a minimum resistivity of 3000 ohm-cm at 100 percent 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 in Paragraph 4. of this Subsection shall be met.

(3) 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 over 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.

d. 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.

715.03 -- Construction Methods

1. Wall Excavation:

Unclassified excavation shall be in accordance with the requirements of the specifications and in reasonably close conformity with the limits shown in the plans.

2. Foundation Preparation:

The foundation for the structure shall be graded level for a width equal to or exceeding the length of the soil reinforcement or as shown in the plans. 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. At each foundation level, a compacted granular leveling pad shall be provided as shown in the plans. 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.

3. Wall Erection:

The wall system components shall be constructed in accordance with the wall supplier's recommendations and construction manual. The wall shall be constructed vertical or as near vertical as the wall system will allow. The overall vertical tolerance of the wall and the horizontal alignment tolerance shall not exceed 0.1 inch per inch (10 mm per 100 mm).

4. 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.

b. Reinforced backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99 Method C or D (with oversize correction, as outlined in Note 7). Reinforced backfill material shall have a placement moisture content less than or equal to the optimum moisture content. 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. The optimum moisture content shall be determined in accordance with AASHTO T 99. 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.

(1) The optimum moisture content shall be determined in accordance with AASHTO T 99 based on a minimum of 4 percent moisture content.

c. 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 plans. 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.

d. 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. No soil density tests need be taken within this area. Care shall be exercised in the compaction process to avoid misalignment of the facing blocks. Heavy compaction equipment shall not be used to compact backfill within 40 inches (1 m) of the wall face. 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.

715.04 -- Method of Measurement

1. The quantity of wall materials is measured by the square foot (square meter) and 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 plan quantity. The wall surface area, as shown in the plans, includes wall penetrations such as pipes and other utilities.

2. The quantity of compacted earth leveling pads is measured by the linear foot (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 plan quantity.

3. The quantity of granular backfill is measured by the cubic yard (cubic meter) and is computed using the plan 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 plan quantity. The quantity shown in the plans is based on a volume equal to the height of the wall times the length of the wall times a width equal to 70 percent of the height.

715.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
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. Payment is full compensation for all work prescribed in this Section.

SECTION 716 -- STEEL RAILINGS

716.01 -- Description

1. This work shall consist of furnishing and placing steel handrail, bridge rail, rail elements, rail posts, barrier rail, pedestrian railing, and all connecting bolts and anchors in accordance with the requirements of these *Specifications* and the plans.

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 plans or special provisions. The bolt projection shall be galvanized.

716.03 -- Construction Methods

1. a. The Contractor shall build railing to the lines, grades, and vertical and horizontal curves shown in the plans.

b. The Contractor shall set rail posts plumb. Concrete areas upon which railing posts are to be set shall be dressed to provide even bearing.

2. The Contractor shall paint all exposed metal except galvanized and weathering grade steel as prescribed in Section 709.

3. The Contractor shall repair galvanized coating which has been scarred, burned, or otherwise damaged in accordance with Section 1061.

716.04 -- Method of Measurement

1. a. Structural steel for handrails and bridge rails is measured by the pound (kilogram).

b. Pedestrian barrier rail, pedestrian handrail, and pedestrian railing (chain link type) shall be measured by the foot (meter). The quantity to be paid for will be the distance in feet (meters) between centers of end posts, with no allowance for splices, joints, overhangs, or end sections.

2. 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. Fabrication, erection, transportation, painting, and galvanizing are subsidiary to this Section's pay items.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 717 -- CONCRETE BOX CULVERTS

717.01 -- Description

This work shall consist of the construction of concrete box culverts. They shall be constructed in accordance with these *Specifications* and in conformity with the lines, grades, dimensions, and designs shown in the plans.

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.

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.

5. Care shall be exercised to prevent dirt, mud, or other foreign material from becoming mixed with concrete which is being placed in footings and curtain walls.

6. 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. a. When box culverts are extended, the thickness of the existing walls, deck, and floor will be shown in the plans.

b. 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. 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

2. No payment will be made for concrete placed outside the dimensions shown in the plans.

3. 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.

4. No additional compensation will be made for the additional work of forming the taper as described in Subsection 717.03, Paragraph 7.b. for the concrete required.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 718 -- CULVERT PIPE

718.01 -- Description

This work shall consist of furnishing and installing culvert pipe of the various types shown in the plans.

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 plans.

6. Granular bedding shall conform to the requirements shown in the plans.

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 plans.

2. The installation of Culvert Pipe shall be in accordance with Sections 701, 702, 719, 720, 721, 722, 724, 725, and 726.

3. 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 percent of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5 percent 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. "Confined space" means a space that:

(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

(2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and

(3) Is not designed for continuous employee occupancy.

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 plans. 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 plans. 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 prescribed in this Section.

SECTION 719 -- FLEXIBLE PIPE CULVERTS (CORRUGATED METAL AND PLASTIC)

719.01 -- Description

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 plans 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 NDR 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 plans.

6. Unless otherwise specified in the plans, 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 plans.

2. The Contractor shall lay the pipe true to the lines and grades shown in the plans 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. 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 percent of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5 percent 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. 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.

c. Deflection testing will not be required on corrugated metal pipe extensions of less than 25 feet (7.6 m).

4. 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 plans call 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.

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 percent 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 plans. Granular bedding and backfill will not be required for corrugated metal pipe extensions unless called for in the plans.

9. Plastic pipe shall be installed by the Contractor in accordance with the plans, 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

1.

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 prescribed in this Section.

SECTION 720 -- CONCRETE PIPE CULVERTS

720.01 -- Description

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 plans 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 plans.

4. Approved preformed plastic gaskets are shown in the NDR 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. 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. 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.

d. 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.

e. The inside of the joint shall be wiped and finished smooth.

f. After the initial set, the cement mortar on the outside shall be protected from the sun with a moist earth covering.

g. After the pipe is laid, all lift holes shall be filled with cement mortar (1 part cement and 2 parts sand).

3. 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.

4. 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. 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.

d. 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.

e. 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 percent 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.

f. The Contractor shall make all repairs or replacements, or both, that are necessary to secure the required watertightness.

g. The Contractor shall be responsible for any damage to the structures or adjacent works due to testing.

h. 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.

5. 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.

6. When the plans designate 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.

7. 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, 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, 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 prescribed in this Section.

SECTION 721 -- DRIVEWAY CULVERT PIPE

721.01 -- Description

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 plans or designated by the Engineer.

721.02 -- Material Requirements

The pipe furnished shall conform to the requirements in Table 721.01.

Table 721.01

Material Requirements	
Applicable Materials	
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 plans, ASTM D 2321, and the manufacturer's recommendations.

3. 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 percent of its design diameter. The internal diameter of corrugated metal pipe shall not be reduced by more than 7.5 percent 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. 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 plans.

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

All driveway culvert pipe will 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)]

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 prescribed in this Section.

SECTION 722 -- SEWERS

722.01 -- Description

This work shall consist of excavating sewer trenches, constructing and laying pipe sewers, and backfilling sewer trenches to the dimensions shown in the plans.

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 NDR Approved Products List.

722.03 -- Construction Methods

1. a. 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 plans.

b. Plastic pipe shall be installed in accordance with the plans, ASTM D 2321, and the manufacturer's recommendations.

2. 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 plans, ASTM D 2321, and the manufacturer's recommendations. Granular bedding and/or backfill will be optional for concrete pipe when the Contractor selects the Type 3 Installation shown in the plans.

3. The Contractor shall lay all pipe to the line and grade established in the plans.

4. The Contractor shall inspect and sound all pipes for cracks or other defects.

5. Pipe alignments shall be marked by the Contractor so that, when joined in the ditch, a smooth tube will be formed.

6. 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:

7. a. When called for in the plans, 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 plans, all joints shall be filled and pointed up 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.

c. All plastic pipe installed for sewers shall be connected with an approved water-tight joint.

d. The Engineer shall approve the Contractor’s method for drawing the pipes together to close the gap.

8. 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. The internal diameter of plastic storm sewer pipe shall not be reduced by more than 5 percent 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. 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. a. 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.

b. When tapping a structure is called for in the plans, measurement

for sewer pipe will terminate where the farthest extension of the pipes intersect the inside face of the structure.

2. 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 plans.

3. Additional allowances for elbows and connecting bands will be made as provided in Tables 718.01 and 718.02.

4. Excavation for sewers shall not be measured for payment.

5. 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.

6. 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.

7. 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 prescribed in this Section.

SECTION 723 -- TAPPING EXISTING DRAINAGE AND SEWER FACILITIES

723.01 -- Description

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 plans or ordered by the Engineer.

723.02 -- Construction Methods

The Contractor shall tap, seal, and connect pipes to pipes and/or structures in a neat and professional manner as shown in the plans.

723.03 -- Method of Measurement

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 prescribed in this Section.

SECTION 724 -- INSTALLATION AND REMOVAL OF FLARED-END SECTIONS

724.01 -- Description

1. As prescribed in the plans, 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 plans.

3. The Contractor shall stockpile and reinstall concrete and metal flared-end sections and bar grates at the locations shown in the plans.

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 prescribed in Subsections 720.04 and 720.05.

7. Payment is full compensation for all work prescribed in this Section.

SECTION 725 -- BAR GRATES FOR FLARED-END SECTIONS

725.01 -- Description

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 plans.

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

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

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 prescribed in this Section.

SECTION 726 -- CULVERT SANDFILL

726.01 -- Description

This work shall consist of sealing existing culverts as shown in the plans 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. a. Concrete shall meet the requirements of Section 1002.

   b. Fly ash slurries will be approved based on mix submission to Materials & Research.

3. Sand shall meet the requirements of Subsection 1033.02, Paragraph 3.a.

726.03 -- Construction Methods

1. a. The Contractor shall plug the culvert at locations shown in the plans.

   b. The plug shall be a bulkhead or other structure as shown in the plans.

2. The Contractor shall fill the culvert with flowable fill, sand, or fine aggregate for concrete.

726.04 -- Method of Measurement

Culvert sandfill is measured by the cubic yard (m^3). The plan quantities shall be based on the culvert dimensions shown in the plans.

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 prescribed in this Section.

SECTION 727 -- SUBSURFACE DRAINAGE MATTING

727.01 -- Description

This work shall consist of furnishing and installing drainage matting at bridge ends as shown in the plans.

727.02 -- Material Requirements

1. The drainage matting to be used shall be on the NDR Approved Products List.

2. The matting shall have a minimum nominal thickness of 0.22 inch (5.5 mm).

727.03 -- Construction Methods

1. The Contractor shall place the matting at the location shown in the plans.

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

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 prescribed in this Section.

SECTION 728 -- RIPRAP FILTER FABRIC

728.01 -- Description

This work shall consist of furnishing and installing a riprap filter fabric at the locations shown in the plans and as directed by the Engineer.

728.02 -- Material Requirements

1. The filter fabric to be used shall be on the NDR Approved Products List.

2. Filter fabric materials that are not on the NDR 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 NDR 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, guillies, 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

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 prescribed 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 plans. The seals shall be capable of the movement specified and shall be built to the lines and elevations shown in the plans.

2. Manufacturers producing acceptable items are shown in the plans.

729.02 -- Material Requirements

1. 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 508 nm RMS finish.

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 polytetraflourethylene 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 plans.

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, plans, 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 plans.

729.04 -- Method of Measurement

Modular type expansion joints will be measured by the linear foot (meter) of the joint in place. Measurement shall be between gutterlines along the centerline of the joint with no allowance for curb units, skewed ends, or slider plate assemblies.

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 prescribed 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 plans. The seals shall be standard prefabricated products corresponding to the types and sizes shown in the plans.

2. Manufacturers producing such items are shown in the plans.

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 plans, and shall be integral with the deck units or otherwise so designed and installed to thoroughly seal the joint against leakage.

3. 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. a. The steel extrusions may be made of one continuous piece.

b. If 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.

c. The neoprene seal shall be made of one continuous length, and no splicing shall be allowed except where specifically called for in the plans.

5. 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

Strip seals shall be measured for payment by the linear foot (meter) of seal properly installed and accepted by the Engineer. Strip seal length shall be measured along the seal's centerline from end to end or between curb faces, with no allowance for skewed ends or for curb units.

Table 730.01

Polychoroprene Requirements		
Property	**ASTM Test**	**Requirements**
Tensile Strength	D 412	2,030 psi (14 MPa), min.
Elongation at Break	D 412	250% min.
Hardness	D 2240 (modified)	60±5 points Durometer A
Compression Set 70 hours at 212°F	D 395 Method B	20% max.
Ozone Resistance Exposed to 300 pphm ozone for 70 hours at 104°F. Sample under 20% strain.	(modified) D 1149	No Cracks
Oil Deterioration Weight increase after immersion in ASTM oil #3 for 70 hours at 212°F	D 471	45% Max.

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 prescribed in this Section.

SECTION 731 -- JACKING CULVERT PIPE, SEWER PIPE, AND CASING

731.01 -- Description

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 plans.

731.02 -- Material Requirements

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 plans.

2. The limits of open trench excavation will be shown in the plans.

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 1/2 inches (38 mm).

731.04 -- Method of Measurement

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** — **Pay Unit**

Jacking _____ inch (mm) _____ Pipe	Linear Foot (LF) [Meter (m)]
Jacking _____ inch (mm) _____ Pipe, Class _____	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 the removal of lead-based painted structural steel members which may involve the cutting of the members, and the collection, site storage, and disposal of all paint debris waste generated during the process of removal 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. Scrape samples of paint were taken from the existing structure and were analyzed for the presence of toxic metals. Analysis of the samples show that the existing paint contains the metals lead and/or chromium, and may also contain other toxic metals. The results of the analysis is shown in the plans.

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

All materials used 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 (IH) 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.

c. 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.

d. 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.

e. 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.

f. The Contractor shall obtain a Uniform Waste Manifest from the EPA or appropriate agency before transporting hazardous waste to the selected TSDF.

g. 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.

h. 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.

i. 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, 901 North 5th Street, Kansas City, Kansas 66101. A copy of this report shall be provided to the Engineer.

732.04 -- Method of Measurement

No measurement required.

732.05 -- Basis of Payment

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 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 .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

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 one inch (25 mm) equals one inch (25 mm) vertically and one 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. Profile of the first and last six feet (2 m) (longitudinally) of the surface being tested cannot always be obtained with the profilograph. These areas will be measured for bumps with a 10-foot (3 m) straightedge according to Subsection 601.16 of the Standard Specifications.

4. One profile will be obtained in each lane approximately three 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 and 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 m) wide and consist of diamond blades with spacers.

3. Each profile will represent a surface width, extending from the centerline of the bridge to 3'-0" (900 mm) in front of the curb or rail, and surface correction will be made over this entire width.

4. The maximum depth of grinding that will be permitted is 1/2-inch (12.5 mm).

5. 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.

6. 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 .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 .50"/100 feet (12.5 mm/30 m).

3. If the profile index cannot be corrected by grinding, to less than .50"/100' (12.5 mm/30 m), those areas will be removed and replaced or overlaid with high density-low slump concrete. All remedial work will be at no additional cost to the Department.

4. 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 Precompressed Polyurethane Foam (PPF) Joint Sealant System in a preformed roadway gap(s) at the locations and limits shown in the plans.

2. The Contractor shall measure the joint width and record the temperature at the time the measurements are taken. Together with the expected movement at the joint, this information must be forwarded to the joint manufacturer who must recommend the proper size of joint filler.

3. The Contractor shall require a manufacturer's technical representative to be present at all times while the expansion device is being installed.

734.02 -- Material Requirements

1. The Precompressed Polyurethane Foam Joint Sealant System shall be a precompressed self-expanding polyurethane foam. The foam sealant shall be precompressed prior to packaging. The precompressed dimension shall be as recommended by the sealant manufacturer to provide a watertight seal throughout the joint movement.

2. Materials shall be resistant to ozone, ultra-violet rays, petroleum products, solvents, salts, industrial cleaners, corrosive vapors and acids.

3. Material shall be Precompressed Polyurethane Foam or approved equal with the following characteristics:

Physical Characteristics

Density	10 lb/ft^3 (160 kg/m^3)
Thermal Conductivity	12.106 BTU/(hr)(ft^2)(°F/ft)
Temperature Stability range	-40°F to 212°F (-40°C to 100°C)
Bleeding	None at 212°F (100° C) at 20% compression
Tensile Strength	ASTM D2406 meets min. 21.8 psi min. 15N/cm^2)
Resistance to Compression Set	ASTM D 1564 meets Max 2%
Softening Point	ASTM D 816 surpasses 122°F (50°C) min.
Shear Strength	Min. 11.6 psi (8N/cm^2)
Mildew Resistance	Excellent
Staining	None
Flammability	Self-Extinguishing UL94VO
Flash Point	590°F (310°C)

4. Storage

a. Sealant material shall be delivered to the storage area and to the job site in the manufacturer's original, undamaged containers with wrapping intact.

b. Storage of sealant material shall be in a dry, enclosed area, off the ground and at room temperature 68°F (20°C).

c. In cold weather, store sealant off the ground, inside at above 68°F (20°C) or ideally in a hot box at job site.

d. In hot weather, keep sealant at room temperature, 68°F (20°C) and out of direct sun.

5. The approved suppliers of precompressed polyurethane foam joint sealant systems are shown on the NDR Approved Products List.

734.03 -- Construction Methods

The installation of the Precompressed Polyurethane Foam Joint Sealant System shall be completed according to the manufacturer Specifications and as directed by their representative.

734.04 -- 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 plans and 12 inches (300 mm) upward at the gutter lines.

734.05 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Precompressed Polyurethane Foam Joint	Linear Foot (LF) [Meter (m)]

2. Any installation that fails to meet the Specifications or manufacturer's recommendations shall be removed and replaced with a properly installed joint at the Contractor expense.

3. Payment is full compensation for all work prescribed in this Section.

DIVISION 800 -- ROADSIDE DEVELOPMENT AND EROSION CONTROL

SECTION 801 -- REMOVING AND RESETTING TREES

801.01 -- Description

This work shall consist of furnishing equipment, stakes, guys, mulch, and water and moving and planting trees in accordance with these *Specifications*, the special provisions, and the plans.

801.02 -- Construction Methods

1. The trees shall be removed and reset with an approved mechanical tree spade. The tree spade shall have a manufacturer's size rating equal to or exceeding the tree sizes to be moved.

2. a. The Contractor shall remove and reset the trees where shown in the plans.

b. The procedures in Section 802 for planting which include mulching, watering, fertilizing, staking, guying, and other requirements shall be followed when resetting the trees.

801.03 -- Method of Measurement

The work of removing and resetting trees will be measured as single units (by the each) for each tree.

801.04 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Remove and Reset Tree	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 802 -- FURNISHING AND PLANTING OF PLANT MATERIALS

802.01 -- 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.

802.02 -- Material Requirements

1. Planting Seasons

a. A minimum of 90 days before each planting season, the Contractor shall submit to the NDR Roadside Development Unit:

(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 plans or special provisions 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 prescribed 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 percent nitrogen, 10 percent phosphorous, and 5 percent potash) analysis with a mass of 21 g ± 1 g per pellet; or the pellets may have a 14-3-3 (14 percent nitrogen, 3 percent phosphorous, and 3 percent potash) analysis with a mass of 16 g ± 1 g per pellet. Either pellet shall contain a minimum of 11.5 percent water insoluble nitrogen.

b. Establishment period fertilizer shall be liquid urea with 28 to 32 percent nitrogen or an approved equal.

12. a. All mulch shall be approved by the NDR Roadside Development Unit.

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 NDR Roadside Development Unit for approval.

15. a. The absorbent polymer shall be an organic cross-linked co-polymer 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 NDR 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 glysophate (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.

802.03 -- 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 plans.

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 plans.

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 plans.

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 percent 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 plans.

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 802.01

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 plans. 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 plans. 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 plans.

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 plans 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 specifications, the special provisions, and the plans, 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, the Project Manager, and a representative from the NDR Roadside Development Unit will make a joint inspection of the project for acceptability.

(2) The NDR Roadside Development Unit representative 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.

802.04 -- Method of Measurement

The work of furnishing and planting of plant materials will be measured by the each as listed in the bid proposal Schedule of Items.

802.05 -- 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 802.02.

3. The Engineer, Contractor, and a representative of the Roadside Development Unit will make an inspection on or about September 1 to determine the plants in an acceptable growing condition. A representative from the Roadside Development Unit will determine acceptability of the plant material at the inspection.

4. If a plant is determined to be not acceptable, any 10-percent payment for establishment work after that determination will not be made.

Table 802.02

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.
An additional 10% of the contract price of each applicable item. An additional 10% of the contract price of each applicable item. An additional 10% of the contract price of each applicable item.	July 31 August 31 September 30	1. Plant materials have been properly maintained as specified during the establishment period. 2. The Project Manager 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 Project Manager 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-percent 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 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 representative of the Roadside Development Unit 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, project manager notified, etc., for the indicated time intervals in Table 802.02, 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 802.02, then the "10% payment" for establishment work for the interval(s) 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 Specifications, the special provisions and the plans.

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 Project Manager 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 prescribed in this Section. Payments and deductions are made from Department determinations of whether or not the work shown in Table 802.02 is properly completed.

SECTION 803 -- SEEDING

803.01 -- Description

1. This work shall consist of furnishing and placing the seed, fertilizer, and mulch in accordance with these *Specifications* at locations shown in the plans.

2. Type "B" seeding work shall be done in the median areas and for a width of approximately 12 feet (3.7 m) adjacent to the edge of the pavement or surfaced shoulder of the roadways and ramps. Type "A" seeding work shall be performed on all other areas within the limits of the project, except areas designated as Type "C".

803.02 -- Material Requirements

1. Seeding methods, rates of application, and seed mixtures shall comply with the special provisions and the plans.

2. No seed shall be mixed until the Engineer provides the Contractor a seed order list. The Engineer will determine the total seed requirement, usually near the end of the construction period. Where practicable, a single seed order will be provided [usually on projects under 30 acres (12 ha)].

3. a. The Contractor shall obtain from the seed dealer and furnish to the Department a laboratory analysis of each type and lot of seed proposed for use. The analysis shall provide complete information on t e seed as required by State and Federal laws. The Department may approve use of the seed if the information on the analysis is satisfactory.

b. If the seed is approved by the Department, the seed shall be mixed, bagged, and tagged at the seed company after the Department gives the seed company authorization for a project.

4. a. The Department 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.

5. Fertilizer type and quantity shall be specified in the special provisions and shall comply with the applicable requirements of Section 804.

6. Mulch shall be as prescribed in Section 805.

803.03 -- Construction Methods

1. Planting Season:

a. Seeding operations shall be performed only during the periods March 1 to June 30 and August 1 to December 31.

b. No work shall be performed when the ground is frozen, wet or otherwise untillable, or when even distribution of materials cannot be obtained.

2. If the seeding and grading work are being performed under separate contracts, any necessary repair to the slopes, borrow areas, or ditches will be performed by State forces or by the Contractor on an extra work basis.

3. a. 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 done parallel to the land contour.

b. Hand work shall be required around signs, delineators, guardrail, or other "highway appurtenances" as part of seed bed preparation.

4. a. The Contractor shall till existing weed stubble, small weeds, and other vegetation into the soil during seedbed preparation.

b. (1) The Contractor shall rotary mow to remove heavy weed growth that cannot be disced under.

(2) If seeding and grading are performed under separate contracts, then rotary mowing will be done by State forces or by the Contractor on an extra work basis before the time for seeding operations to begin.

c. The Contractor shall rake and remove the mowing residue as extra work if it cannot be satisfactorily tilled into the seedbed.

d. Extreme care shall be exercised to avoid injury to trees and shrubs that have been designated by the Engineer to be preserved.

e. The Engineer may direct that areas of desirable vegetation be preserved.

5. The Contractor shall fertilize the area and then apply seed as prescribed in Section 804.

6. a. Grass drills equipped with press wheels or drag chains, Brillion type seeders, or hydraulic seeders may be used to plant the seeds. The special provisions will indicate which equipment shall be used on the project.

b. When hydraulic seeders are used, the seeded area shall be harrowed except on slopes that are jointly (Contractor and Engineer) agreed to be too steep or too irregular to safely operate equipment.

c. (1) Hydraulic seeding equipment shall include a pump rated and operated at 100 gal/min (379L/min) and at a pressure of 100 psi (690 kPa).

(2) The equipment shall have a suitable pressure gauge and a nozzle adapted for hydraulic seeding.

(3) Storage tanks of irregular shapes shall have a means of estimating the volume used or remaining in the tank.

d. When using a hydraulic seeder, the fertilizer and mulch shall be applied separately from the seed.

7. The Contractor shall apply mulch as prescribed in Section 805.

803.04 -- 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 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 not to exclude isolated areas of approximately 10,000 square feet (929 m^2) or less upon which erosion control blankets or netting have been or will be placed.

3. Mulch shall be measured as prescribed in Subsection 805.04.

803.05 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Seeding, Type _____	Acre (A) [Hectare (ha)]

2. Mowing, raking, and removing heavy weed growth that is approved by the Engineer shall be paid on an extra work basis.

3. When all or part of the specified seed mixture is unavailable, the Engineer may direct that a substitute seed mixture is used. If an approved substitute seed mixture is furnished at no increase or decrease in cost, it may be used without amending the contract.

4. Mulch is paid for as prescribed in Subsection 805.05.

5. Payment is full compensation for all work prescribed in this Section.

SECTION 804 -- FERTILIZING

804.01 -- Description

This work shall consist of furnishing and applying synthetic organic and/or inorganic nutrients to the soil as required in the special provisions for seeding.

804.02 -- Material Requirements

1. All fertilizers shall be approved by the Engineer before their use.

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 bulk fertilizer delivery shall have a completed DR Form 125, "Fertilizer Certification." This form is to be given to the Engineer.

804.03 -- Construction Methods

1. The Contractor shall apply the fertilizer uniformly with approved mechanical spreaders or with a hydraulic seeder at the rates specified in the special provisions.

2. Fertilizer may be blended before delivery to the site.

3. The fertilizers shall be incorporated into the soil before seeding or sodding.

804.04 -- Method of Measurement and Basis of Payment

No measurement is required. This work will not be paid for directly but shall be considered as subsidiary to seeding, sodding, erosion control, and all other items that require fertilizer.

SECTION 805 -- MULCHING

805.01 -- Description

This work shall consist of providing, placing, and crimping mulch on areas shown in the plans or identified by the Engineer as being seeded in accordance with Section 803.

805.02 -- Material Requirements

1. a. 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 threshed grain straw.

b. Brome hay is not allowed.

c. (1) The mulch shall be certified as "Noxious Weed Free" by the "County Weed Control Authority" or other authorized agents.

(2) The certification or a copy shall accompany each load of mulch.

(3) The certification shall be placed in a weather-proof container and attached to the stack of mulch it represents.

2. Hay or straw in a stage of decomposition so advanced as to "powder" in the mulch blower shall be rejected.

3. The Contractor shall notify the Engineer as to where he/she proposes to obtain the hay. The Contractor will be notified if the source of hay is satisfactory or unsatisfactory.

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. a. All mulch deliveries shall have tickets from a scale approved by the Engineer before the mulch is unloaded for use on the project. The scale ticket shall indicate the weight and be dated and signed by the scale operator.

b. The scale ticket shall be given to the Engineer or left in a weather-proof container and attached to the stack of mulch it represents.

c. The Engineer may, at any time, order the Contractor to reweigh the mulch as a check of the scale ticket.

805.03 -- 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. Hay shall be applied at the rate of 2 tons/acre (4.5 Mg/ha).

3. Straw shall be applied at the rate of 2.25 tons/acre (5 Mg/ha).

4. The mulch shall be applied loose enough to allow 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.

5. a. Immediately after applying the mulch, the Contractor shall anchor 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 the shoulder area. More than one crimping may be necessary in the shoulder area if directed by the Engineer.

6. The Contractor shall use 10 percent more mulch and no crimping on:

a. Seed beds that get rained on before being mulched.

b. Mulched areas that get rained on before crimping.

805.04 -- Method of Measurement

1. The weight of the mulch is measured in tons (Megagrams).

2. The Contractor will provide the Engineer scale tickets showing the weight of mulch provided.

3. a. The weight of mulch applied is calculated by multiplying the measured area times the specified application rate.

b. When the total weight from the scale tickets is within 5 percent of the specified weight, then the pay quantity will be the specified weight.

c. When the Engineer directs in writing the application of a weight greater than the specified weight, then the Department will pay for the quantity of additional mulch that is more than 105 percent of the originally specified weight.

d. When the weight tickets show that the weight applied is less than 95 percent of the specified weight, then the Department pay quantity will be the weight determined by adding the quantities on the scale tickets.

e. If the Contractor applies more mulch than directed by the Engineer, then the weight over 100 percent of the specified weight or the amount directed by the Engineer is provided at no additional cost to the Department.

805.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Mulch	Ton (Tn) [Megagram (Mg)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 806 -- SODDING

806.01 -- Description

1. This work shall consist of furnishing, transporting, fertilizing, watering, and placing bluegrass sod in accordance with these *Specifications*, the plans, and the special provisions.

2. Sodding operations shall not be performed between May 1 and September 10, when the ground is frozen, or when weather conditions are not favorable for growth as determined by the Engineer.

806.02 -- Material Requirements

1. The Contractor shall place the sod immediately after the finish grading work has been completed on a section of the project. However, the finish grading must be approved by the Engineer before the sod is placed.

2. The sod shall be obtained from a source approved by the Engineer.

3. 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.

4. a. The sod shall be mowed and raked to remove stems, sticks, and grass clippings before cutting.

b. The sod shall be cut to a depth of approximately 3/4 inch (19 mm).

c. All sod shall be free from noxious weeds and all other weeds.

d. Extreme care shall be taken in cutting, handling, transporting, and laying the sod to avoid unnecessary damage to and loss of earth from the roots of the sod.

e. The sod shall not have dry or dead edges.

5. a. The composition and application rates for pre-sodding fertilizers are:

(1) Rate of application of inorganic fertilizer shall be:

	Rate of Application Per 1,000 Square Yard (Min.)	**Rate of Application per 1,000 Square Meters (Min.)**
Available Nitrogen (N_2)	8 pounds	4.5 Kg
Available Phosphoric Acid (P_2O_5)	23 pounds	12.5 Kg

(2) Rate of application of granular urea-formaldehyde fertilizer shall be:

	Rate of Application Per 1,000 Square Yard (Min.)	**Rate of Application per 1,000 Square Meters (Min.)**
Nitrogen (Total Available)	45 pounds	25 Kg

b. The composition and rate of application of post-sodding inorganic fertilizer shall be:

	Rate of Application Per 1,000 Square Yards (Min.)	Rate of Application per 1,000 Square Meters (Min.)
Available Nitrogen (N_2)	8 pounds	4.5 Kg
Available Phosphoric Acid (P_2O_5)	23 pounds	12.5 Kg

6. The acceptable pre-emergent weed control chemicals are:

a. Siduron. Shall be applied at the midrange of the manufacturer's suggested range. [For example: If the range was 4 to 12 pounds/acre (4.5 to 13.5 Kg/ha), then the application rate would be 8 pounds/acre (9 Kg/ha).]

b. Dacthal. May be used at the midrange of the manufacturer's suggested range.

c. Other. Any approved and equal weed control chemicals may be used.

806.03 -- Construction Methods

1. a. The area to be sodded is shown in the plans.

b. The Contractor shall clear all areas to be sodded of debris and dead vegetation before the sod bed is prepared.

c. The soil shall not be crusted and the fertilizer shall be incorporated.

d. All erosion shall be filled and loose earth firmed before laying the sod.

e. Topsoil, when specified, shall be spread and tilled into the soil by discing or other methods to the depth shown in the special provisions or the plans.

2. The sod bed shall be approved by the Engineer before laying the sod.

3. The Contractor shall apply pre-sodding fertilizer to the prepared sod bed immediately before sodding.

4. The Contractor shall thoroughly dampen the sod bed before and while placing the sod.

5. 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.

6. The Contractor shall roll all sod 1 time, unless on a slope steeper than 1 vertical to 3 horizontal, with a sod roller approved by the Engineer.

7. 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.

8. a. The Contractor shall apply a pre-emergent herbicide of the type shown in the special provisions over the top of the sod immediately after laying and fertilizing and before the sod is watered.

b. The rate of application shall be as shown in Subsection 806.02.

c. The pre-emergent is not required on sod laid after September 1.

9. 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.

10. The Contractor shall apply the post-sodding fertilizer at the end of the establishment period.

11. Establishment Period:

a. (1) The Contractor shall keep all sodded areas thoroughly watered for 30 calendar days after laying.

(2) Watering required by the Engineer after 30 days will be extra work.

b. All sod must be moist and growing at the time of acceptance.

c. If, at the end of the establishment period, the growth or stand of the sod is unacceptable, the sod shall be rejected.

d. (1) Rejected sod may be overseeded with a mixture of rye and bluegrasses or other suitable mixtures at rates determined by the Engineer.

(2) The overseeded sod shall not be accepted until the quality of the overseeding work can be determined by the Engineer.

(3) (i) The Contractor shall water overseeded sod for 30 calendar days.

(ii) Watering required by the Engineer after 30 days will be extra work.

(4) There will be no extra compensation for overseeding or watering the areas where the sod was rejected.

806.04 -- Method of Measurement

The sod shall be measured for payment by the number of square yards (square meters) of surface area of sod furnished and placed.

806.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

Sodding Square Yards (SY) [Square Meter (m^2)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 807 -- EROSION CONTROL

807.01 -- Description

This work shall consist of the preparation of slopes and waterways and the furnishing and application of soil retention blankets at the locations shown in the plans. Seed and fertilizer is not required with Erosion Control Type B, B-1 and B-2.

807.02 -- Material Requirements

1. The soil retention blanket shall be of the type specified in the plans and shall be on the NDR Approved Products List.

2. Wire staples shall be used for anchoring the soil retention blanket. The staples for the soil retention blankets shall be as follows:

a. For "Erosion Control", “Erosion Control, Type C”, and "Erosion Control Type HV": 11 gauge [(0.12 inch) (3 mm) diameter] U-shaped steel wire with a 1 inch (25 mm) or larger throat with at least 6 inch (150 mm) long legs.

b. For "Erosion Control Types A, AA, and AAA": 8 gauge [(0.15 inch) (4 mm) diameter] U-shaped steel wire with a 1 inch (25 mm) or 2 inch (50 mm) throat with 8 inch (200 mm) or 10 inch (250 mm) long legs. 11 gauge [0.12 inch (3 mm) diameter] U-shaped steel wire with a 1 inch (25 mm) or larger throat with at least 6 inch (150 mm) long legs may be used for Erosion Control, Type A and Type AA if the staples are machine placed and one-third more staples are used.

c. For the filter fabric: 11 gauge [0.12 inch (3 mm) diameter] U-shaped steel wire with a one inch (25 mm) throat and at least 6 inches (150 mm) long.

3. The seed shall comply with the applicable portion of Section 803. The seed mixture shall be of the types and applied at the rate shown in the special provisions.

4. The fertilizer shall comply with the applicable portion of Section 804. The fertilizer shall be of the types and applied at the rate shown in the special provisions.

5. An approved filter fabric shall be placed under "Erosion Control, Types A, AA, and AAA". Approved filter fabrics are listed on the NDR Approved Products List.

807.03 -- Construction Methods

1. This work shall be performed as soon as possible after finish grading operations have been completed.

2. No restrictive seeding time periods shall apply to this work.

3. a. The Contractor shall tamp and shape fill earth to the finish grade as needed to repair erosion to the grades and conditions shown in the plans.

b. If additional fill dirt is required, it will not be paid for as extra work and must be provided and placed at no additional cost to the Department.

4. a. 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.

b. All lumps of soil shall be pulverized, raked out, or removed.

c. Vegetation shall be removed from these areas except for the desirable native vegetation that has been designated by the Engineer to remain undisturbed.

d. 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.

5. The Contractor shall obtain the Engineer's approval of all soil preparation work, fertilizer, and seed.

6. a. The Contractor shall place the soil retention blankets immediately following fertilizing and seeding.

b. The blanket shall be laid out flat, parallel to the surface runoff flow direction, and secured as shown in the plans for each specific type of erosion control.

c. The soil retention blanket for Erosion Control, Type B, Type B-1, and Type B-2 shall be placed longitudinally next to the shoulder of the roadway. The soil retention blanket shall be placed after the area is seeded and before the area is mulched. One-third more staples are required than shown in the plans.

d. Care shall be exercised in placing the blanket so as not to disturb previously seeded areas.

7. a. Erosion Control, Type A and Type AA

i. Place the erosion control material with the filter fabric attached over the prepared area. Pin the area. Seed and fertilize and then soil fill. The soil fill shall be fine enough to fill the voids and cover all of the seed.

ii. If the filter fabric is not attached to the erosion control material, the installation is as follows: prepare the area, lay out the filter fabric, pin the filter fabric, lay out the erosion control material and pin, seed and fertilize and soil fill.

8. Erosion Control, Type AAA

After the area around the culvert is shaped and graded, the filter fabric shall be placed and pinned. The filter fabric shall be placed under the pipe and the full length of the installation as shown in the plans. Place the Erosion Control, Type AAA mat over the pipe to allow for a three foot (1 m+/- piece of material on top of the pipe. Cut out the hole for the pipe, leaving an area uncut that will be tucked under the culvert and in front of the culvert. Pin the mat as shown and trench in and compact the downstream end. Seed and fertilize the area and soil fill, raking the soil in well. Reseed and re-rake the area.

807.04 -- 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 plans.

807.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Erosion Control, Type _____	Square Yard (SY) [Square Meter (m^2)]
Erosion Control	Square Yard (SY) [Square Meter (m^2)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 808 -- EROSION CHECKS

808.01 -- Description

This work shall consist of seeding, trenching, furnishing and placing filter fabric, furnishing and placing soil retention blankets, and furnishing and placing hay bales to construct erosion checks at the locations shown in the plans. There are two separate and distinct types of erosion checks – "Erosion Checks" which are permanent and are placed as shown in the plans or as directed by the Engineer after final grading is complete; and "Temporary Erosion Checks" which are temporary and placed as shown in the plans or as directed by the Engineer when rough grading is begun or as necessary.

808.02 -- Material Requirements

1. The bales for erosion checks shall be either hay or straw tied firmly with a wire or plastic tie and shall be approximately 16 inches x 18 inches x 36 inches (400 mm x 450 mm x 900 mm).

2. a. The hold down stakes shall be wood and shall be approximately 1 1/2 inches x 1 1/2 inches x 36 inches (38 mm x 38 mm x 900 mm).

b. Hold down stakes in shale shall be steel reinforcement bars approximately 1/2 inch (13 mm) diameter x 30 inches (750 mm) in length.

3. The soil retention blankets shall be of the type specified in the plans and shall be on the NDR Approved Products List.

4. The erosion check filter fabric shall be on the NDR Approved Products List.

5. a. The "Temporary Erosion Checks" shall be on the NDR Approved Products List.

b. The wire staples for "Temporary Erosion Checks" shall be 11 ga. (3 mm diameter) steel wire with a 1-inch (25 mm) or larger throat with 6-inch (150 mm) to 8-inch (200 mm) long legs.

808.03 -- Construction Methods

1. The Contractor shall place erosion checks immediately after finish grading is complete in areas where erosion checks are to be constructed.

2. The Contractor shall excavate a trench to seat the hay bales.

3. The Contractor shall place the filter fabric as shown in the plans and immediately pin any splice joints in the filter fabric.

4. The Contractor shall place a layer of soil 1/2 to 1 inch (13 mm to 25 mm) in depth over the filter fabric.

5. The remainder of the area shall be prepared and the entire area shall be fertilized and seeded in accordance with Sections 803 and 804.

6. a. The Contractor shall then place the soil retention blanket in the trench and staple it as shown in the plans.

b. If the filter fabric is attached to the erosion control blanket, then the seed shall be broadcast over the blanket and then the blanket shall be soil filled.

7. The hay bales shall then be placed in the trench over the filter fabric and soil retention blanket with bale ties up and backfilled to the level of the finished ditch elevation.

8. The limits of the completed erosion 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.

9. All bales shall be held securely in place by driving 2 stakes through each bale [6 inches (150 mm) from the ends].

10. In shale, the 2 reinforcing steel stakes in each bale shall be wired together to prevent the bale from floating off the stakes.

11. All stakes shall be driven into the ground approximately 10 inches (250 mm).

12. Temporary Erosion Checks

a. The "Temporary Erosion Checks" shall be installed at the locations shown in the plans, and as directed by the Engineer. The upstream edge shall be slightly buried and pinned with wire staples on approximately 24-inch (600 mm) spacings. The pins may be left slightly exposed for easier removal. The triangular portion shall be pinned on 3-foot (1 m) centers. The downstream edge does require pinning.

b. The "Temporary Erosion Checks" shall be in place immediately after the rough grading is done in an area.

c. The "Temporary Erosion Check" shall be left in place until the finish grading begins. Reinstall the "Temporary Erosion Checks" as soon as finish grading is done unless the permanent erosion control is initiated immediately after finish grading. "Temporary Erosion Checks" should be in place at all times after finish grading until permanent "Erosion Check," are in place.

d. At the completion of the project, the temporary erosion checks shall remain the property of the Contractor.

808.04 -- Method of Measurement

1. All work involved in constructing erosion checks as described above will be included and paid for per bale for the number of bales used in the erosion checks.

2. "Temporary Erosion Checks" shall be measured by the linear foot (meter) for the initial installation. The removing or relocating of the temporary silt checks will not be measured for payment, but will be considered subsidiary to the initial installation.

808.05 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Erosion Check	Bales
Erosion Checks, Type _____	Bales
Temporary Erosion Check	Linear Foot (LF) [Meter (m)]

2. If cleanout of an “Erosion Check” or “Temporary Erosion Check” is required, it will be paid as equipment rental as prescribed in Subsections 809.04 and 809.05.

3. Payment for “Temporary Erosion Checks” includes any cost incurred to reinstall the “Temporary Erosion Checks” once the area is finish graded.

4. Payment is full compensation for all work prescribed in this Section.

SECTION 809 -- SILT FENCE

809.01 -- Description

This work shall consist of installing the silt fence at the locations shown in the plans. The installation shall be in accordance with these *Specifications*, the special provisions, and the plans.

809.02 -- Material Requirements

1. The silt fence material shall be on the NDR Approved Products List.

2. a. The stakes shall be as shown in the plans.

b. Used posts are acceptable.

c. Fabric Silt Fence, type coir fiber may also be installed with wooden posts. The posts shall be 1½" x 1½" x 6' (38 mm x 38 mm x 1.8 m) and shall only be driven until firm.

3. The pins that are required shall be 11 gauge (0.120 inch) steel wire with a 1 inch or larger throat with at least 6 inch legs.

809.03 -- Construction Methods

1. a. The silt fence shall be installed and in good working condition prior to any grading operations taking place.

b. The Contractor shall excavate a trench to the depth, width, and length shown in the plans.

2. The Contractor shall place the silt fence in the trench and pin it as shown in the plans.

3. a. The Contractor shall backfill the trench, compact the soil, and attach the fabric to the posts as shown in the plans.

b. All silt fence splice joints shall be overlapped a minimum of 6 feet (1.8 m).

4. The Contractor shall remove and dispose of silt that accumulates near the silt fence during construction and at completion of the project. Each time silt is removed, the fence shall be repaired to a good working condition.

5. The Contractor shall maintain the silt fence in good working condition at all times.

6. Fabric Silt Fence, Type Coir Fiber wet and below water installation:

a. Trenching is not required. Fold a 6 inch (150 mm) flap toward the silt source and pin as shown in the plans. 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. For a wet and/or below water installation, the silt shall be left in place.

809.04 -- Method of Measurement

1. Fabric silt fence is measured by the length of the silt fence in linear feet (meter).

2. Cleaning the slit fence will be measured based on the equipment rental provisions in Section 919.

809.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

Fabric Silt Fence _____	Linear Foot (LF) [Meter (m)]
Rental of Skid Loader	Hour (h)
Rental of Loader	Hour (h)
Rental of Dump Truck	Hour (h)
Rental of Backhoe	Hour (h)
Rental of Crawler Mounted Hydraulic Excavator	Hour (h)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 810 -- SLOPE PROTECTION

810.01 -- 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 plans.

810.02 -- Material Requirements

1. The mulch shall be prairie hay in good condition and generally less than 2 years old. Prairie hay shall mean hay from warm season grass stands.

2. Brome hay is not allowed.

3. a. The mulch shall be free of noxious weeds and certified as "noxious weed free." The certification shall be from the "County Weed Control Authority" or other authorized agent.

b. A copy of the certification shall accompany each load of mulch.

c. The certification shall be placed in a weather-proof container and attached to the stack of mulch it represents.

4. The Engineer shall approve the mulch before use.

5. The seed shall meet the requirements shown in the special provisions.

810.03 -- Construction Methods

1. The Contractor shall commence slope protection work within 5 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. a. When the soil conditions will allow, the Contractor shall drill and broadcast the seed.

b. The seed drill rate and the broadcast rate shall be shown in the special provisions.

c. Broadcast seed is applied after the area is mulched.

4. a. The Contractor shall place the mulch for the slope protection uniformly at 2 pounds/square yard (1.1 Kg/m^2).

b. The slope protection mulch may be applied either by hand or machine. A Hay Buster type machine that unwinds a bale may be used.

c. A machine that chops a bale apart shall not be used.

5. a. The Contractor shall place piles of earth on the mulch to hold it in place. The earth 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 earth shall be of sufficient size to hold the mulch in place. The sources from which the Contractor obtains the earth for weighting down the mulch shall be approved by the Engineer and shall be left in a condition which is satisfactory to the Engineer.

b. (1) In lieu of securing the mulch with piles of earth, 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.

(2) The cleats on both the roller and the crawler tractor shall punch the mulch approximately 6 inches (150 mm) into the soil.

(3) Either device shall have sufficient cleats to anchor all of the mulch.

(4) Shoulders shall average 10 cleat punches per square yard (12 cleat punches per m^2).

(5) Areas other than shoulders shall average 4 cleat punches per square yard (5 cleat punches per m^2).

(6) More than 1 pass may be required to obtain the specified rate of cleat punches.

c. The equipment shall not be operated perpendicular to any slope if such action will promote soil erosion.

6. a. The Contractor shall cleat punch mulch on the project shoulders, and the Contractor shall pile earth as described in Paragraph 6. of this Subsection on the mulch that is within 4 feet (1.2 m) of the pavement.

b. (1) In lieu of using piles of earth on the first 4 feet (1.2 m) of the shoulder, the Contractor may apply 2 continuous strips of soil.

(2) One strip shall be placed at the roadway edge, and another strip should be placed at approximately 40 inches (1 m) from the roadway edge.

(3) The dimension of this strip shall be approximately 5 inches (12.5 mm) wide and 3 inches (75 mm) high at the time of application.

(4) The soil strips shall be applied by machines.

7. a. The Contractor is cautioned that there may be areas requiring mulch that are too steep for machine application or anchoring.

b. Areas that are too steep for machine methods will be done by hand methods.

c. Steep areas are defined as slopes on which the mechanical devices being utilized would significantly disturb the finish grade.

810.04 -- Method of Measurement

1. The slope protection quantity measured is the number of square yards (square meters) of surface area mulched and anchored.

2. The slope protection 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.

3. Slope protection mulch is measured as prescribed in Subsection 805.04.

810.05 -- 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 prescribed in this Section.

SECTION 811 -- SLOPE PROTECTION NETTING

811.01 -- Description

This work shall consist of furnishing and installing a slope protection netting at the locations shown in the plans.

811.02 -- Material Requirements

1. The slope protection netting shall be as shown in the NDR Approved Products List.

2. The pins for the netting shall be 10 inch (250 mm) U-pins with a 2 inch (50 mm) throat. The pin shall be made of 11 gauge [0.120 inch (3 mm)] diameter wire or heavier.

811.03 -- Construction Methods

1. The Contractor shall place the slope protection netting after the hay slope protection mulch is soil anchored and/or cleat crimped.

2. The netting shall be pinned to the ground as shown in the plans.

811.04 -- Method of Measurement

The quantity of slope protection netting for which payment will be made will be the number of square yards (square meters) of slope protection netting placed over the surface of the completed work.

811.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Slope Protection Netting	Square Yard (SY) [Square Meter (m^2)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 812 -- COVER CROP SEEDING

812.01 – Description

1. Cover crop seeding shall consist of furnishing and applying the appropriate cover crop seed as shown in Table 812.01.

2. Cover crop seeding shall be applied to any disturbed area requiring erosion control except areas to receive "Slope Protection" or "Erosion Control, Type _____". It is intended to be used in staged construction areas, surcharge areas, or other disturbed areas that have not been permanently seeded.

3. Certain areas may require cover crop seeding more than once, either because the Contractor disturbs the area as a consequence of normal construction activity or for some other reason that the Engineer determines the seed needs to be replaced.

4. If the cover crop is disturbed through the Contractor's negligent action, then the Contractor shall replant the disturbed cover crop at no additional cost to the Department.

5. The Engineer will designate the areas that are to be cover crop seeded and when they are to be seeded.

812.02 -- Material Requirements

1. The cover crop seed shall comply with the following requirements and shall be applied at the rates shown in Table 812.01.

Table 812.01

Cover Crop Seed Requirements				
Cover Crop Seed and Limitations	**Minimum Purity (%)**	**Minimum Germination (%)**	**Approved Broadcast or Hydraulic Seeder Application Rate**	**Approved Mech. Drill Application Rate**
Oats: Jan. 1 - Aug. 31	80	60	96 lbs/acre (107 Kg/ha)	96 lbs/acre (107 Kg/ha)
Pearl Millet or Foxtail Millet: May 2 - July 15	80	60	25 lbs/acre (27 Kg/ha)	25 lbs/acre (27 Kg/ha)
Winter Wheat: Sept. 1 - Dec. 31	80	60	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 covercrop shall be delivered in bags and tagged with the purity and germination shown on the tag. Bulk seed may be used also, but it too will need a current purity and germination test.

3. Fertilizer is required for cover crop seeding. Rate of application of commercial inorganic fertilizer shall be:

	Rate of Application
Available Nitrogen (N2)	66 lbs./Acre (73 kg/ha)

4. Mulch is not required for cover crop seeding.

5. When there is no quantity of wetland seeding shown in the bid items, the wetland areas shall be covercrop seeded with oats or wheat at a rate of 20 percent of that shown for covercrop seeding. The wetland areas to be covercrop seeded are included in the quantity of "Covercrop Seeding" shown in the plans.

6. If the wetland area is too wet to seed with conventional equipment, the area shall be broadcast seeded or hydroseeded. If the area has too much standing water and the germination of the seed does not seem likely, the project manager will determine if the area shall not be seeded.

812.03 -- Construction Methods

1. The Contractor shall prepare the seed bed only where less than 1 1/2 inch (38 mm) of loose soil is available. This requirement is dependent upon soil type and may be altered at the direction of the Engineer so that less loose earth may be acceptable, but never will more than 1 1/2 inches (38 mm) depth of loose soil be required.

2. a. The Contractor shall apply the seed at the rate shown in Table 812.01.

b. The covercrop seed may be drilled or broadcast and harrowed. If seed is broadcast and harrowed, the covercrop shall be considered “guaranteed to grow”. If replanting is necessary due to failure to obtain an erosion controlling stand of covercrop, the reseeding shall be done at the Contractor’s expense.

c. The seeding equipment shall be calibrated in accordance with the manufacturer's recommended procedures.

d. If the seed is broadcast, a light harrowing shall be required to incorporate the seed into the soil.

e. The harrow may be attached to the broadcast seeder.

3. The work of cover crop seeding shall be started within 24 hours following the finish grading operation.

4. a. Mulching, when directed by the Engineer, shall be applied as stated in Subsection 805.03.

b. Mulching directed by the Engineer for cover crop seeding areas is paid on an extra work basis.

5. The fertilizer shall be applied prior to seeding and incorporated into the soil.

812.04 -- Method of Measurement

1. Cover crop seeding is measured by the acre of ground surface seeded.

2. The quantity to be paid for shall be the quantity shown in the plans, and no field measurement is required. However, when the Engineer

determines that adjustments to the quantity are required due to major deviations from the plans or authorized additions, deletions, or reseeding eligible for compensation, the areas will be calculated from surface measurements of the length and width ± 1 yard. (±900 mm)

812.05 -- Basis of Payment

1. **Pay Item** **Pay Unit**

   Cover Crop Seeding Acre (A) [Hectare (ha)]

2. The quantity shown in the plans includes the necessary additional cover crop seeding due to anticipated phased construction.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 813 -- PEAT MOSS

813.01 -- Description

This work shall consist of incorporating and placing a mixture of commercial peat moss and backfill soil around plant materials at the locations shown in the plans.

813.02 -- Material Requirements

1. The peat moss shall be dark in color, be of a granular variety, and have a pH value between 5.5 and 7.5.

2. The Contractor shall provide the Engineer documents showing the pH of the peat moss before delivery to the project site.

813.03 -- Construction Methods

When called for in the plans, the Contractor shall furnish and thoroughly mix peat moss with the backfill for plant material at the rates as specified in the plans.

813.04 -- Method of Measurement

Peat moss will be measured by the each, where each is a 40 pound (18 Kg) bag; and it must be applied to a designated area. When peat moss is provided in other than 40 pound (18 Kg) bags, the total weight [in pounds (kilograms)] of peat moss applied will be divided by 40 pounds (18 Kg) to get the equivalent number of 40 pound (18 Kg) bags that were applied.

813.05 -- Basis of Payment

1.

Pay Unit	**Pay Item**
Peat Moss	Each (ea)

2. Payment is full compensation for all work prescribed in this Section.

SECTION 814 – TEMPORARY EROSION CONTROL

814.01 -- Description

This work shall consist of the installation of temporary erosion control measures described in the Contractors' "Erosion Control Plan".

814.02 – Material Requirements

1. Temporary Silt Fence

a. The temporary silt fence material may be on the NDR Approved Products List for high or low porosity silt fence, or from other commercially available sources. The material shall be at least 36 inches (900 mm) in height.

b. The stakes may be as shown on the Silt Fence Plan, or as described in Section 809, or they may be wood posts that are furnished already fastened to the silt fence. Prefastened wood stakes may have a spacing of 6 to 8 feet (1.8 m to 2.4 m). If metal studded "T" posts are used, they need not be new.

2. Temporary Mulching

a. The County Weed Control Authority or other authorized agents shall inspect the temporary mulch for noxious weeds. The certification or copy of the noxious weed free status shall be with each load of temporary mulch. Temporary mulch that does not have a certificate with the load shall not be used until the certificate is delivered. If no certificate can be delivered, then the mulch is considered rejected until further information about the mulch is made available.

b. Temporary mulch shall be either dry cured prairie hay, native grass hay from seed growing operations, native grass hay from planted (CRP) warm season grass stands, threshed grain straw, or rushes.

c. Temporary mulch in a stage of decomposition so advanced as to "powder" in the mulch blower shall be rejected and removed from the project.

d. All straw shall be from fields of oats, wheat, or rye that have been harvested for grain. Rye straw shall not be used in any wheat growing area. All straw shall be baled before the seasonal growth of annual weeds begins.

e. All temporary mulch deliveries shall have a weight ticket from a scale approved by the Engineer. The scale ticket shall indicate the weight, be dated, and be signed by the scale operator. The scale ticket shall be given to the Engineer or left in a weatherproof container and attached to the mulch it represents. The Engineer may at any time order the Contractor to reweigh the mulch as a check of the scale ticket.

3. Temporary Ditch Checks

a. Earth or Rock may be used for the Temporary Ditch Checks.

4. Temporary Bale Checks

a. The bales for the temporary bale checks may be grass hay, straw, corn or Milo stalks, or any other approved material. The bales shall be

approximately 18 inches x 18 inches x 36 inches (450 mm x 450 mm x 900 mm).

b. The hold down stakes shall be wood approximately 1½ inch x 1½ inch x 36 inches (38 mm x 38 mm x 900 mm).

c. The filter fabric shall be on the NDR Approved Products List as shown for Erosion Control Type A, AA, or AAA.

814.03 – Construction Methods

1. Temporary Silt Fence

a. The temporary silt fence shall be constructed as shown on the Silt Fence Plan.

b. The temporary silt fence may also be “plowed” in the soil instead of trenched.

c. The Contractor shall maintain the temporary silt fence in good working condition at all times. Good working condition includes fabric repair, post repair, and silt removal.

d. The temporary silt fence shall be removed as directed by the Engineer at the end of its usefulness. Any silt remaining in the temporary silt fence shall be disposed of properly.

2. Temporary Mulching

a. The temporary mulch shall be applied uniformly by a mulch-blowing machine and as directed by the Engineer.

i. Hay shall be applied at the rate of 1.5 tons/acre (3.35 Mg/ha).

ii. Straw shall be applied at the rate of 2 tons/acre (4.5 Mg/ha).

iii. Rushes or similar material shall be applied at the rate of 2.5 tons/acre (5.6 Mg/ha).

b. The Contractor shall anchor the temporary mulch to the soil with a mulch crimper. The crimper for the temporary mulch may be a crimper as described in Section 805 or other approved method or methods. All temporary mulch shall be crimped the same day that it is applied.

3. Temporary Ditch Checks

a. The Contractor shall construct the temporary ditch checks with either earth or rock at locations on the project as determined by the Engineer and the Contractor. The Contractor in the absence of the Engineer may place the temporary ditch checks at other locations to protect the project. The earth temporary ditch check shall be lightly compacted with the machinery that is used to build it.

b. The dimensions of the temporary ditch checks shall be as shown in the plans or as near as practical. The limits of the completed temporary ditch shall extend up the foreslope and backslope far enough to prevent the water from going around the ends.

c. When the life of the temporary ditch checks are determined to be over, they shall be removed. The earth shall be removed and incorporated with the finish grading, or disposed of as determined by the Engineer or Contractor. The rock shall be removed and taken to other places on the project where rock is required, or disposed of off the project.

4. Temporary Bale Checks

a. The Contractor shall place the temporary bale checks at locations shown on the Contractors Erosion Control Plan or as determined by the Engineer and the Contractor. The Contractor, in the absence of the Engineer, may place temporary bale checks at additional locations to protect the project.

b. The installation for temporary bale checks is the same as shown for erosion checks, except there is no erosion control blanket, seed, or soil fill required.

c. The limits of the completed temporary bale check shall extend up the foreslope and backslope far enough to prevent water from going around the ends.

5. Contour Cultivation of Backslopes

a. This work shall consist of using a field cultivator to produce parallel cultivation strips on the contours of the backslopes. The contour cultivation strips shall be 8 feet to 12 feet (2.5 m to 3.7 m) wide located on 25-foot (7.7 m) centers as shown in the plans, or as directed by the Engineer. The areas shall be tilled to a depth of 3 to4 inches (75 mm to 100 mm).

b. This work shall be done as soon as the finish grade is established for any slope slated to be cultivated. This work shall also be performed on slopes that are rough grades but will sit and wait for several weeks before finish grading will be completed.

814.04 – Method of Measurement

1. Temporary Silt Fence

a. Temporary silt fence is measured by the length of the temporary silt fence in linear feet (meters).

b. Cleaning the temporary silt fence will be measured based on the equipment rental provisions of Section 919.

2. Temporary Mulch

a. The weight of the temporary mulch is measured in tons (Mg).

b. The Contractor will provide the Engineer scale tickets showing the weight of the temporary mulch provided.

c. The weight of temporary mulch applied is calculated by multiplying the measured area times the specified application rate.

i. When the total weight from the scale tickets is within 5 percent of the specified weight, then the pay quantity will be the specified weight.

ii. When the Engineer directs in writing the application of a weight greater than the specified weight, then the Department will pay for the quantity of additional mulch that is more than 105 percent of the originally specified weight.

iii. When the scale tickets show that the weight applied is less than 95 percent of the specified weight, then the Department pay quantity will be the weight determined by adding the quantities on the scale tickets.

iv. If the Contractor applies more mulch than directed by the Engineer, then the weight over 100 percent of the specified weight or the amount directed by the Engineer is provided at no additional cost to the Department.

3. Temporary Ditch Checks

a. All work involved in the construction and removal of the temporary ditch checks as directed above, will be included and paid for per linear foot (meter).

4. Temporary Bale Checks

a. All work involved in constructing the temporary bale checks as described above will be included and paid for per bale for the number of bales used as temporary bale checks.

5. Contour Cultivation of Backslopes

a. The work of contour cultivating the backslopes will be measured by the linear foot (meter).

814.05 – Basis of Payment

1.

Pay Item	**Pay Unit**
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 Crawler Mounted Hydraulic Excavator, Fully Operated	Hour (h)
Rental of Dump Truck, Fully Operated	Hour (h)
Temporary Mulch	Ton (Tn) [Megagram (Mg)]
Temporary Rock Checks	Linear Foot (LF) [Meter (m)]
Temporary Earth Checks	Linear Foot (LF) [Meter (m)]
Temporary Bale Checks	Bales
Contour Cultivation of Backslopes	Linear Foot (LF) [Meter (m)]

2. Payment is full compensation for all work prescribed in this Section.

DIVISION 900 -- INCIDENTAL CONSTRUCTION

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 all utility connections for the buildings as prescribed in the plans and specifications.

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) All buildings shall be completely insulated and weathertight.

(2) All buildings shall be constructed from wood or metal.

b. The outside door(s) 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 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. 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/have 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 m^2).

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 m^2). 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.

(3) Waste water shall be drained from the building so as to avoid health and safety problems.

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 m^2).

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.

(3) Waste water shall be drained from the building so as to avoid health and safety problems.

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 grounded and have the capability of producing a power output of 500 watt minimum, 120 VAC at 60 Hz, and have heating volume dimensions of 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) Leakage flux must be 5 mW/cm² or less at 915 or 2450 MHz.

(5) The 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 m^2).

b. An exterior door and sufficient sliding or swinging type windows to provide adequate light and ventilation.

c. Solid work benches, a writing table or desk, and a chair.

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 m^2).

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 working 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 m^2) 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 92 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 all utilities to the office, laboratory, and scale house.

901.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 902 -- GUARDRAIL AND GUARD POSTS

902.01 -- Description

1. This work shall consist of furnishing and erecting guardrails and guard posts at locations shown in the plans.

2. Cable guardrail shall consist of 3 wire cables supported by cable mounts that are attached to steel posts.

3. W-beam and thrie-beam guardrail shall consist of rigid beam elements bolted to the posts with offset blocks.

902.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 902.01.

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

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 and need not be sampled. The aggregate shall be from acceptable sources.

3. The Contractor shall not order or deliver any guardrail items until the Engineer has furnished a field checked list of items, lengths, and locations.

902.03 -- Construction Methods

1. a. The Contractor shall set all posts plumb, firm, and spaced as shown in the plans and to lines and grades given.

b. (1) The Contractor may elect to drive, rather than set, the posts in prebored holes.

(2) Posts damaged when driven into the ground shall be rejected, removed, and replaced with acceptable materials.

(3) Should the Engineer determine that damage is occurring to the surfaced shoulder during post placement due to the Contractor's driving operation, the Engineer will require that the post holes be dug.

c. All areas where the surface of treated timber is broken by cutting, boring, or other means shall be thoroughly coated with 3 applications of the original preservative. Each application should be reasonably dry before the next coat is applied. Bearing plates or washers shall be positioned as shown in the plans and placed under all heads and nuts of bolts which have bearing on wood posts.

d. (1) Steel intermediate posts for cable guardrail may be either driven or placed in predrilled holes. Steel posts that are driven should be protected with a device to prevent deformation of the post.

(2) Cable guardrail end posts shall be installed in predug holes.

(3) Any damage to galvanizing shall be repaired in accordance with Repair Method 2 as prescribed in Section 1061.

e. Sections of steel "W" beams [W6 x 9 (W150 x 14) steel post] will be allowed as an alternate to treated timber posts. Any damage to galvanizing shall be repaired in accordance with Repair Method 2 as prescribed in Section 1061.

f. (1) When posts 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 8 inches (200 mm) deep around the post. 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 plans. 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 moderately compacted to the elevation of the existing surface.

g. The anchorage and bracing of posts shall be as shown in the plans; and all casting, placing, excavating, and backfilling shall be done in a manner approved by the Engineer.

2. a. The Contractor shall install cable guardrail and all associated hardware as shown in the plans. The posts shall be placed, and approved by the Engineer before the guardrail is installed. The cable shall be drawn taut and fastened securely on both ends as shown in the plans. All cable shall be installed with the turnbuckles in approximately the midpoint of take-up or release to provide for future adjustments.

b. Intermediate anchors and terminal anchors shall be installed at the locations shown and in accordance with the applicable plans.

3. a. The Contractor shall assemble "W" and "thrie"-beam guardrail using galvanized steel beams mounted in accordance with the details shown in the plans.

b. Each end of all "W" and "thrie"-beam guardrails shall be fitted with a terminal end section formed in accordance with the details shown in the plans.

c. (1) The beam elements shall be straight and of uniform section, except those elements which must be manufactured to be curved shapes as prescribed in the plans.

(2) Warped or deformed elements will be rejected.

(3) All connections and splices shall be formed with flat round-headed bolts or bolts with heads of similar detail so that no appreciable projection will obstruct a vehicle sliding along the rail.

(4) The edges of the beam elements shall be smooth after fabrication.

d. (1) The Contractor shall install bridge approach sections at the locations shown and in accordance with the plans.

(2) Bridge approach sections shall be mounted directly to the bridge with existing bolts or through special curb mountings or flush mountings shown in the plans. Curb mountings, anchor bolts, and incidentals will be considered as part of the bridge approach sections.

e. The Contractor shall furnish and install, at designated locations, special guardrail posts, fittings, and hardware as prescribed in the plans. The finish will also be prescribed in the plans.

f. The Contractor shall furnish and install all terminal sections at designated locations in conformance with the plans.

g. The Contractor shall submit for the approval of the Engineer such additional plans and shop drawings showing rail and beam punchings, fittings, and assemblies for guardrail as may be requested by the Engineer.

4. Guardrails shall be placed before traffic is allowed access to the road or as indicated in the plans.

902.04 -- Method of Measurement

1. 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 plans.

2. 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 posts 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 end post shall be indicated in the plans. This post shall not be considered as part of the "W" and "thrie"-beam guardrail but shall be included for payment as part of the bridge approach section.

c. When "W" and "thrie"-beam guardrail is installed in conjunction with terminal end sections, the end post shall be shown in the plans and shall be considered as part of the "W" and "thrie"-beam guardrail.

d. Guardrail end treatment is measured by the each.

e. 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)]
Terminal Sections _____	Each (ea)
Special Guardrail Posts	Each (ea)
Special Guardrail Posts _____	Each (ea)
Guardrail Adapter _____	Each (ea)
Guardrail Posts	Each (ea)
Guardrail End Treatment _____	Each (ea)

2. Terminal end shoes, when required by the plans, shall not be measured for payment but shall be considered subsidiary to the items for which direct payment is provided.

3. Payment is full compensation for all work prescribed 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 plans 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 plans. New concrete 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

New materials, replacement materials, and concrete shall conform to the requirements of Section 902.

903.03 -- Construction Methods

1. a. (1) When the pay item is “Remove and Salvage Guardrail”, the Contractor shall remove the guardrail so that all materials may be salvaged.

(2) When the pay item is “Remove Guardrail”, the Contractor shall remove the guardrail and all materials belong to the Contractor and must be removed from the site.

b. Cable removed and not to be reset 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. If the plans call for "Resetting Guardrail", 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 Project Manager 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. The Contractor shall reset the guardrail at the locations shown in the plans or as directed by the Engineer. The work shall be done in accordance with the requirements of Section 902.

3. End posts may be reset providing the 8 inch x 8 inch x 1/4 inch (200 mm x 200 mm x 6 mm) plate is removed from the bottom of the post and

a support bracket is installed on the post at the ground line.

4. Extra line posts may be converted to end posts by removing hook bolts and installing an end post cap and a support bracket as shown in the plans.

903.04 -- Method of Measurement

1. Resetting cable and "W" and "thrie"-beam 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. Removal of cable and "W" and "thrie"-beam guardrails 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 required in this Section.

SECTION 904 -- INERTIAL BARRIER MODULES

904.01 -- Description

The Contractor shall furnish and install sand filled inertial barrier modules (impact attenuators) at the locations shown in the plans.

904.02 -- Material Requirements

1. The inertial barrier modules shall be listed on the NDR Approved Materials List.

2. Filler material for inertial barrier modules shall meet the material and gradation requirements shown in the plans.

904.03 -- Construction Methods

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 prescribed in this Section.

SECTION 905 -- ROCK RIPRAP

905.01 -- Description

The Contractor shall prepare the slopes and furnish and place stone on the slopes at locations shown in the plans.

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/m^3).

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 percent by weight at the completion of 16 cycles of freezing and thawing when tested in accordance with NDR 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 plans.

b. The Contractor shall excavate for energy dissipation holes (scour holes) as prescribed in the plans.

c. All 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 dumped in such a manner as to produce a reasonably solid mass of rock within the limits shown in the plans 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.

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/m^3).

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. Payment is full compensation for all work prescribed 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 plans.

b. Any excavation or embankment necessary to place the riprap to the limits shown in the plans shall be part of this work.

2. The concrete riprap shall be obtained from the areas designated in the plans.

3. a. It shall be the responsibility of the Contractor to ensure that a sufficient quantity of old 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. The concrete riprap shall be reasonably well graded from the largest to the smallest sizes.

2. 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 m^3) feet.

b. No more than 10 percent of the riprap pieces shall have a volume of less than 30 cubic inches (0.0005 m^3).

c. Fifty percent of the riprap shall be composed of pieces with a volume less than 1,220 cubic inches (0.02 m^3).

d. Each piece shall have no dimension greater than 3 times its least dimension.

3. Control of the sizing shall be by visual inspection to verify that the concrete rubble is well graded and does conform to the maximum and minimum sizes specified.

906.03 -- Construction Methods

1. 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 reasonably solid mass within the limits shown in the plans.

2. All material shall be placed so that the large and small sizes are well mixed.

3. Reinforcing steel bars projecting from the mass shall be cut off.

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/m^3).

906.05 -- Basis of Payment

1.

Pay Item	**Pay Unit**
Broken Concrete Riprap	Ton (Tn) [Megagram (Mg)]

2. Payment is full compensation for all work prescribed in this Section.

SECTION 907 -- GABIONS AND REVET MATTRESSES

907.01 -- Description

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 plans.

907.02 -- Material Requirement

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 plans.

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 plans.

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.

907.04 -- Method of Measurement

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 prescribed in this Section.

SECTION 908 -- CONCRETE SLOPE PROTECTION, DITCH LINING, FLUMES AND DISCHARGE STRUCTURES

908.01 -- Description

The Contractor shall furnish all materials, prepare the subgrade, and construct the following as prescribed in the plans:

1. Concrete slope protection.
2. Concrete ditch lining.
3. Concrete flumes.
4. 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.

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 plans.

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.

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 plans. 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.

4. The Contractor shall place joints and reinforcing steel as prescribed in the plans.

5. The backfill shall be graded and compacted to the elevation of the top of the concrete structure as shown in the plans.

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 prescribed in Section 603.

9. a. Concrete ditch liners shall have joints cut through them at least 25 percent 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 plans 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 plans, 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 linear foot (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 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 plans, an appropriate designation will be added to the pay item to differentiate as to the type or dimensions required.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 909 -- INSTALLING TIE BARS

909.01 -- Description

The Contractor shall furnish and install transverse deformed steel tie bars in concrete slabs as prescribed in the plans.

909.02 -- Material Requirements

1. Steel bars used shall be of the size and length specified in the plans and in conformance with Section 1020.

2. Grout shall be listed on the NDR Approved Products List.

909.03 -- Construction Methods

1. a. The Contractor shall drill tie bar holes to the depth shown in the plans. 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

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 prescribed in this Section.

SECTION 910 -- RIGHT-OF-WAY AND BARBED WIRE FENCE

910.01 -- Description

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 prescribed in the plans.

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 Timer 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 to a minimum width of 2 feet (600 mm) on each side of the fence so that the fence will conform to the general contour of the ground.

2. a. Concrete footing construction shall be performed in accordance with the requirements of Section 704.

b. Excavations shall be free of standing water before concrete is placed.

c. 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.

d. Care shall be exercised to prevent dirt, mud, or foreign material from becoming mixed with the concrete which is being placed.

e. Any excavation and backfilling work necessary in connection with the concrete footings shall be in accordance with the applicable requirements of Section 702, except that any excavation and backfilling will not be paid for directly, but 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 consolidated 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 plans 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 plans 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 plans.

i. Fence at stream crossings or drainage ways shall be installed in accordance with the details shown in the plans.

j. (1) When indicated in the plans, 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 prescribed in the plans.

(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.

l. (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 prescribed in the plans.

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 plans.

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 plans. 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 prescribed 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 prescribed in the plans.

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 area 2 feet (600 mm) on each side 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 plans.

(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 plans.

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 plans. Braces and cross ties shall be installed in accordance with the requirements of Subsection 910.03.

c. As indicated in the plans, 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 plans, 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 plans. 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 prescribed in this Section.

SECTION 912 -- SPECIAL SURFACE COURSE FOR MAILBOX TURNOUTS

912.01 – Description

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 prescribed in the plans.

912.02 -- Material Requirements

1. The mailbox turnout surface course shall be constructed from the following:

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 or asphaltic concrete material.

d. Any combination of the above approved in writing by the Engineer.

2. 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 plans.

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 plans.

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 plans.

b. The materials shall be bladed to a uniform thickness over the prescribed 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

Special surface course for mailbox turnouts is measured by the square yard (square meter).

912.05 -- Basis of Payment

1. **Pay Item**	**Pay Unit**
Special Surface Course for Mailbox Turnouts	Square Yard (SY) [Square Meter (m^2)]

2. When asphaltic concrete is used, the amount used, including asphalt cement, is added to the quantities for those pay items.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 913 -- RIGHT-OF-WAY MARKERS

913.01 -- Description

The Contractor shall furnish, install, and relocate right-of-way markers as prescribed in the plans.

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 plans.

2. The forms shall be designed so the finished marker will conform to the dimensions shown in the plans.

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
Right-of-Way Markers	Each (ea)
Reset Right-of-Way Markers	Each (ea)

2. Removal of damaged markers shall be subsidiary to the marker pay item.

3. Payment is full compensation for all work prescribed in this Section.

SECTION 914 -- PIPE UNDERDRAINS

914.01 -- Description

The Contractor shall furnish and install pipe underdrains, filter fabric, and underdrain headwalls as prescribed in the plans.

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 percent 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 100 percent of maximum density as determined by NDR T 99.

4. The trench should be lined with an approved filter fabric before filling with aggregate. The filter fabric shall be installed according to the plan details.

5. Filter fabric shall be on the NDR 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 prescribed 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 material as specified in these Specifications.

b. The granular 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 plans.

7. a. The underdrain headwalls shall be constructed as shown on the plans.

b. The concrete for the headwalls shall be Class 47B-SG-3000 (47B-SG-20 MPa).

8. The Contractor shall place filter fabric as shown on the plans.

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 prescribed in this Section.

SECTION 915 -- GRANULAR SUBDRAINS

915.01 -- Description

The Contractor shall construct granular subdrains as prescribed in the plans.

915.02 -- Material Requirements

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 plans.

2. The Contractor shall provide and place aggregate in the trench as prescribed in the plans.

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

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 prescribed in this Section.

SECTION 916 -- CATCH BASINS, MANHOLES, INLETS, AND JUNCTION BOXES

916.01 -- Description

The Contractor shall construct catch basins, manholes, inlets, junction boxes, and similar concrete structures as prescribed in the plans.

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 plans.

2. The Contractor shall backfill as prescribed 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 as dry as practicable 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 plans 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 plans. 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 prescribed in Section 704.

3. Reinforcement for catch basins, inlets, and junction boxes is measured as prescribed 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 plans with an addition of 3 percent 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)]
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 plans 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 prescribed 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 prescribed in the plans.

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 prescribed in the plans.

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 prescribed in this Section.

SECTION 918 -- ABANDONING MANHOLES, INLETS, AND JUNCTION BOXES

918.01 -- Description

This work consists of demolishing manholes, inlets, and junction boxes and backfilling the area as prescribed in the plans.

918.02 -- Material Requirements

1. Granular material in this Section is defined as material having 90 percent or more retained on the No. 200 (75 µm) sieve.

2. The backfill materials shall be compacted to the density requirements for Class III embankment as prescribed in Subsection 205.03, Paragraph 14.b.(3).

918.03 -- Construction Methods

1. The Contractor shall remove and salvage 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 density 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

"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 prescribed in this Section.

SECTION 919 -- EQUIPMENT RENTAL

919.01 -- Description

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 mm^2) nor more than 12 square inches (7,740 mm^2).

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 m^3).

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 m^3) cubic yards (10.3 m^3).

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 m^3) 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 m^3), 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. 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 steel dump boxes of the end dump type having a volumetric struck capacity of at least 5 cubic yards (3.8 m^3).

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. 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.

12. Disc harrows shall be of the construction type with off-set discs having a diameter of not less than 22 inches (560 mm).

13. Skid loaders shall be loaders or tractors with pneumatic tires and a minimum operating lifting capacity of 1,100 pounds (500 Kg).

14. 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

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 prescribed in this Section.

SECTION 920 -- DAMPPROOFING

920.01 -- Description

The Contractor shall furnish materials and dampproof surfaces as shown in the plans.

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 damproofing 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 loose 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/m^2) of horizontal surface and 5 gallons per 100 square feet (2.25 L/m^2) 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

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 prescribed in this Section.

SECTION 921 -- MAILBOX POSTS

921.01 -- Description

The Contractor shall install and assemble mailbox posts and brackets. The Contractor will not be required to install the mailbox.

921.02 -- Material Requirements

The Department of Roads 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

The post assembly shall be installed as shown in the plans. The Contractor will be required to use a follower block to protect the post during driving.

921.04 -- Method of Measurement

Mailbox posts are measured by the each.

921.05 -- Basis of Payment

1. | **Pay Unit** | **Pay Unit** |
   |---|---|
   | Mailbox Post | Each (ea) |

2. Payment is full compensation for all work prescribed in this Section.

(This page was intentionally left blank.)

DIVISION 1000 -- MATERIAL DETAILS

SECTION 1001 –
GENERAL INSTRUCTIONS AND REQUIREMENTS

1001.01 -- General

Materials used in Department contracts shall meet the requirements prescribed in Division 1000.

1001.02 -- Certified Tests

1. Most certified tests, sampling frequencies, and material certifications are identified and their procedures outlined in the *NDR Materials Sampling Guide* and the *Standard Method of Tests*.

2. a. The contract shall identify other certification tests which are required and the number of copies of certification reports to provide.

b. Certificates of compliance shall be signed by the manufacturer's authorized representative and indicate the representative's job title.

c. Manufacturer's certified tests, reports, and certificates of compliance shall show:

(1) The project number.

(2) The name of the Contractor.

(3) Data analyzed (reports only).

(4) Tests performed.

(5) The quantity of material covered. (Indicate lot numbers.)

(6) The NDR specifications that the product is in compliance with.

(7) Signature and title of an authorized representative.

3. a. 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.

b. The Contractor will be notified by letter from the Engineer that the material is approved for use in the project.

1001.03 -- NDR Approved Products List

1. Materials identified on the NDR 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 NDR Approved Products List do not require a certificate of compliance or certified test report unless the need for such a document is specifically identified in the list or these *Specifications*.

3. Materials added to the NDR 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 NDR Approved Products List may be used, provided:

a. The specifications or special provisions specify that the material must meet appropriate ASTM, AASHTO, Federal, other specifications, and;

b. There are no other NDR specification requirements such as required testing by NDR 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 NDR Approved Products List may use the New Products Evaluation Request Form found at our Department website, or should contact the Physical Testing Section, NDR Materials and Research Division, at (402) 479-4746, for the required material and/or documentation submittal requirements.

b. Products may also be submitted on-line, through the Department's web site.

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 percent 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

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 III portland cement shall be used in Class PR 3 and 47B-PHE concrete. Type I and II portland cement shall be used in all other classes of concrete.

4. 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.

English
Table 1002.02

Concrete Proportions										
Class of Concrete (5), (6)	Cementitious Material (pounds per cubic yard)				Percent Air Content (1)		Slump (inches) (6)		Percent Coarse Agg. to Total Agg.	Water/ Cementitious Ratio Max.
	Total Min.	Portland Cement Min.	Fly Ash Max.	Silica Fume Min.	Min.	Max.	Min.	Max.	(2)	(3)
47B	564	480	98		5.0	7.5		3	30±3	0.48
BX	564	480	98		5.0	7.5		3	(4)	0.48
47BD	658	560	113		5.0	7.5	0.75(7)	4	30±3	0.42
47B-Special	611	520	106		5.0	7.5		3	30±3	0.48
AX	658	560	113		5.0	7.5		3	(4)	0.48
PR1	752	752	Exclude		4.0	7.0		7	30±3	0.36
PR3	799	799	Exclude		4.0	7.0		3	30±3	0.45
Overlay Concrete SF	589	564	Exclude	25	4.0	7.0		5	50±3	0.36
Overlay Concrete HD	823	823	Exclude		5.5	7.5	0.60	1	50±5	0.45
47B-HE	564	565	Exclude		5.0	7.5		7	30±3	0.40
47B-P & 47-PHE	658 to 705	560 to 598	113 to 121		3.0	6.0		7	30 to 60	0.45

(1) As determined by ASTM C 138 or ASTM C 231.

(2) Coarse aggregate shall be limestone unless otherwise specified.

(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 maximum water/cement ratio for any pavement concrete is 0.45. All ratios greater than 0.45 apply only to structures like bridge abutments, piers, or foundations.

(4) Single aggregate (sand-gravel) used for these classes of concrete.

(5) All classes of concrete shall be air-entrained.

(6) The maximum slump may be exceeded by use of water reducer, high range water reducer, or both. Any increase in slump must be preapproved by the Engineer.

(7) When bridge curb is placed with slip form equipment, there is no minimum slump requirement.

Metric
Table 1002.02M

Concrete Proportions										
Class of Concrete (5), (6)	**Cementitious Material (kilograms per cubic meter)**				**Percent Air Content (1)**		**Slump (millimeter) (6)**		**Percent Coarse Agg. to Total Agg.**	**Water/ Cementitious Ratio Max.**
	Total Min.	**Portland Cement Min.**	**Fly Ash Max.**	**Silica Fume Min.**	**Min.**	**Max.**	**Min.**	**Max.**	**(2)**	**(3)**
47B	335	285	58		5.0	7.5		75	30±3	0.48
BX	335	285	58		5.0	7.5		75	(4)	0.48
47BD	390	332	67		5.0	7.5	20(7)	100	30±3	0.42
47B-Special	363	308	63		5.0	7.5		75	30±3	0.48
AX	390	332	67		5.0	7.5		75	(4)	0.48
PR1	446	446	Exclude		4.0	7.0		175	30±3	0.36
PR3	474	474	Exclude		4.0	7.0		75	30±3	0.45
Overlay Concrete SF	349	335	Exclude	15	4.0	7.0		125	50±3	0.36
Overlay Concrete HD	488	488	Exclude		5.5	7.5	15	25	50±5	0.45
47B-HE	335	335	Exclude		5.0	7.5		175	30±3	0.40
47B-P & 47-PHE	390 to 418	332 to 354	67 to 71		5.0	7.5		175	30 to 60	0.45

(1) As determined by ASTM C 138 or ASTM C 231.

(2) Coarse aggregate shall be limestone unless otherwise specified.

(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 maximum water/cement ratio for any pavement concrete is 0.45. All ratios greater than 0.45 apply only to structures like bridge abutments, piers, or foundations.

(4) Single aggregate (sand-gravel) used for these classes of concrete.

(5) All classes of concrete shall be air-entrained.

(6) The maximum slump may be exceeded by use of water reducer, high range water reducer, or both. Any increase in slump must be preapproved by the Engineer.

(7) When bridge curb is placed with slip form equipment, there is no minimum slump requirement.

Table 1002.03

Table of Acceptable Concrete Class Substitutions	
Class Specified	**Acceptable Class for Substitution**
BX	AX, 47B, 47BD, or 47B-HE
AX	47B, 47BD or 47B-HE
47B	47BD, or 47B-HE

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.

5. Class PR3 Concrete:

a. The calcium chloride for use in Class PR3 concrete shall be either:

(1) A commercially prepared solution with a concentration of approximately 32 percent 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 percent 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 Calcium Chloride shall be added at a rate not to exceed 2.0 percent of the weight of the cement for Grade 1 or 1.6 percent of the weight of the cement for Grade 2.

e. An approved Type B set retarding admixture shall be used.

f. Where mixing trucks are used, calcium chloride shall be thoroughly mixed into the concrete before placement. The minimum mixing time is 60 seconds.

g. Where continuous batching equipment is employed, such as the concrete mobile, the calcium chloride solution shall be incorporated in the concrete through a flow meter.

6. a. For Class PR1 concrete, calcium chloride shall be added first and then the concrete mixed at least 2 minutes. Next, the Type F admixture is added and the concrete is mixed at least 5 minutes.

b. The maximum allowable slump after the addition of the admixtures is 7 inches (175 mm).

c. Flaked calcium chloride and Type F high range water-reducer admixture shall be added to the mixing truck according to the procedures in Subsection 1007.03.

d. The Contractor may use liquid calcium chloride in Class PR1 concrete from June 1 through August 31. Flaked calcium chloride shall be used during the remainder of the year, as stated in Paragraph 6.c.

7. a. High Early (HE) strength concrete shall be cured as prescribed in Subsection 603.03, Paragraph 6.a.(1) when the ambient air temperature is 70°F (21°C) or higher.

b. (1) If the ambient air temperature is less than 70°F (21°C), then 47B-HE-3,500 (25) and all other High Early (HE) concrete shall be covered with polyethylene film and insulation board immediately after the curing-compound has been applied.

(2) The insulation board shall have an R-value equal to or greater than 5 ft.² x hr. x °F/BTU (1.0 m^2 x °C/W).

(3) The insulation board shall be protected from the rain.

(4) Insulation must be covered with sheeting to form a tight seal around the concrete and must be adequately anchored to keep the insulation in place.

(5) Insulation board and sheeting shall be maintained for at least 48 hours.

c. High early concrete shall achieve a compressive strength of 3,500 psi (25 MPa) at 48 hours after initial set.

d. The 48-hour compressive strengths shall be used to determine pay factor deductions for high early concrete in accordance with Table 603.02.

8. a. Fly Ash (see Section 1008) may be used in all classes of concrete except those listed as "Exclude" in Table 1002.02.

b. A water-reducing admixture at the manufacturer's recommended dosage is required when using fly ash.

c. Prescribed quantities of fly ash may be used year-round provided loads are not placed on the concrete until the concrete achieves the required compressive strength.

9. Aggregate weight in Table 1002.04 is based on an aggregate bulk specific gravity of 2.62 in a saturated surface-dry condition. When the saturated surface-dry specific gravity of the fine and course aggregates differ by more than 0.01, the weight of the fine and coarse aggregates shall be adjusted by multiplying by the factors in Table 1002.04.

10. The yield of the concrete proportions shall be determined and adjusted by the Engineer.

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.

2. Portland cement concrete shall be supplied by only those plants determined by the Engineer to be in substantial 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.

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. 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. The concrete plant's manufacturer mixing times may be used if the Contractor submits a letter which certifies:

a. What the tolerances are for the plant's drum, paddles, screws and other essential parts;

b. The parts are within the manufacturer's tolerances;

c. The plant is able to mix the concrete as the manufacturer stipulated at the manufacturer's recommended mixing times.

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. Delivery tickets shall be prepared as prescribed in the National Ready Mixed Concrete Association's *Quality Control Manual*. A ticket shall accompany each load to the delivery site and be available for the Engineer.

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 shall be uniformly saturated with water before it is used. The wetting shall begin 24 hours before concrete mixing to allow complete saturation.

9. 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. 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.

b. If the water/cement ratio is varied by more than 1 percent, 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. 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. a. (1) Mobile mixers shall be self-contained and continuously mix the concrete.

(2) The mixer shall be self-propelled and shall be capable of carrying unmixed, dry bulk cement, aggregate, and water.

(3) 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.

b. 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.

c. 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. a. Any combination of aggregates which requires the use of more than the specified maximum pounds (kilograms) of water per 100 pounds (100 kg) of cement to produce a workable mixture with the brand and type of cement to be used will be considered as being unsatisfactory, and all such combinations will be rejected.

b. However, the Contractor may elect to use a water reducing admixture to improve the workability of any unsatisfactory mix if the amount of mixing water is within the requirements of Table 1002.02.

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, 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. Permission may be granted for the use of cement and aggregates already combined in the truck mixers, central plant mixers, transit mix trucks, or truck agitators.

c. 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 AASHTO T 22. Compressive strength cylinders shall be cured in accordance with AASHTO T 23, Paragraph 9.4. The compressive strength requirements shall be as specified. In general, 7-day compressive strength should be 70 percent of the 28-day compressive strength.

7. Concrete shall be sampled as prescribed in the NDR *Materials Sampling Guide*. Samples shall be taken at the point of placement, never before the discharge from the last conveyance.

SECTION 1003 -- FLOWABLE FILL

1003.01 -- Description

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 percent passing the No. 4 sieve (4.75 mm) and not more than 5 percent passing the No. 200 (75 μm) 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 NDR Approved Products List.

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 of paris).

2. Equivalent alkali referred to herein is hereby defined as the sum of the sodium oxide (Na_20) and the potassium oxide (K_20) calculated as sodium oxide (equivalent alkali as $Na_20 = Na_20 + 0.658\ K_20$).

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 percent equivalent alkali.

b. Processing additions may be used in the manufacture of the cement, provided such materials have been shown to meet the requirements of ASTM C 465 and the total amount does not exceed 1 percent of the weight of portland cement clinker.

2. Type IP (portland pozzolan) cement may be used in any application where fly ash modified concrete is allowed. Type IP cement shall conform to the requirements as prescribed in ASTM C 595 and the following requirements:

a. The pozzolan content shall be 25$\pm$2 percent of the cementitious materials by weight.

b. The pozzolan shall be Class F fly ash or a Class N natural pozzolan.

c. Additional fly ash substitution shall not be allowed with Type IP cement containing Class F fly ash. If Class N natural pozzolan is used in the Type IP cement, fly ash substitution is allowed to a total pozzolan content of 25$\pm$2 percent.

d. A water-reducing admixture shall be used in concrete produced with Type IP cement.

e. Mortar bars made and tested according to the provisions of ASTM C 1260 shall have an expansion of no more than 0.10 percent after 28 days. The mortar bars shall be composed of Type IP cement, limestone, and sand and gravel in the proportions used for 47B concrete. The limestone shall be from a Weeping Water, NE, source and the sand/gravel shall be from an eastern Platte River Valley source.

f. 47B concrete made with Type IP shall have a Durability Factor not less than 70 and a mass loss not greater than five percent after 300 freeze/thaw cycles when tested in accordance with ASTM C 666. The freeze/thaw testing shall be conducted according to Procedure A.

1004.03 -- Procedures

1. The Contractor shall provide adequate protection for the cement against dampness. Cement shall be stored in railroad cars or in suitable moisture-proof buildings. The use of tarpaulins for the protection of the cement will not be allowed.

2. No cement which has become caked or lumpy shall be used.

3. Cement which has been spilled shall not be used.

4. Accepted cement which has been held in storage at the concrete mix plant more than 90 days shall be retested.

1004.04 -- Acceptance Requirements

1. a. Approved cements are on the NDR Approved Products List.

b. Cements will be placed on the NDR Approved Products List based on conformance with the NDR Acceptance Policy for Portland Cement. This information is available upon request from the NDR Concrete Materials Section.

2. Portland cement having false set when tested in accordance with the method set forth in ASTM C 187 will not be used. Portland cement will be considered to have false set when either the second or third penetration is less than 50 percent of the first penetration and the fourth penetration is 90 percent or more of the first penetration.

3. Cement coming directly from the manufacturer shall not be used until the temperature is 180°F (82°C) or less.

4. Cement which is placed in storage or is received on the project at temperatures of over 200°F (93°C) shall not be used until acceptable test results are obtained. Samples shall be taken when the temperature of the cement has decreased to 180°F (82°C).

5. 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 cement be held in special silos or bins at the plant or some facility under control of the company furnishing the 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.

6. 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 NDR Materials and Tests Division and approval for use is issued.

b. This procedure will be continued until it can reasonably be assured that the cement from the supplier will again continue to meet contract requirements.

SECTION 1005 -- WATER FOR CONCRETE

1005.01 -- Description

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.

1005.02 -- Material Characteristics

1. Water which contains more than 0.25 percent total solids by weight shall not be used.

2. When required by the Engineer, the quality of mixing water shall be determined by AASHTO T 26.

SECTION 1006 -- CALCIUM CHLORIDE

1006.01 -- Description

Calcium Chloride shall be Grade 1 - Class A or Grade 2 - Class A, B, or C.

1006.02 -- Material Characteristics

The requirements for calcium chloride shall be as shown in AASHTO M 144.

1006.03 -- Acceptance Requirements

Acceptance shall be based on sampling and testing in accordance with AASHTO T 143 and requirements contained in the NDR *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, strength, imperviousness, 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 percent 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 percent or greater and slows down the setting of concrete.

h. Air-Entraining - An admixture that encapsulates air in the 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 percent 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 prescribed in Table 1002.02.

1007.03 -- Procedures

1. 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.

d. The Contractor is responsible for the addition of the admixture.

2. a. If the air content is less than the minimum specified, only one addition of air-entraining admixtures is allowed.

b. If the air content is then outside the limits in Table 1002.02, the load of concrete shall be rejected.

1007.04 -- Acceptance Requirements

1. Admixture approval shall be based upon annual certifications and certified test results submitted to the NDR Materials and Research Division.

2. a. Approved chemical admixtures are shown on the NDR Approved Products List.

b. Every 5 years, suppliers must perform product testing as prescribed in ASTM C 494, Paragraph 1.3.2. level 2 and submit a report of the testing to the NDR Materials and Research Division.

3. The admixture must be essentially identical in concentration, composition, and performance to the admixture tested for certification.

4. Admixtures not identified on the NDR Approved Products List may be used under the following conditions:

a. A certificate of compliance and certified test results must be submitted to the NDR Materials and Research Division, and;

b. Approval for use must be given by the NDR Materials and Research Division.

SECTION 1008 -- FLY ASH

1008.01 -- Description

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 NDR Materials and Research Division. 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 6.0 percent. Additionally, both Class C and Class F pozzolans shall have a maximum allowable free carbon content not to exceed 3.0 percent as determined in accordance with ASTM E 31. Either class of fly ash shall not contain more than 1.5 percent 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 NDR *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 unrepeated order number or other identification number so that each shipment is separately identified.

i. The NDR 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 Roads 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 NDR 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. a. Approved fly ash will be on the NDR Approved Products List.

b. Fly ash may be added to the NDR Approved Products List if it is in conformance with the NDR Acceptance Policy for Fly Ash. This information is available upon request from the Department's Concrete Materials Section.

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 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.

b. 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. 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 NDR Materials and Research Division and approval for use is issued.

b. 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

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 SiO_2 shall be 90 percent 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 86°F (30°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 NDR 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 NDR Approved Products List. The suppliers, in addition to providing a manufacturer's certification of compliance for each shipment, must submit certification annually to the NDR Materials and Research Division stating that their product meets NDR specifications.

2. Silica fume that arrives without proper certification shall be sampled, tested, and approved by the NDR Materials and Research Division before use.

SECTION 1010 -- WHITE OPAQUE POLYETHYLENE FILM AND WHITE BURLAP-POLYETHYLENE SHEET FOR CURING CONCRETE

1010.01 -- Description

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/m^2).

   b. The reflectance, minimum percent, shall be 60.

1010.03 -- Acceptance Requirements

Acceptance shall be based on sampling and testing in accordance with requirements in the NDR *Materials Sampling Guide*.

SECTION 1011 -- BURLAP FOR CURING CONCRETE

1011.01 -- Description

Burlap for curing concrete shall conform to the requirements of this Section.

1011.02 -- Material Characteristics

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

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

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

Liquid membrane-forming compounds shall conform to the requirements of AASHTO M 148, Type 2.

1012.03 -- Acceptance Requirements

Acceptance shall be based on sampling and testing in accordance with requirements of the NDR *Materials Sampling Guide*.

SECTION 1013 -- BITUMINOUS LIQUID COMPOUNDS FOR CURING CONCRETE

1013.01 -- Description

The compound shall consist essentially of an asphaltic base and shall be of a consistency suitable for spraying at temperatures existing at the time of construction operations. It shall 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

When tested in accordance with AASHTO T 155, the loss of water shall not be more than 0.11 lb/ft² (0.55 kg/m^2) of surface area at 3 days, unless otherwise specified by the Engineer.

1013.03 -- Acceptance Requirements

Bituminous liquid curing compounds approved for use are shown on the NDR Approved Products List.

SECTION 1014 -- JOINT SEALING FILLER

1014.01 -- Description

Joint sealing filler shall be either a silicone product or an asphalt product (hot pour) conforming to the requirements of this Section. The type of joint filler to be used shall be as specified in the plans or special provisions. If not specified, any of the joint sealing fillers in this Section may be used.

1014.02 -- Material Characteristics

1. a. Hot-poured joint and crack sealer shall conform to the requirements of ASTM D 6690, Type II. The bond test shall be according to ASTM D 5329 Bond, Non-immersed at 0°F.

i. Material having a bond specification will be tested on concrete blocks that will be constructed by the Department's Concrete Laboratory. The concrete blocks will be constructed using 47B-3000 concrete meeting the requirements of Section 1002 in the Standard Specifications.

ii. The design is amended so that no fly ash is used in the mixture. All other specification for Portland cement concrete apply.

iii. If a Department approved independent laboratory will be used for testing purposes, the Department must be notified so that concrete blocks for bond testing can be sent to the approved independent laboratory.

b. The flow at 140°F (60°C) shall not exceed 0.2 inch (5 mm). Resilience, when tested at 77°F (25°C), shall exhibit a minimum recovery of 50 percent.

2. 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 D 792
Work Time, minimum	10 minutes	
Tack-Free, at 25°C	20-360 minutes	
Cure Time, at 25°C, maximum	14 days	
Full Adhesion, maximum	21 days	
As cured, at 25°C + 1.5		
Elongation, minimum	800%	ASTM D 412
Durometer		
Non-Sag, Shore A	10-25	ASTM D 2240
Self-Leveling, Shore 00, minimum	40	ASTM D 2240
Joint Movement Capacity	+100% to -50%	ASTM C 719
Tensile Stress, at 150% Elongation	45 psi	ASTM D 412

1014.03 -- Acceptance Requirements

1. Acceptance of hot-pour and cold-pour joint sealers shall be based upon sampling and testing of each lot [11 pound (5 kg) sample] in accordance with the NDR *Materials Sampling Guide*.

2. a. Acceptable joint sealing filler lots are listed on the NDR Approved Products List.

b. Approval may be based upon test results from an independent laboratory submitted to the NDR Concrete Materials Section by the manufacturer and random sampling and testing by the NDR.

c. The silicone joint sealer must be essentially identical in composition and performance to that tested for approval.

SECTION 1015 -- PREFORMED JOINT FILLER

1015.01 -- Description

Preformed expansion joint filler shall be furnished in strips of the dimensions specified in the plans.

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 plans 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 plans or specified in the special provisions.

1015.04 -- Acceptance Requirements

1. Preformed joint fillers that are on the NDR 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 NDR Approved Products List.

SECTION 1016 -- PREFORMED POLYCHLOROPRENE ELASTOMERIC JOINT SEALS

1016.01 -- Description

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

Preformed polychloroprene elastomeric joint seals shall conform to the requirements of AASHTO M 220.

1016.03 -- Acceptance Requirements

Acceptance shall be based on sampling and certification requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1017 -- CAULKING COMPOUND

1017.01 -- Description

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

Caulking compounds approved for use are shown on the NDR Approved Products List.

SECTION 1018 -- EPOXY COMPOUNDS AND ADHESIVES

1018.01 -- Description

This specification provides requirements for two-component, epoxy-resin bonding systems and 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 NDR 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.
	Type IV	For use in load bearing applications for bonding hardened concrete and other material to hardened concrete.
	Type V	For use in load bearing applications for bonding freshly mixed concrete to hardened concrete.
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 plans 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 compounds and adhesives approved for use are shown on the NDR Approved Products List.

2. Epoxy compounds that are not on the NDR Approved Products List may be accepted based on a manufacturer's certificate of compliance.

SECTION 1019 -- SEALING COMPOUNDS

1019.01 -- Description

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 NDR Approved Products List are acceptable.

2. Sealing compounds that are not on the NDR Approved Products List may be accepted based on a manufacturer's certificate of compliance.

SECTION 1020 –
STEEL BARS FOR CONCRETE REINFORCEMENT

1020.01 – Description

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 plans, 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

Acceptance shall be based on sampling, testing, and certification requirements in accordance with the NDR Materials Sampling Guide.

SECTION 1021 -- EPOXY COATED REINFORCING STEEL

1021.01 -- Description

1. Steel bars for concrete reinforcement required to be epoxy coated shall conform to the requirements of Section 1020 and as shown in the plans. 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 prescribed in AASHTO M 284M/M 284 and tests performed by the National Bureau of Standards (NBS), a qualified independent testing laboratory, or a state laboratory approved by the NDR 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 NDR 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. 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 plans.

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 strips. Bundled bars shall be handled in a manner which will prevent excessive sagging of bars which will damage the coating. The bundled bars shall not be dropped or dragged and must be stored on wooden cribbing. 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 plans and as specified in Section 707.

8. 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 percent. (The 5 percent 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. 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. a. A plant intending to supply epoxy coated reinforcing steel under these *Specifications* shall be inspected and approved by NDR representatives before making shipments to job sites. The plant shall notify the NDR Materials and Research Division 30 days before processing any material. A date and time of inspection will be arranged by the NDR 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 NDR 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 plans and shall comply with ASTM A 615/A 615M, Grade 40 or 60 (300 or 420).

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.

c. Both Type A and Type B coated dowel bars shall be coated with a bond breaker, dipped in asphalt or paraffin, or greased in accordance with the specified requirements as shown in the Standard Plans.

1022.02 -- Acceptance Requirements

1. 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 NDR 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

Cold-drawn steel wire for concrete reinforcement shall conform to the requirements of AASHTO M 32.

1023.02 -- Acceptance Requirements

Acceptance shall be based on sampling and testing requirements in accordance with the NDR *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 221/M 221M.

1024.02 -- Acceptance Requirements

Acceptance shall be based on sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1025 -- STEEL WIRE FOR PRESTRESSED CONCRETE UNITS

1025.01 -- Description

Steel wire for parallel wire assemblies for post-tensioning shall conform to the requirements of ASTM A 421.

1025.02 -- Acceptance Requirements

Acceptance shall be based on sampling and testing requirements in accordance with the NDR *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 prescribed in the plans.

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

Acceptance shall be based on sampling and testing requirements in accordance with the NDR *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:

Metal center joint sections shall be manufactured from sheets no less than 18

The trapezoidal shaped section of the metal keyway shall be gauge [0.05 inch (1.3 mm)] thick and shall be of the size and trapezoidal shape shown in the plans. The sections shall be punched along the centerline of the narrow face of the trapezoid to admit the tie bars required by the plans 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:manufactured from sheets no less than 24 gauge [0.0276 inch (700 μm)] thick and shall be of the size shown in the plans. 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 plans. 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

Acceptance shall be based on visual inspection by the Engineer to assure the material meets specification and plan requirements.

SECTION 1028 -- SUPERPAVE ASPHALTIC CONCRETE

1028.01 -- Description

1. a. Superpave Asphaltic Concrete is a Contractor-designed mix.

b. The Contractor will be required to define properties using a gyratory compactor that has met the Superpave evaluation test procedures, during mix design and production.

2. a. Before production of asphaltic concrete, the Contractor shall submit, in writing, a tentative job mix formula on the NDOR Mix Design Submittal Form for verification to the NDR Flexible Pavement Engineer at the Lincoln, Nebraska Central Laboratory.

b. The job mix formula shall identify the virgin mineral aggregates, RAP, if used, hydrated lime and mineral filler, if needed, with the value of the percent passing each specified sieve for the individual and blended materials.

c. (1) The Contractor shall submit six – 95 mm gyratory pucks compacted to 7% ±0.5% air voids, and two – 75 mm gyratory pucks compacted to 4% ± 0.5% air voids for testing and 3 proportioned 22 lb. (10,000-gram) samples of the blended mineral aggregates (2 of which that are precoated with hydrated lime and 1 that is not coated) and two one-quart (liter) samples of the proposed PG Binder to be used in the mixture to the NDR Materials and Research Central Laboratory at least 15 NDR working days before production of asphaltic concrete. These samples will be used to verify the Contractor's Superpave mix design test results and mix properties.

(2) Submitted with these samples shall be a copy of the Contractor's results for all Superpave mix design tests.

(3) This mix design shall include at a minimum:

(i) The bulk specific gravity of the blended uncoated aggregate. Whenever RAP is used it shall be processed through an ignition oven and then combined proportionally with the virgin aggregate. The bulk specific gravity shall be determined for the blend from an unwashed sample of the - #4 and a washed sample of + #4 material in accordance with AASHTO T 84 and AASHTO T 85 respectively.

(ii) The target binder content.

(iii) The supplier and grade of PG Binder.

(iv) The maximum specific gravity of the combined mixture (Rice).

(v) The bulk specific gravity and air voids at N initial (Nini), N design (Ndes) and N maximum (Nmax) of the compacted gyratory specimens.

(vi) Voids in the Mineral Aggregate (VMA) and Voids Filled with Asphalt (VFA) at Ndes.

(vii) Fine Aggregate Angularity (FAA), Coarse Aggregate Angularity (CAA), Flat and Elongated Particles and Clay Content of the aggregate blend.

(viii) Location description and/or legal descriptions and producers of materials used in the mix.

(ix) Dust to Binder Ratio

(x) PG Binder recommended mixing and compaction temperatures.

(xi) Type of PG Binder modification, if modified.

(xii) The hydrated lime content.

d. Before the mix design is approved, the Materials and Research Laboratory shall test all properties. This approval is on the submitted laboratory materials, and allows the contractor to begin plant production test strip and verification testing with the QA/QC Program.

3. PG Binder in Recycled Asphalt Pavement:

a. The Contractor may approach the State with a proposal to supplement the virgin aggregates of the asphaltic concrete mix with a Contractor's specified percentage of recycled asphalt pavement (RAP). The State may accept or reject the proposal based on whether the mix design meets the specified criteria of the asphaltic concrete proposed. The RAP may come from the project or an existing stockpile. The Contractor is responsible for investigating the quality and quantity of the RAP material.

b. In recycled asphaltic concrete mixtures, the allowable maximum percent of Reclaimed Asphalt Pavement (RAP) will be as shown in Table 1028.01. If the Contractor elects to exceed these values, the Contractor will be required to lower the minimum pavement design temperature of the PG Binder, one grade, according to AASHTO M320.

Table 1028.01

Asphaltic Concrete Type	Percent, Maximum RAP
SPS	50
SP1	35
SP2	25
SP3	25
SP4 Special	25
SP4	15
SP5	15

4. Quality Control Program:

a. The Contractor shall establish, provide, and maintain an effective 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.

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 course that meets the target field values.

c. The Contractor shall establish a necessary level of control that will:

(1) Adequately provide for the production of acceptable quality materials.

(2) Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met.

(3) Allow the Contractor as much latitude as possible in developing control standards.

d. (1) The Contractor shall develop and keep on file with the Materials and Research Flexible Pavements Engineer a copy of their QC Program.A copy of the QC Program shall be kept on file in the QC lab trailer. This Program shall be updated as needed and submitted annually for review.

(2) The Contractor shall not begin any construction or production of materials without an approved QC Program.

e. The QC Program shall address, as a minimum, the following items:

(1) QC organization chart.

(2) Submittals schedule.

(3) Inspection requirements.

(i) Equipment.

(ii) Asphalt concrete production.

(iii) Asphalt concrete placement.

(4) QC testing plan.

(5) Documentation of QC activities.

(6) Requirements for corrective action when QC and/or acceptance criteria are not met.

(7) Any additional elements deemed necessary.

(8) A list, with the name and manufacturers model number, for all test equipment used during laboratory testing.

(9) A description of maintenance and calibration procedures, including the frequency that the procedures are performed.

f. The QC organization chart shall consist of the following personnel:

(1) A Program Administrator:

(i) The Program Administrator shall be a full-time employee of the Contractor or a Subcontractor (Consultant) hired by the Contractor.

(ii) The Program Administrator shall have a minimum of 5 years experience in highway construction.

(iii) The Program Administrator need not be on the job site at all times but shall have full authority to institute any and all actions necessary for the successful implementation of the QC Program.

(iv) The Program Administrator's qualifications and training shall be described in the QC Program.

(2) One or more Quality Control Technicians:

(i) The quality control technicians shall report directly to the Program Administrator and shall perform all sampling and quality control tests as required by the contract.

(ii) The QC technicians shall be certified by the NDR Materials and Research Division.

(iii) Certification at an equivalent level by a state or nationally recognized organization may be acceptable.

(iv) The QC technician's credentials and NDR training records shall be submitted to the NDR Materials and Research Division.

(v) The Contractor may have a non-certified technician working under the direct supervision of a certified technician for no more than one construction season.

g. (1) Inspections shall be performed daily to ensure continuing compliance with contract requirements until completion of the work.

(2) QC test results and periodic inspections shall be used to ensure the mix quality and to adjust and control mix proportioning.

h. QC Testing Plan:

(1) The testing plan shall include the NDR statistically based procedure of random sampling for acquiring test samples.

(2) The Contractor may add any tests necessary to adequately control production.

(3) All QC test results shall be reported on the latest version of NDR provided Superpave software by the Contractor with a copy provided to the Engineer within 1 week after the tests are complete. Daily review by the Engineer will be allowed if requested. At the completion of the project, the Contractor shall submit a final copy of the Superpave test results on a CD.

i. Corrective Action Requirements:

(1) The Contractor shall establish and utilize QC charts for individual QC tests. The requirements for corrective action shall be linked to

the control charts.

(2) The Contractor's QC Program shall detail how the results of QC inspections and tests will be used to determine the need for corrective action.

(3) (i) A clear set of rules to determine when a process is out of control and the type of correction to be taken to regain process control will be provided.

(ii) As a minimum, the plan shall address the corrective actions that will be taken when measurements of the following items or conditions approach the specification limits:

(I) Plant produced mix gradations at laydown.

(II) Binder content.

(III) Air voids.

(IV) VMA

(V) VFA (mix design only)

(VI) FAA AASHTO T 304

CAA ASTM D 5821

(VII) Dust to Binder Ratio

(iii) Corrective actions that will be taken when the following conditions occur:

(I) Rutting

(II) Segregation

(III) Surface voids

(IV) Tearing

(V) Irregular surface due to mix tenderness

1028.02 -- Material Characteristics

1. The type of PG Binder shall be shown in the plans or special provisions.

2. 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 60 percent limestone on the final surface lift of asphaltic concrete.

c. Crushed rock material for use in asphaltic concrete, 1/4 inch (6.35 mm) down, screenings and manufactured sand shall have a Sodium Sulfate loss of not more than 12 percent by mass at the end of 5 cycles. One 20-lb.

(10-kg) sample shall be taken by NDR personnel at the project for every 5,000 tons (4500 Mg) of aggregate used, with a minimum of one per project for quality testing.

d. Quartzite, granite, and chat shall conform to the requirements of Subsection 1033.02, Paragraph 4, a. (8). One 60-lb. (30 kg) sample shall be taken by NDR personnel at the project every 5,000 tons (4500 Mg) of aggregate used, with a minimum of one per project for quality testing.

e. 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 NDR Materials Sampling Guide. (Some aggregate can be adversely affected by ignition ovens resulting in erroneous reading for asphalt content and gradation unless corrected for.)

f. Amend Paragraph 4.a. (7) of Subsection 1033.02 to provide that soundness tests shall not be required for fine sand.

g. Amend Subsection 1033.02 to provide that 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.

h. Aggregate consensus properties shall be performed on material that does not contain hydrated lime.

i. 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	35
SP1	55
SP2	65
SP3	75
SP4 Special	85/80*
SP4	85/80*
SP5	95/90*

* Denotes two faced crushed requirements

j. 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.

Note: 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. The Contractor will determine the specific gravity to be used in the calculation of FAA mixture design value(s) and, if verified by the NDR Aggregate Laboratory, this same value can be used throughout production. The verification value determined by the NDR 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 NDR 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	--
SP1	40.0
SP2	43.0
SP3	43.0
SP4 Special	45.0
SP4	45.0
SP5	45.0

k. The coarse aggregate shall not contain flat and elongated particles exceeding the maximum value for the appropriate asphaltic concrete type category shown in these provisions according to Table 1028.04.

Table 1028.04
Flat and Elongated Particles*
(ASTM D 4791)

Asphaltic Concrete Type	Percent, Maximum
SPS	25
SP1	10
SP2	10
SP3	10
SP4 Special	10
SP4	10
SP5	10

*Criterion based on a 5:1 maximum to minimum ratio.

l. The sand equivalent of the blended aggregate material from the fine and coarse aggregates shall meet or exceed the minimum values for the appropriate asphaltic concrete type shown in these provisions according to Table 1028.05.

Table 1028.05
Clay Content Criteria
(AASHTO T 176)

Asphaltic Concrete Type	Sand Equivalent, Minimum
SPS	30
SP1	40
SP2	40
SP3	45
SP4 Special	45
SP4	45
SP5	45

m. The blended aggregate shall conform to the gradation requirements specified below for the appropriate nominal size.

(1) It is recommended that the selected blended aggregate gradation does not pass through the restricted zones as specified in the following control points for nominal size. The plot of the blended aggregate gradation of Superpave mix designs with FAA values of less than 43.0 will not enter the limits of the restricted zone. The plot of the blended aggregate gradation of Superpave mix designs with FAA values of 43.0 to less than 45.0 passing through the restricted zone must intersect both the upper and lower limits of the restricted zone between 1) any two consecutive sieves used to define the restricted zone limits, or 2) two vertical lines plotted between the #8

and #50 sieve a distance apart no greater than 1/3 the horizontal distance between the #8 (2.36-mm) and #50 (300-μm) sieves. Superpave mix designs with FAA values of 45.0 or greater will not be restricted from passing through the restricted zone.

Table 1028.06
Gradation Control Points for 0.375 Inch (9.5 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
1/2 inch (12.5 mm)	100.0			
3/8 inch (9.5 mm)	90.0	100.0		
No. 4 (4.75 mm)		90.0		
No. 8 (2.36 mm)	32.0	67.0	47.2	47.2
No. 16 (1.18 mm)			31.6	37.6
No. 30 (600 μm)			23.5	27.5
No. 50 (300 μm)			18.7	18.7
*No. 200 (75 μm)	2.0	10.0		

* see note following Table 1028.08

Table 1028.07
Gradation Control Points for 0.5 Inch (12.5 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
3/4 inch (19 mm)	100.0			
1/2 inch (12.5 mm)	90.00	100.00		
3/8 inch (9.5 mm)		90.00		
No. 8 (2.36 mm)	28.0	58.0	39.1	39.1
No. 16 (1.18 mm)			25.6	31.6
No. 30 (600 μm)			19.1	23.1
No. 50 (300 μm)			15.5	15.5
* No. 200 (75 μm)	2.0	10.0		

* see note following Table 1028.08

Table 1028.08
Gradation Control Points for 0.75 Inch (19 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
1 inch (25 mm)	100.0			
3/4 inch (19 mm)	90.0	100.0		
1/2 inch (12.5 mm)		90.0		
No. 8 (2.36 mm)	23.0	49.0	34.6	34.6
No. 16 (1.18 mm)			22.3	28.3`
No. 30 (600 μm)			16.7	20.7
No. 50 (300 μm)			13.7	13.7
* No. 200 (75 μm)	2.0	8.0		

* Dust to binder ratio is the ratio of the percentage by weight of aggregate finer than the No. 200 (75 μm) sieve to the asphalt content expressed as a percent by weight of total mix. The dust to binder ratio shall be between 0.70 and 1.70.

n. The combined mineral aggregate for Asphaltic Concrete, Type SPS, shall be an aggregate or a combination of aggregates, and mineral filler if needed.

Table 1028.09
Gradation Control Points for Type SPS

	Control Points (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**
1 inch (25 mm)	100.0	
¾ inch (19 mm)	94	100.0
½ inch (12.5 mm)	81	94
No. 8 (2.36 mm)	42	70
No. 16 (1.18 mm)	29	43
No. 30 (600 μm)	19	34
No. 50 (300 μm)	11	20
* No. 200 (75 μm)	2	8

* see note following Table 1028.08

o. Mineral filler shall consist of pulverized soil, pulverized crushed rock, broken stone, gravel, sand-gravel, sand or a mixture of these materials that conforms to the following requirements.

Table 1028.10
Mineral Filler for Type SPS

	Min.	Max.
Total Percent Passing the No. 50 (300 μm) Sieve	95	100
Total Percent Passing the No. 200 (75 μm) Sieve	80	100
Plasticity Index (material passing the No. 200 (75 μm) Sieve, except soil	0	3
Plasticity Index for Soil	0	6

3. Contractor's Lab Equipment:

a. The Contractor shall calibrate and correlate the testing equipment according to the procedures prescribed for the individual tests and conduct tests in conformance with specified testing procedures.

b. The Contractor shall have the following equipment (or approved equal) at or near the project location:

(1) An AASHTO approved gyratory compactor and molds.

(2) An AASHTO approved Asphalt Content Ignition Oven.

(3) Rice equipment specified in AASHTO T 209, procedure 9.5.1, Weighing in Water. The thermometer being used to measure water temperature will be as specified in T 209.

(4) FAA equipment

(5) To test density of compacted asphaltic concrete, a minimum 6000 gm balance, 0.1 gm resolution, with under body connect and water container large enough to conveniently place specimen in the basket and completely submerge the basket and specimen without touching the sides or bottom is required.

(6) QC Laboratory (suggested size 8 ft. x 45 ft.) (2.4 m x 13.7 m) which contain the following:

Air conditioner.

Dedicated phone (where available).

FAX machine.

Xerox type copy machine.

Sample storage.

Work table.

Bulletin board.

Running water.

Desk and chair.

Separate power supply.

Incidental spoons, trowels, pans, pails.

(7) Diamond saw for cutting cores.

(8) Diamond core drill 6 inch (150 mm) and 4 inch (100 mm) diameter core.

(9) Oven, 347°F (175°C) minimum, sensitive +5°F. (+2°C).

(10)USA Standard Series Sieves for coarse and fine aggregate with appropriate shakers (12 inch (300 mm) recommended).

(11)Personal Computer capable of running and creating a CD copy of the latest version of NDR Superpave software and Color Printer.

1028.03 -- Acceptance Requirements

1. Volumetric Mix Design

a. The job mix formula shall be determined from a mix design for each mixture. A volumetric mixture design in accordance with AASHTO R 35 as modified within this special provision will be required. However, the mixture for the Superpave specimens and maximum specific gravity mixture shall be short-term aged for two hours.

(1) Practice for Short and Long-Term Aging of Hot Mix Asphalt (HMA), AASHTO R30

(2) Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of the SHRP Gyratory Compactor, AASHTO T312

b. The optimum binder content shall be the binder content that produces 4.0 percent air voids at Ndes. The design shall have at least four binder content points, with a minimum of two points above and one point below the optimum. Submitted with the design will be plots showing the values of Air Voids, VMA, VFA and Density at the four binder contents. The amount of uncompacted mixture shall be determined in accordance with AASHTO T209. For Type SPS Asphaltic concrete the optimum binder content shall be that which produces air voids at Ndes of 1.5 percent to a maximum of 5.0 percent.

c. The Contractor shall inform the Engineer when changes in mixture properties occur for any reason, such as, but not limited to, the result of changes in the types or sources of aggregates are made or when changes in grades, sources, properties or modification procedures (if modified) of PG Binders are made. These changes 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 and submitted 5 working days prior to use for verification.

d. Superpave mixtures shall contain 1% 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 loose mixture shall be short-term aged for two hours in accordance with AASHTO R30. The 6-inch (152-mm) specimens shall be compacted in

accordance with AASHTO T 312 to seven percent air voids at 95-mm in height and evaluated to determine if the minimum Tensile Strength Ratio (TSR) of 80 percent has been met. If the mixture has not met the minimum TSR value, additional lime shall be added, such that the mix will meet the minimum TSR of 80 percent. All data shall be submitted with the mix design verification request. During production of Lot #1, the Contractor shall provide to the NDR Central laboratory properly prepared gyratory samples for AASHTO T 283 testing for all mixtures. A TSR test result of less than 80 percent will require mixture modification(s) and a sample from subsequent lots will be tested until a TSR value of at least 80 percent is achieved. Moisture sensitivity testing is not required for Asphaltic Concrete Type SPS.

e. Design Criteria:

(1) The target value for the air voids of the asphaltic concrete design shall be 4 percent at the Ndes number of gyrations. For Type SPS Asphaltic concrete the air voids at Ndes shall be a minimum of 1.5 percent with a maximum of 5.0 percent.

Table 1028.11
Gyratory Compaction Effort
(Average Design High Air Temperature ≤39 degrees C)

Asphaltic Concrete Type	Nini	Ndes	Nmax
SPS	6	40	62
SP1	7	68	104
SP2	7	76	117
SP3	7	86	134
SP4 Special	7	76	117
SP4	8	96	152
SP5	8	109	174

(2) The design criteria for each mixture shall be determined from Tables 1028.12, 1028.13, and 1028.14.

Table 1028.12

Mix Criteria	SPS, SP1	SP2	SP3, SP4 Special, SP4, SP5
Voids In Mineral Aggregate	See Table 1028.13		
Voids Filled with Asphalt	See Table 1028.14		
%Gmm at Nini	91.5*	90.5	89.0
%Gmm at Nmax	98.0*	98.0	98.0

* No specification requirement for SPS, only %Gmm at Ndes = 95 to 98.5

Table 1028.13
Voids in Mineral Aggregate
Criteria at Ndes

Nominal Maximum Aggregate Size (Metric)	Minimum VMA, Percent*
3/8 inch (9.5 mm)	15.0
1/2 inch (12.5 mm)	14.0
3/4 inch (19 mm)	13.0

* No specification requirement for SPS

Table 1028.14
Voids Filled with Asphalt
Criteria at Ndes
(for mix design only)

Asphaltic Concrete Type	Design VFA, Percent
SPS	N/A
SP1	70 – 80
SP2	65 – 78
SP3	65 – 78
SP4 Special	65 - 75
SP4	65 – 75
SP5	65 – 75

2. The Contractor shall make Mix adjustments when:

a. Air voids, VMA, FAA, CAA or Binder content do not meet the currently approved criteria.

b. Surface voids create a surface and/or texture that does not meet the criteria of Sections 502 and 503 in these Standard Specifications.

c. Pavement does not meet any other design criteria.

d. Rutting occurs.

3. Mix adjustments at the plant are authorized within the limits shown in Table 1028.15 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 1028.15 will be the tolerances allowed for adjustments from the NDR verified mix design “Combined Gradation” target values which resulted from production or mix design adjustments, but cannot deviate from Superpave gradation criteria, or violate restricted zone criteria specified in paragraph 2. I. (1) of Subsection 1028.02. 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 1028.15

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)	± 6%
No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 μm), No.50 (300 μm)	± 4%
No. 200 (75 μm)	± 2%

4. Sampling and Testing:

a. The Contractor shall take samples at frequencies identified by the Engineer, according to the NDR statistically based procedure. The samples shall be approximately 75 pounds (34 kg) and split according to NDR T-248 either at: 1) the sampling location, with the NDR taking custody of their sample at that time or 2) after being transported to the test facility in an insulated container, 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 the lab calculation sheet from the latest version of the superpave software, stored, and retained by the Contractor until the NDR has completed the verification testing process.

c. (1) The sample shall be taken from the roadway, behind the paver before compaction or from the windrow.

(2) At least one QC sample shall be tested for every 750 tons (680 Mg) of plant produced mix.

(i) If, at the completion of the project, the final lot consists of less than 3,750 tons (3,400 Mg) of asphaltic concrete, 1 sample for each 750 tons (680 Mg) or fraction thereof, shall be taken and tested.

(3) Additional sampling and testing for the Contractor's information may be performed at the Contractor's discretion. Any additional testing will not be used in pay factor determination.

(4) At least 1 sample shall be taken between the first 110 tons (100 Mg) and 300 tons (270 Mg) at the following times: 1) at the project start-up, 2) when a test result, identified in Paragraph 4,h,(3) of Subsection 1028.03, is out of specification, and 3) when a substantial aggregate proportion or other major mix change has been made. This sample, when other than at start-up, will be in lieu of the next scheduled random sample location.

(5) The Contractor will be notified what sublot sample must be tested for FAA and CAA according to the NDR random sampling schedule. The FAA and CAA may be sampled from the blended cold feed material prior

to hydrated lime coating, but in addition the Contractor will be required to test FAA and CAA from a roadway sample using an ignition oven sample for correlation. If the coarse portion of the blend is all ledge rock the CAA tests can be waived. If the samples tested with the ignition oven meet the CAA and FAA minimum requirement, then the cold feed sample does not have to be tested. When both ignition oven and cold feed samples are being tested the acquisition of the samples shall be timed such that each sample represents, as close as possible, the same aggregate being fed into the plant.

(6) 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) (i) 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 AASTHO T 209 procedure 9.5.1. Weight in water - Maximum Specific Gravity of Bituminous Paving Mixtures.

(3) (i) The Blended Aggregate Bulk Specific Gravity (Gsb) shall be determined from a combined aggregate blend not coated with hydrated lime, including any RAP following ignition burn-off, on the + #4 and - #4 material. This test and recalculation will be required if the mix design changes according to the tolerances in Paragraph 3.c. of subsection 1028.03 and/or table 1028.15.

(ii) AASHTO T 84 - Specific Gravity and Absorption of Fine Aggregate.

(iii) AASHTO T 85 - Specific Gravity and Absorption of Coarse Aggregate.

(4) The laboratory air voids shall be determined in accordance with the following:

Table 1028.16

Gmb(corr)@Nany = Gmb(meas)@Nmax x (height@Nmax ÷ height@Nany)
%Gmm(corr)@Nany = 100 x (Gmb(corr)@Nany ÷ Gmm(meas))
% Air Voids@Nany = 100 - %Gmm(corr)@Nany
VMA@Ndes = 100 – (Gmb(corr)@Ndes x Ps ÷ Gsb)
VFA@Ndes = 100 x ((VMA@Ndes - % Air Voids@Ndes) ÷ VMA@Ndes)
Measured = (meas)
Corrected = (corr)

(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 0.4% 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 prescribed in the NDR 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 NDOR provided "Superpave" software. A copy containing complete project documentation will be provided to the Materials and Research Division at the completion of the project.

g. QC Charts:

(1) QC charts shall be posted at the asphalt production site and kept current with both individual test results and moving average values for review by the Engineer.

(2) Control charts shall include a target value and specification limits.

(3) As a minimum, the following values shall be plotted or reported on NDR 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 0.1 percent by ignition oven results in accordance with AASHTO T 308 as stated in paragraph 4.e.(5)(i) of Subsection 1028.03..

(iv) The theoretical maximum specific gravity (Rice) to the nearest 0.001 percent will be reported.

(v) Laboratory Gyratory air voids at Ndes shall be plotted to nearest 0.1 percent. Laboratory Gyratory air voids, at Nini, Ndes and Nmax shall be reported to nearest 0.1 percent.

(vi) FAA and CAA of the asphaltic concrete for both cold feed and ignition oven samples will be reported to the nearest 0.1 percent.

(vii) VMA content shall be plotted to nearest 0.1 percent and VFA shall be reported to the nearest 0.1 percent.

(viii) Dust to Binder ratio to the nearest 0.01 will be reported.

h. Independent Assurance (IA) Review of Testing:

(1) The Contractor will allow NDR personnel access to their laboratory to conduct IA review of technician testing procedures and apparatus. Any deficiencies discovered in testing procedures will be noted and corrected.

(2) During IA review, NDR personnel and the Contractor will split a sample for the purpose of IA testing. The sample(s) selected will be tested in the NDR Branch Laboratory. Any IA test results found to be outside of defined testing tolerances will be noted. The Contractor must then verify the testing apparatus and make corrections if the apparatus is out of tolerance.

(3) Testing Tolerances

(i) Asphaltic Concrete and Asphaltic Concrete Aggregates.

Table 1028.17

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	0.5%
CAA	10.0%
Field Core Density	0.020

(4) Aggregate Gradation (Blended Aggregate)

Table 1028.18

Size Fraction Between Consecutive Sieves, %	**Tolerance**
0.0 to 3.0	2%
3.1 to 10.0	3%
10.1 to 20.0	5%
20.1 to 30.0	6%
30.1 to 40.0	7%
40.1 to 50.0	9%

5. a. In response to tests results, the Contractor shall notify the Engineer whenever the process approaches the Specification limits.

b. When any single test result(s), on the same mix property, from two consecutive QC samples fall outside the allowable production tolerances in Table 1028.19, the material represented by these tests will be accepted with a 20% penalty or rejected, as determined by the Engineer.

Table 1028.19
Production Tolerances*

Test	***Allowable Single Test*** **Deviation from Specification**
Voids in the Mineral Aggregate	- 1.00% to + 1.25% from Min.
Dust to Asphalt Ratio	None
Coarse Aggregate Angularity	- 5% below Min.
Fine Aggregate Angularity	- 0.50% below Min.

* These tolerances are applied to the mix design specification values, not the submitted mix design targets.

c. The Contractor shall assume the responsibility to cease operations when specifications other than those stated in Table 1028.19 are not being met and production shall not be started again without approval of the Engineer.

6. Verification Sampling and Testing:

a. The NDR will select and test at random one of the sublot samples (750 tons, 680 Mg) within a Lot (3750 tons, 3400 Mg) for verification and report results in a timely manner.

b. The results of Contractor QC testing will be verified by NDR verification tests. On any given Lot, if the results of Air Void verification testing and its companion QC testing are within 1.4 percent 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 sublot. Any or all of the remaining four NDR sublot samples may be tested and the NDR sublot test results may be applied to the respective sublots and the resulting pay factors will apply.

c. When verification test results show a consistent pattern of deviation from the QC results, the Engineer may cease production and request additional verification testing or initiate a complete IA review.

d. If the project personnel and the Contractor cannot reach agreement on the accuracy of the test results, the Materials and Research Laboratory will be asked to resolve the dispute, which will be final.

7. Acceptance and Pay Factors

a. Acceptance and pay factors for Asphaltic Concrete Type SPS will be based on compacted in place average density.

b. Acceptance and pay factors for Asphaltic Concrete Type SP1, SP2, SP3, SP4 Special, SP4 and SP5 will be based on single test air voids, running average air voids, compacted in place average density, and production tolerances pay factor as stated in Paragraph 5.b. subsection 1028.03

(1) When there is a production tolerance pay factor penalty as stated in Paragraph 5.b. subsection 1028.03 this penalty percentage will be subtracted from the percent pay for single test air voids for each sublot affected. These three individual pay factors will then be multiplied by each other to determine a total pay factor for each sublot [(750 tons) (680 Mg)].

8. Asphaltic Concrete Air Voids

a. Normally, 1 sample for testing will be taken from each sublot [(750 tons) (680 Mg)] at locations determined by the Engineer.

b. 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 1028.20.

c. If the average air voids pay factor is (50% or reject) the NDR will have the first option of accepting or rejecting the asphaltic concrete represented in this sublot. If the NDR accepts this sublot the Contractor will have the second option of replacing this asphaltic concrete for no pay on the removal and for whatever pay factor that applies to the replacement.

d. In the case of removal, the foremost limits of the removal will be defined as the tonnage (mass) at which the production and placement was halted and a design change was made. The rear limits will be at the tonnage (mass) where linear interpolation with the previous test return to an accepted range and out of rejection limits or at the limit(s) of the defective material as determined by additional core samples taken and tested by the Contractor which show result(s) in an acceptable range and out of rejection limits to the satisfaction of the Engineer.

Table 1028.20

Acceptance Schedule Air Voids - N_{des}		
Air voids test results	**Moving average of four**	**Single test**
Less than 1.5%	Reject	Reject
1.5% to less than 2.0%	Reject	50%
2.0% to less than 2.5%	50% or Reject	95%
2.5% to less than 3.0%	90%	95%
3.0% to less than 3.5%	100%	100%
3.5% to 4.5%	102%	104%
Over 4.5% to 5.0%	100%	100%
Over 5.0% to 5.5%	95%	95%
Over 5.5% to 6.0%	90%	95%
Over 6.0% to 6.5%	50% or Reject	90%
Over 6.5% to 7.0%	Reject	50%
Over 7.0%	Reject	Reject

9. Asphalt Concrete Density Samples:

a. Density tests will be performed by the Contractor under direct observation of NDR personnel. The Contractor will establish the method of testing in the preconstruction conference and shall be tested in accordance with the AASHTO T 166 or NDR T 587. The Contractor will insure that the proper adjustment bias and/or correction factors are used and accessible to NDR personnel along with all other inputs when NDR T 587 is selected. All correlation factors and test results shall be generated and reported on the NDOR Density spreadsheet. All disputed values determined using NDR T 587 shall be resolved using AASHTO T 166.

b. Density of samples shall be determined by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice) as follows:

$$\% \text{ Density} = \frac{\text{Specific Gravity of Core}}{\text{Maximum Mix Specific Gravity (Rice)}} \times 100$$

where:

$$\text{Sp. Gr. of Core} = \frac{\text{Wt. of Core in Air}}{\text{Wt. of SSD Core} - \text{Wt. of Core in Water}}$$

$$\text{Maximum Mix Specific Gravity (Rice)} = \frac{\text{Wt. of Mix in Air}}{\text{Wt. of Mix in Air} - \text{Wt. of Mix in Water}}$$

Note: The individual QC test value of the Maximum Mix Specific Gravity (Rice) will be used to calculate the density of each corresponding core.

c. Either 4 inch (100 mm) or 6 inch (150 mm) diameter core samples shall be cut by the Contractor the first day of work following placement of the mixture.

d. Normally, 1 sample for determination of density will be taken from each sublot (750 tons) (680 Mg) at locations determined by the Engineer.

e. The theoretical maximum density for each lot (3,750 tons) (3,400 Mg) shall be calculated using AASHTO T 209.

f. 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.

(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 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 samples of more than 1 inch (25 mm) thickness for the determination of the pay factor for density.

g. For the first lot (3,750 tons) (3,400 Mg) of asphaltic concrete produced on a project and for asphaltic concrete used for temporary surfacing, the pay factor for density shall be computed in accordance with Table 1028.21. After the completion of the first lot, the pay factor for density shall be computed in accordance with Table 1028.22.

h. (1) If, at the completion of the project, the final lot consists of less than 3,750 tons (3400 Mg) of asphaltic concrete, a minimum of 3 samples, or 1 sample for each 750 tons (680 Mg) 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 1028.22.

(3) Should the average of less than 5 density tests indicate a pay factor less than 1.00, additional density samples to complete the set of five shall be taken at randomly selected locations and the density pay factor based on the average of the 5 tests.

Table 1028.21

Acceptance Schedule Density of Compacted Asphaltic Concrete (First Lot)	
Average Density (5 Samples, Percent of Voidless Density)	**Pay Factor**
Greater than 90.0	1.00
Greater than 89.5 to 90.0	0.95
Greater than 89.0 to 89.5	0.70
89.0 or Less	0.40 or Reject

Table 1028.22

Acceptance Schedule Density of Compacted Asphaltic Concrete (Subsequent Lots)	
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

i. If requested by the Contractor, check tests for all density tests in the original set, taken no later than the working day following placement 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 checks tests will be determined by a new random sampling schedule provided by the Engineer. The average density obtained by the check tests shall be used to establish the density pay factor for the lot.

10. PG Binder Sampling

a. At least one sample (2-1 quart cans) (2-1 liter cans) of PG Binder will be sampled by the Contractor's QC Technician for every Lot (3750 tons) (3400 Mg) of asphalt concrete mixture produced.

b. Samples will be taken in accordance with NDR Standard Method T40.

c. The QC Technician will include on the Sample Identification form all information required by the contract.

SECTION 1029 – PERFORMANCE GRADED BINDER

1029.01 -- Description

1029.02 -- Material Characteristics

I. Description

The performance graded binder to be used on this project shall be supplied by a Certified Supplier.

Certified Supplier

A supplier must be certified by the Nebraska Department of Roads to be allowed to supply Performance Graded Binder in Nebraska. 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
3. Combined States Binder Group

The supplier must maintain and follow the requirements of the group or groups in which they participate in, to maintain certification by the Nebraska Department of Roads. In addition, active participation is required to maintain certification by the Department. Active participation will include submitting of round robin sample results, along with meeting other requirements of the group or groups. Failure to do so will result in loss of certification by the Department.

A certified supplier may be asked to supply to the Department, past round robin results, laboratory inspection reports, reasons for and investigative reports on out lying results, quality control testing, and/or technician training and proficiency testing reports.

The binder supplier agrees 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.

Supplier Certification

A supplier may request certification by contacting the Nebraska Department of Roads, Materials and Research Division, Flexible Pavement Engineer at (402) 479-4675. 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. 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 binder groups.

A supplier may become certified through active participation in other binder certification/round robin groups that are approved by the Department. The Department may request from the supplier prior to approval, past or current round robin results, quality control testing, laboratory inspection reports, and/or technician training and proficiency testing reports.

II. Binder Sampling and Testing:

1. Lots. Each 3750 tons (3400 Mg) of HMA produced will be a binder lot.

2. A binder lot will include only one PG Binder grade or a blend as allowed in paragraph 6.e.

3. A binder lot will only include one supplier of the PG Binder or a blend as allowed in paragraph 6.e.

4. Blending of different binder grades and binders from different suppliers will be allowed with restrictions as noted in paragraph 6.e. The Engineer must be notified of the intent to blend prior to actual blending.

5. All binders shall be sampled at the rate of at least one sample per lot with a minimum of three samples per project.

a. The sample shall consist of two one-quart (liter) cans and shall be taken by the Contractor's Certified Sampling Technician, with assistance from or under supervision of NDR 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 at which material sampled is representative of the material in the line to the mixer. One can will be tested for compliance with AASHTO M320 specifications and the other can portion will be saved for dispute resolution, if needed. The sampling process shall follow procedures of the NDR Materials Sampling Guide and NDR T 40.

b. Testing. When the tested PG Binder is in compliance, the binder lot will be accepted and both cans of the sample can be discarded. If the tested PG Binder does not comply, then the price of the PG Binder lot represented by the sample shall be adjusted according to Tables 2, 3, 4 and 5. Overall project average testing requirements and price adjustments will also apply, as stated in Table 6.

6. Material Requirements

a. Performance graded binder, as specified in the contract items shall be in accordance with the PG+ specifications as noted, and AASHTO M320 with the exception of Direct Tension.

b. Substitution of a PG Binder, which exceeds the upper and lower grade designations from the specified, requires advance notification of the Engineer, and be documented by a no cost change order. The bill of lading or delivery ticket shall state the binder grade and specific gravity.

c. Material Certification - A Material Certification shall be submitted prior to construction, stating the type of modifier being used, and the recommended mixing and compaction temperatures for the Hot Mix Asphalt. The Material Certification must state that acid has not been used. The Material Certification must also state that the material has not been air blown or oxidized.

d. The Contractor shall receive from the supplier, instructions on the proper storage and handling of each grade and shipment of PG Binder.

e. Blending of PG Binders at the hot mix plant site will be allowed only when transitioning to an asphalt mixture requiring a different grade of binder and with the following restrictions:

(1) The resultant blend will meet AASHTO M320 specifications when tested as ±3° C of the specified PG binder. The sample of the blended material will 1) be considered as a lot sample, 2) be taken during initial production following the blending of the binders, and 3) deductions when not meeting M320, will apply. On the blended sample's identification form will be a note explaining the blending conditions and a statement that the sample is a blend of materials. 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 M320 specifications.

(2) Modified Binders - When a type of modification is used and stated in the Material Certification as required in paragraph 6.c., it will not be allowed to be blended with a binder containing a different type of modification. Blending of the same type of modifiers will be allowed.

f. When PG 64-28, 70-28 and 76-28 are specified the following PG+ specifications (Table 1) and AASHTO M320 with the exception of Direct Tension) will apply:

(1) The performance graded binder shall be a binder, which incorporates a blend of base asphalt and elastomer modifiers of styrene-butadiene (SB), styrene-butadiene-styrene (SBS) or styrene-butadiene-rubber (SBR). Acid shall not be used. Air blown and/or oxidized asphalt will not be allowed. The supplier must certify that the binder is not acid modified, and that acid was not used. The binder supplier must also certify that air blowing or oxidization has not been done/used to modify the binder or used to change the properties of the binder. The composite material shall be thoroughly blended at the asphalt refinery or terminal prior to being loaded into the transport vehicle. The polymer modified binder shall be heat and storage stable and shall not separate when handled and stored per the suppliers storage and handling recommendations.

(2) Samples of binder proposed for use and production lot samples shall be submitted to the Materials and Research, Bituminous Laboratory for testing to insure the binder is of a modification system in which no acid is used. ARR-MAZ AD-here LOF65-00, amine anti strip will be added at the rate of 0.5% to sample(s) that have been heated to 300 degrees F or until viscous and stirred for a minimum of 5 minutes. The resultant blend will then be tested for PG grading and compared to PG grading prior to the blending. The resultant blend shall meet M320 specifications and shall not show a drop of G*/sin(delta) of more than 25% when compared to the result(s) of the sample prior to blending the anti strip. If the resultant blend does not meet M320 specification or shows a drop of greater than 25%, the material that is represented by the sample will be rejected.

(3) Approval for initial use will be based on the sample(s) meeting the PG+ specifications as stated in Table 1 and M320 specifications. Approval for use will also be based on PG grading when comparing results after blending anti strip to PG grading prior to the addition of anti strip.

(4) Lot samples of the binder shall meet or exceed the PG+ specifications as listed, in addition to M320 specifications. For PG+, Table 1 specification testing, material will be tested on original unaged binder for phase angle specification and RTFO aged material for elastic recovery. Anti strip will also be added to project lot samples as described in 6.g.(2).

(5) When it is determined that material does not meet Table 1 specifications, Table 2, 3 and 4 will apply, depending on the grade of binder. When it is determined that a single sample(s) does not meet M320 specifications, Table 5 will apply.

(6) All project samples will be tested for PG+ specification compliance.

Table 1
Additional Specifications for PG 64-28, 70-28 and 76-28

	PG 64-28	PG 70-28	PG 76-28
Elastic Recovery; AASHTO T301 tested at 77°F (RTFO Aged AASHTO T301)	Minimum 60%	Minimum 70%	Minimum 75%
Phase Angle; degrees (Max) (Original Binder)	77.0	75.0	70.0

Table 2
Single Sample Tolerance and Pay Factor Table
PG 64-28

	(1) Pay Factor of 0.75	(2) Pay Factor of 0.50 or Removal
Elastic Recovery Percentage (RTFO Aged AASHTO T301)	54 to 57.5%	Less than 54%
Phase Angle (degrees) (Original Binder)	78.5 – 79.0	Greater than 81.0°

Table 3
Single Sample Tolerance and Pay Factor Table
PG 70-28

	(1) Pay Factor of 0.75	(2) Pay Factor of 0.50 or Removal
Elastic Recovery Percentage (RTFO Aged AASHTO T301)	64 to 67.5%	Less than 64%
Phase Angle (degrees) (Original Binder)	78.5 – 79.0	Greater than 79.0°

Table 4
Single Sample Tolerance and Pay Factor Table
PG 76-28

	(1) Pay Factor of 0.75	(2) Pay Factor of 0.50 or Removal
Elastic Recovery Percentage (RTFO Aged AASHTO T301)	65 to 70%	Less than 65%
Phase Angle (degrees) (Original Binder)	71.5 – 75.0	Greater than 75.0°

Table 5
Single Sample Tolerance and Price Factor Table

	Pay Factor of 0.75[1]	Pay Factor of 0.50 or Removal[2]
Tests on Original Binder Dynamic Shear, G*/Sin δ, kPa	0.86-0.92	< 0.86
Tests on Rolling Thin Film Oven Residue Dynamic Shear, G*/Sin δ, kPa	1.60-1.80[3]	< 1.60[3]
	1.76-1.97	< 1.76
Tests Pressure Aging Vessel Residue Dynamic Shear, G*Sin δ, kPa	5601-6200	> 6200
Creep Stiffness S, mPa	325-348	> 348
m-Value	0.270-0.284	< 0.270

Note: If more than one test fails to meet requirements, the largest individual price reduction (pay factor of 0.75 or 0.50) will be used to calculate price reduction for the asphalt binder.

[1] Price Reduction will be based on contract unit price of asphalt binder.

[2] The Engineer will determine if the non-compliant material will be removed. Removal and replacement will be at no additional cost to the Department. If the non-compliant material is accepted, a price factor of 0.50 will be applied. The price factor will be applied to the contract unit price of asphalt binder.

[3] For PG Binder 76-28 only.

The pay factor will be applied to the quantity of material that the sample represents.

Overall Project Average - Price Reduction Based on Complete M320 Testing

Overall Project Averages does not apply to tested samples after the addition of anti strip. Samples not meeting PG+ specifications and the requirements after the addition of anti strip will be rejected.

PG+, Table 1 specifications do not apply to Overall Project Averages. PG+, Table 1 specification testing will be conducted on each Lot sample.

Out of specification material will be determined by the specifications outlined in AASHTO M320, excluding Direct Tension.

The Nebraska Department of Roads, Materials and Research, Bituminous Laboratory will do complete testing, per M320 specifications, on a minimum of three samples or 20% of the total samples from the project, whichever is the greatest. The Department will randomly select one sample for complete M320 testing out of every five samples received. When any test result shows sample not meeting M320 specifications, the previous and following sample received will be tested for complete M320 compliance. Testing will continue in this manner until tested samples meet all of M320 specifications, or there are no more lot samples to be tested.

Original Dynamic Shear Rheometer testing will be completed on all samples. When a sample being tested for only Original Dynamic Shear Rheometer compliance falls out of M320 specification, it will then be tested for complete M320 specification compliance. Adjacent samples will be tested when results, other than the Original Dynamic Shear Rheometer result, do not meet specification. This additional complete testing for M320 compliance is in addition to the minimum number of samples that will be tested for complete M320 compliance.

At the completion of testing, all complete M320 test results will be averaged. For averages that do not meet M320 specifications, the largest reduction shown in Table 6 will be applied to all the Performance Graded Binder used on the project.

Table 6
Overall Project Average – Pay Factor Table

	Range of Average	Pay Factor Applied
Tests on Original Binder Dynamic Shear, G*/Sin δ, kPa Min. 1.00 kPa	< 1.00 – 0.98 < 0.98 – 0.96 < 0.96 – 0.94 < 0.94	0.98 0.95 0.92 0.85
Tests on Rolling Thin Film Oven Residue Dynamic Shear, G*/Sin δ, kPa Min. 2.20 kPa	< 2.20 – 2.156 < 2.156 – 2.09 < 2.09 – 2.024 < 2.024	0.98 0.95 0.92 0.85
Tests Pressure Aging Vessel Residue Dynamic Shear, G*Sin δ, kPa Max. 5000 kPa	< 5000 – 5100 < 5100 – 5250 < 5250 – 5400 < 5400	0.98 0.95 0.92 0.85
m-Value Min. 0.300	< 0.300 – 0.298 < 0.298 – 0.293 < 0.293 – 0.290 < 0.290	0.98 0.95 0.92 0.85
Creep Stiffness S, mPa Max. 300 mPa	< 300 – 306 < 306 – 315 < 315 – 324 < 324	0.98 0.95 0.92 0.85

Single Sample Reduction and Overall Project Average Reduction

A sample representing a lot, not meeting M320 Specification, will have a reduction for the material that the sample represents. Only the largest reduction from Table 5, will apply when more than one result of a single sample does not meet M320 specifications. Only the largest overall project average reduction from Table 6, will apply when more than one test average falls out of M320 specifications. Pay Factors based on both Table 5 and Table 6 test results are separate from each other and both will be applied.

Investigation of Verification Lot Samples That Do Not Meet Specifications

When the lot sample shows test results out of specification limits, the process of resolving the sample failure will include the following actions as appropriate:

1. The Bituminous Lab may conduct retesting of the remaining portion of the original can sample as determined necessary to confirm or disaffirm the original test result(s).

2. The Flexible Pavement Engineer will notify the Contractor who will arrange to investigate all aspects of the testing, loading, handling and delivery of the material in question. The Contractor shall report findings to the Central Laboratory, Flexible Pavement Engineer.

3. The Department will collect and compile all information and prepare a report. A copy of the report will be distributed to the District and the Contractor.

4. The Bituminous Laboratory will issue the standard report of tests for all samples tested, to include any resulting pay factor deductions. A copy of the report of tests will be distributed to the District, Construction Division, and Contractor.

Dispute Resolution

After testing and investigations have been completed on the one can of the sample and there is still a dispute, the Department will select an independent laboratory for referee testing to take place on the second can of the sample. 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.

1029.03 -- Procedure

1. Storage tanks, transfer lines, and loading facilities for performance graded binder shall be provided with adequate heating equipment that can be controlled to prevent overheating. Performance graded binder offered for testing, in storage or at the time of loading, shall not exceed 401°F.

2. The producer or supplier furnishing performance graded binder shall comply with the following requirements for tank cars and tank trucks:

a. Tank cars used for shipment shall be in good order and equipped with heating coils. Leaking heating coils or other defects in the tank car which may allow contamination of the performance graded binder will be sufficient cause for rejection of the performance graded binder. Cars shall be inspected, drained, and cleaned, if necessary, by the Contractor before loading to prevent contamination from previous loads.

b. Tank trucks shall be carefully inspected by the Contractor before loading and, if necessary, shall be drained and cleaned to prevent contamination from previous loads.

1029.04 -- Acceptance Requirements

Performance graded binder will be accepted on the basis of sampling and testing procedures outlined in the NDR *Materials Sampling Guide*.

SECTION 1030 -- LIQUID ASPHALTS

1030.01 -- Description

AASHTO Rapid-Curing Cut-back Asphalt is the accepted NDR liquid asphalt.

1030.02 -- Material Characteristics

Cut-back asphalts shall conform to the AASHTO M 81, Rapid Curing Type requirements.

1030.03 -- Procedures

1. Storage tanks, transfer lines, and loading facilities for liquid asphaltic materials shall conform to the requirements of Subsection 1029.03, Paragraph 1. Liquid asphaltic materials offered for testing, in storage or at the time of loading, shall not exceed the temperature limits shown in Table 1030.01.

Table 1030.01

Maximum Storage Temperature		
Type	**Grade**	**Degrees (Maximum)**
MC	30	175°F (80°C)
MC, RC	70	250°F (120°C)
MC, RC	250	275°F (135°C)
MC, RC	800	300°F (150°C)
MC, RC	3000	330°F (165°C)
(These limits are higher than permissible application temperatures. See Division 500 for application temperature limits.)		

2. All tank cars and tank trucks used for shipment of liquid asphaltic materials and the producer's or supplier's storage and heating provisions for these materials shall conform to the requirements of Subsection 1029.03, Paragraph 2.

1030.04 -- Acceptance Requirements

Liquid asphalts will be accepted as prescribed in the NDR *Materials Sampling Guide*.

SECTION 1031 -- EMULSIFIED ASPHALT (ANIONIC)

1031.01 -- Description

Emulsified asphalt (anionic) shall conform to the requirements of AASHTO M 140.

1031.02 -- Material Characteristics

HFE-150, HFE-300, and HFE-1000 shall meet the requirements in Table 1031.01

Table 1031.01

Anionic Emulsified Asphalt		
HFE-300 - used for warm weather windrow mixes, base stabilization, or pug mill mixes.		
	Min.	**Max.**
Saybolt Furol Vs. @ 50°C	50	400 sec.
Settlement, 5 days %		5
Sieve Test, %		0.10
Residue by distillation	65	
% Oil Distillation		7
Residue Penetration		
Residue Solubility in Trichloroethylene 1%	97.5	
Float Test on Residue, 60°C sec	1200	
HFE-150 - sand seal, chip seal, especially with more graded or dusty materials.		
	Min.	**Max.**
Saybolt Furol Vis. @ 50°C	50	400 sec.
Settlement, 5 days %		5
Sieve Test, %		0.10
Residue by distillation, %	65	
Residue Penetration		
25°C, 5 sec, 100 g	150	250
Residue Solubility in		
Trichloroethylene 1%	97.5	
Float Test on 60°C sec	1200	
HFE-1000 - winter mix		
	Min.	**Max.**
Viscosity, Saybolt Furon at 50°C sec	50	400 sec.
Oil Distillates by volume of emulsion, %	---	7
Residue by distillation, %	65	
Tests on Residue from Distillation Test:		
Viscosity by Vacuum Capillary Viscometer at 60°C, Poises	20	90
Penetration, 25°C, 100 g, 5 sec	300	---
Float Test at 60°C, sec	1200	

1031.03 -- Acceptance Requirements

Emulsified asphalt (anionic) will be accepted as prescribed in the NDR *Materials Sampling Guide*.

SECTION 1032 -- EMULSIFIED ASPHALT (CATIONIC)

1032.01 -- Description

Emulsified asphalt (cationic) shall conform to the requirements of AASHTO M 208.

1032.02 -- Material Characteristics

1. a. This Specification shall govern the sampling and testing of Grades CRS-1h and CM-4.

b. Grade CRS-1h shall comply with the requirements of CRS-1 in AASHTO M 208 except that the residue from the distillation test shall have a penetration of 40 minimum and 90 maximum (25°C, 100 g, 5 seconds).

c. Grade CM-4 shall comply with the test requirements in Table 1032.01.

Table 1032.01

Emulsified Asphalt (Cationic) Requirements[a]		
	CM-4	
	Min.	Max.
Tests on Emulsion:		
Viscosity, Saybolt Furol at 50°C (50°C) sec	50	500
Settlement, ([b]) 5 days %[b]	---	5
Storage Stability Test, 1 day, %[b]	---	1
Sieve Test, %[b]	---	0.5
Distillation:		
Oil Distillate, by volume of emulsion, %	---	12
Residue, %	65	---
Tests on Residue from Distillation Test:		
Penetration, 25°C, 100 g, 5 sec	300	---
Solubility in Trichloroethylene	97.0	---
Viscosity, Saybolt Furol at 82°C, sec	200	600

[a] Refer to AASHTO R 5 for typical applications.

[b] This test requirement on representative samples may be waived if successful application of the material has been achieved in this field.

1032.03 -- Acceptance Requirements

Emulsified asphalt (cationic) will be accepted as prescribed in the NDR *Materials Sampling Guide*.

SECTION 1033 -- AGGREGATES

1033.01 -- Description

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 NDR Materials and Research Engineer.

1033.02 -- Material Characteristics

1. Sampling and Testing Procedures:

Sampling and testing shall be performed in accordance with Table 1033.01.

Table 1033.01

Sampling and Testing Procedures	
Procedure	**Method**
Sampling	NDR T 2
Sieve Analysis	NDR T 27
Clay Lumps, Shale, and Soft Particles	NDR T 504
Abrasion	AASHTO T 96
Freeze and Thaw Soundness	NDR T 103
Specific Gravity and Absorption (course aggregate)	AASHTO T 85
Specific Gravity and Absorption (fine aggregate)	AASHTO T 84
Plasticity Index	AASHTO T 89, AASHTO T 90
Sodium Sulfate Soundness	AASHTO T 104
Calcium Carbonate	NDR T 5
Organic Impurities	AASHTO T 21
Mortar-Making Properties	AASHTO T 71
Reducing Field Samples of Aggregate to Testing Size	AASHTO T 248

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 percent (computed as $CaCO_3$ from the value determined for CaO).

d. Fine sand shall have at least 95 percent of its particles pass the No. 10 (2.0 mm) sieve and no more than 25 percent 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.

3. Portland Cement Concrete Aggregate:

a. Fine aggregate and sand-gravel aggregate:

Table 1033.02A

Fine Aggregate for Concrete Gradation Limits								
	Class A Aggregate		Class B Aggregate		Sand-Gravel Aggregate for Concrete Class C Aggregate		Class D Aggregate	
	Percent Passing							
Sieve Size	Target Value	Tolerance	Target Value	Tolerance	Target Value	Tolerance	Target Value	Tolerance
1 inch (25 mm)	---	---	100	None	100	---	---	---
3/8 inch (9.50 mm)	100	None	---	---	---	---	---	---
No. 4 (4.75 mm)	96	±4	87	±10	66	±22	100	0
No. 10 (2.00 mm)	77	±13	60	±10	37	±13	95	±5
No. 30 (600 μm)	25	±15	28	±12	12	±8	57	±18
No. 200 (75 μm)	1.5	±1.5	1.5	±1.5	1.5	±1.5	3	±3

Table 1033.02B

Aggregate Classes and Uses	
Aggregate Class	**Concrete Description**
A	Overlay Concrete SF Overlay Concrete HD
B	47B, 47B-HE, 47B-P, 47B-PHE, 47BD, and PR 1, PR 3
C	AX and 47B-SG
D	Grout Sand

(1) Fine aggregate shall be washed and composed of clean, hard, durable, and uncoated particles.

(2) Aggregates produced from wet pits by pumping will be considered to be washed.

(3) Aggregates from a dry pit shall have the method for washing approved by the Department.

(4) Fine aggregate and sand-gravel aggregate for concrete shall have a soundness loss of not more than 10 percent by weight at the end of 5 cycles using sodium sulfate solution.

(5) The weight of the fine aggregate and sand-gravel aggregate shall not contain more than 0.5 percent clay lumps.

(6) Fine aggregate and sand-gravel 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).

(7) Fine aggregate and sand-gravel 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 percent 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.

(8) Aggregate shall be evaluated based upon its past performance in concrete pavement and in laboratory test results. Aggregate with adversely reactive constituents shall not be used.

(9) Aggregate shall meet the requirements in Tables 1033.02A and B.

b. Coarse Aggregate:

Table 1033.03A

Coarse Aggregate for Concrete Gradation Limits				
	Class E Aggregate		Class F Aggregate	
	Percent Passing			
Sieve Size	Target Value	Tolerance	Target Value	Tolerance
1 1/2 inch (375 mm)	100	---	---	---
1 inch (25 mm)	100	- 8	---	---
3/4 inch (19.0 mm)	78	±12	100	0
1/2 inch (12.5 mm)	---	---	98	±2
3/8 inch (9.50 mm)	30	±15	65	±25
No. 4 (4.75 mm)	6	±6	17	±13
No. 10 (2.00 mm)	---	---	4	±4
No. 20 (850 μm)	2*	±2	---	---
No. 200 (75 μm)	1.5	±1.5	1.5	±1.5

* The percent passing may be increased to 3±3 provided no more than 1.5% is passing the No. 200 (75 μm) sieve when washed.

Table 1033.03B

Aggregate Classes and Uses	
Aggregate Class	**Concrete Description**
E	47B, 47B-P, 47B-PHE, and 47B-HE 47BD, PR 1, and PR 3
F	Overlay Concrete SF Overlay Concrete HD

(1) Coarse Aggregate shall consist of limestone composed of clean, hard, durable, and uncoated particles. These materials are natural sedimentary rock composed principally of calcium carbonate.

(2) The calcium carbonate content of limestone shall be at least 80 percent (computed as $CaCO_3$ from the value determined for CaO).

(3) The percent of clay lumps, shale, or soft particles shall not exceed the following amounts:

Clay Lumps	0.5 percent
Shale	1.0 percent
Soft Particles	3.5 percent

(4) Any combination of clay lumps, shale, and soft particles shall not exceed 3.5 percent.

(5) Coarse 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.

(6) Coarse aggregate for concrete shall not have a soundness loss greater than 8.0 percent by weight at the completion of 16 cycles of alternate freezing and thawing.

(7) Limestone aggregates for concrete shall have a Los Angeles Abrasion loss percentage of not more than 40.

(8) Aggregate shall be evaluated based upon its past performance in concrete pavement and in laboratory test results. Aggregate with adversely reactive constituents shall not be used.

(9) Aggregate shall meet the requirements in Tables 1033.03A and B.

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]		
	Percent 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)]		
	Percent 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 percent 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 percent by mass at the end of 16 cycles of the freezing and thawing test.

(7) (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 percent 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 percent 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 μm) Sieve	95	100
Total Percent Passing the No. 200 (75 μm) Sieve	80	100
Plasticity Index [material passing the No. 200 (75 μm) Sieve]	0	3

d. At the start of production, one sample of mineral filler will be analyzed for its properties by the NDR 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		
	Percent Passing	
Sieve Size	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 percent will pass the 1/2 inch (12.5 mm) sieve and at least 90 percent 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. Armor Coat:

a. Mineral aggregate for armor coat shall have a Los Angeles Abrasion loss percentage of not more than 40.

b. Mineral aggregate for armor coat shall have a soundness loss of not more than 5 percent by mass at the end of 5 cycles using sodium sulfate solution.

c. Aggregate shall meet the requirements in Table 1033.06.

Table 1033.06

Armor Coat Aggregate Gradation Limits	
	Percent Passing
Sieve Size	
3/8 inch (9.5 mm)	99 to 100
No. 4 (4.75 mm)	65 to 85
No. 10 (2.0 mm)	0 to 15
No. 50 (300 μm)	0 to 10
No. 200 (75 μm)	0 to 3

7. 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 percent by weight at the end of 5 cycles using sodium sulfate solution.

c. Aggregate shall meet requirements in Table 1033.07 or 1033.08, as applicable.

Table 1033.07

Gravel Surfacing Gradation Limits		
	Percent Passing	
Sieve Size	**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 percent by weight at the end of 5 cycles using sodium sulfate solution.

Table 1033.08

Crushed Rock for Surfacing Gradation Limits		
	Percent Passing	
Sieve Size	**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 μm)	---	---
No. 200 (75 μm)	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.

8. Base Course:

Table 1033.09

Crushed Rock				
	Crushed Rock for Base Course		Crushed Rock Screenings for Base Course	
	Percent Passing			
Sieve Size	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 μm)	---	---	28	±12
No. 200 (75 μm)	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. (1) Crushed rock shall be crushed limestone, dolomite, granite, quartzite, or other ledge rock approved for the intended purpose by the NDR 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 percent 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 percent 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 percent, 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 1033.09.

9. Foundation Course:

Table 1033.10

Foundation Course Mixture		
	Percent Passing	
Sieve Size	**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 1033.11

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 percent will pass a 1/2 inch (12.5 mm) sieve and at least 60 percent will pass a No. 10 (2.00 mm) sieve. The binder shall be pulverized before it is mixed with the other aggregates.

b. Except for crushed rock for use in asphaltic concrete, when 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, other than crushed rock for asphaltic concrete, shall have a soundness loss of not more than 12 percent by weight at the end of 5 cycles using sodium sulfate solution.

d. Foundation course material shall meet the requirements in Table 1033.10 or 1033.11, as applicable.

1033.03 -- Procedures

1. Freshly washed or pumped aggregates shall be drained for 12 hours before use.

2. 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. 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. 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

Aggregates will be accepted based on the requirements of this Section and sampling and testing requirements as prescribed in the NDR *Materials Sampling Guide*.

SECTION 1034 -- SOIL BINDER

1034.01 -- Description

Soil binder shall consist of fine particles of sand, silt, and clay approved by the Engineer.

1034.02 -- Material Characteristics

Soil binder shall have at least 85 percent passing the No. 200 (75 μm) sieve, and the plasticity index shall be not less than 8 nor more than 25.

1034.03 -- Sampling and Testing Procedures

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

Soil binder will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1035 -- CORRUGATED METAL PIPE

1035.01 -- Description

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 on the plans, 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 dimple bands) are not acceptable.

1035.03 -- Acceptance Requirements

Corrugated metal pipe will be accepted based on the requirements of this Section and sampling and testing requirements as prescribed in the *NDR Materials Sampling Guide.*

SECTION 1036 -- METAL FLARED-END SECTIONS

1036.01 -- Description

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 plans.

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 on the plans, 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

Metal flared-end sections will be accepted based on the requirements of this section and sampling and testing requirements as prescribed in the *NDR Materials Sampling Guide*.

SECTION 1037 -- REINFORCED CONCRETE PIPE, MANHOLE RISERS, AND FLARED-END SECTIONS

1037.01 -- Description

This *Specification* provides NDR 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 by the NDOR plans and Specifications.

4. 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 (in^2/ft (mm^2/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 plans 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

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 *NDR Materials Sampling Guide.*

SECTION 1038 -- PLASTIC PIPE

1038.01 -- Description

High density polyethylene (HDPE), polyvinyl chloride (PVC), and other NDR approved plastic pipes are authorized for use as stipulated in the contract documents.

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 or S (Cell Class 335420C)
18 to 36 in (450 to 900 mm)	ASTM F 894	Profile, CP, OP, RSC 160 (Cell Class 335434C)

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 36 in (450 to 900 m)	ASTM F 679	Gravity Sewer Pipe & Fittings
15 to 36 in (375 to 900 m)	ASTM F 794	Profile Gravity Sewer Pipe & Fittings, CP,OP, Series 46
15 to 36 in (375 to 900 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 NDR Materials and Tests Laboratory in Lincoln for testing, before being incorporated into the project.

1038.03 -- Acceptance Requirements

Plastic pipe will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the *NDR 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 plans or special provisions, ductile iron pipe shall be encased with Class C polyethylene encasement material conforming to the requirements of ANSI A21.5.

1039.02 -- Acceptance Requirements

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

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

Concrete drain tile shall conform to the "Extra-Quality Drain Tile" requirements of AASHTO M 178.

1041.02 -- Acceptance Requirements

Drain tile will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *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

Structural pipe plate will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1043 -- FLAP GATES

1043.01 -- Description

Flap gates shall be a double-hinged type furnished in accordance with the dimensions shown in the plans. 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 plans. 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

Flap gates approved for use are shown in the plans.

SECTION 1044 -- BAR GRATES FOR FLARED END SECTIONS

1044.01 -- Description

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 prescribed in the plans. 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 NDR Approved Products List.

(2) Apply the coating as recommended by the manufacturer (3 mil (76 um) minimum).

c. Galvanized

(1) Hot-dip galvanized in accordance with ASTM A 123.

1044.03 -- Acceptance Requirements

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

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 plans or special provisions.

2. Notch toughness is mandatory for structural steel designated in the plans 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 plans or special provisions.

1045.03 -- Steel Plate Substitution

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	½	40	1 5/8
14	9/16	45	1 3/4
16	11/16	50	2
18	¾	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 ¼		

SECTION 1046 – END WELDED STUDS

1046.01 -- Description

End welded studs shall conform to the requirements of the AWS Standard Specifications.

SECTION 1047 -- WELDING ELECTRODES AND FLUXES

1047.01 -- Description

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

Steel forgings shall conform to the requirements of AASHTO M 102.

1048.02 -- Acceptance Requirements

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

Cold-finished bars and shafting shall conform to the requirements of ASTM A 108.

1049.02 -- Acceptance Requirements

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

Carbon steel castings shall conform to the requirements of ASTM A 27/A 27M, Grade 70-36.

1050.02 -- Acceptance Requirements

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

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

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

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

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

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

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

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

Sheet lead will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *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 plans.

1056.02 -- Acceptance Requirements

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 NDR *Materials Sampling Guide*.

SECTION 1057 -- LOW CARBON STEEL FASTENERS

1057.01 -- Description

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

Low carbon steel fasteners will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *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. Alternate design fasteners or bolting systems not referenced in this specification must be tested and approved by the Department before use.

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, then 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 overtap in the nut shall be so the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of 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	5/18
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 prescribed 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 percent of the minimum bolt tension (minimum bolt tension is equal to 70 percent 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 percent 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

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

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

Acceptance will be based on requirements identified in the NDR *Materials Sampling Guide*.

SECTION 1060 -- GALVANIZED CABLE CLAMPS

1060.01 -- Description

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

Acceptance will be based on requirements identified in the NDR *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 percent 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 percent 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 percent 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

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

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 NDR *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 plans or special provisions.

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

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 NDR *Materials Sampling Guide*.

SECTION 1064 -- FENCES

1064.01 -- Description

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 percent 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 plans or special provisions.

(5) The fabric shall be the height specified in the plans. 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 plans.

(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/m^2) 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/m^2).

(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 percent 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 percent 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 percent 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 plans or special provisions. 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 percent 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/ft^2 (244 g/m^2).

(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) (i) 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.

(ii) 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/ft^2 (244 g/m^2). 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.

(3) Staples shall conform to Paragraph 2.d. of this Subsection.

(4) Wire fasteners shall conform to Paragraph 1.e.(1) of this Subsection.

(5) 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 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

Fences will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1065 -- POLYSTYRENE BOARD FILLERS

1065.01 -- Description

This specification covers the use of polystyrene board as it is used to form concrete.

1065.02 -- Material Characteristics

1. Polystrene 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 percent by volume compression.

2. When the plans require 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

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 Materials and Research Division.

SECTION 1066 -- W-BEAM AND THRIE-BEAM GUARDRAIL

1066.01 -- Description

Galvanized W-beam and Thrie-beam guardrail shall be constructed as prescribed in the plans.

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. Special 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

W-beam and Thrie-beam guardrail will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1067 -- STEEL GUARDRAIL POSTS AND SPECIAL POSTS

1067.01 -- Description

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" (W50 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 plans. 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

Steel guardrail posts and special posts will be accepted based on requirements of this Section and sampling and testing requirements in accordance with the NDR *Materials Sampling Guide*.

SECTION 1068 -- ELASTOMERIC BEARINGS AND LAMINATED BEARING PADS

1068.01 -- Description

Elastomeric bearings and laminated bearing pads shall conform to the requirements of the current AASHTO *Standard Specifications for Highway Bridges*.

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 NDR'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. 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. 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 reflectized 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. 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. 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 plans. Any commercially available reflectorized traffic paint may be acceptable if the plans or special provisions do not specify the type of paint.

1069.03 -- Acceptance Requirements

1. Acceptable temporary pavement markings, except paint and glass beads, are shown on the NDR Approved Products List.

2. Temporary pavement markings not on the NDR Approved Products List shall be approved by the Engineer before use.

SECTION 1070 -- HIGHWAY SIGNS

1070.01 -- Description

Materials authorized for use in constructing highway signs, Type A and Type B, are listed in this Section.

1070.02 -- Material Characteristics

1. 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 III sheeting.

2. 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 plans.

b. Panels cut from coil sheet will not be accepted.

3. Letters, numerals, symbols, and borders for Type B signs shall conform to AASHTO M 268 high intensity direct applied Type III reflective sheeting.

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. 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 plans.

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 NDR Traffic Engineer.

7. 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 plans.

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 plans 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 plans.

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) 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. (1) Type A signs shall be fabricated from Alloy 6061-T6 or 5052-H38 (ASTM B 209M) sheet aluminum.

(2) (i) 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 for the intended purpose.

(ii) All blanks shall be uniform in thickness and flat.

(iii) All shearing, cutting, and punching shall be done before preparation of blanks for application of reflectorizing material.

(iv) Sign blanks cut from coil sheet will not be accepted.

(3) (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 plans.

(iii) All punched or drilled holes shall be round and free from tears, raggedness, or distortion of the metal.

(4) All thicknesses shall be as required in the plans.

(5) 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 plans. 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 plans.

1070.03 -- Acceptance Requirements

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

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 plans. 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, ±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 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 μm).

(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 1.20 lb/ft (1.8 kg/m), and the post shall have at least 15 and not more than 20 holes.

(3) Light-duty posts shall be painted black.

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 plans.

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 plans) conforming to the requirements of ASTM F 568.

1071.03 -- Acceptance Requirements

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 NDR *Materials Sampling Guide*.

SECTION 1072 -- REFLECTORS

1072.01 -- Description

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; however, the foil back reflectors must have a minimum 0.018 inch (0.46 mm) thick aluminum housing.

3. The aluminum housing is not required with the acrylic plastic back.

4. The reflector shall have a mounting hole in the center with a diameter of not less than 3/16 inch (5 mm).

5. The reflector shall have a visible reflective area when mounted of not less than 6.5 square inches (4200 mm^2).

6. The lens shall consist of a smooth front surface free from projections or indentations other than the central mounting hole and manufacturer's identification.

7. The rear surface shall be a prismatic configuration such that it will cause total internal reflection of light.

8. 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.

9. The unit shall be permanently sealed against dust, water, and water vapor.

10. Fasteners for delineators shall be at least 3/16 inch (5 mm) diameter pan or round head machine screws (length shown in the plans) conforming to the requirements of ASTM F 568.

11. 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)

1072.03 -- Acceptance Requirements

1. Acceptable reflectors are shown on the NDR Approved Products List.

2. Fasteners for delineators shall be sample and tested in accordance with the requirements shown in the NDR *Materials Sampling Guide*.

SECTION 1073 -- ROADWAY LIGHTING, SIGN LIGHTING, AND TRAFFIC SIGNALS

1073.01 -- Description

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 Specification No. 62 and be installed in accordance with Article 250 of 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 1/2 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 Specification No. 62 and be installed in accordance with Article 250 of the *National Electric Code* and the project plans.

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, coilable 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, coilable HDPE duct of the type specified above. Conductors shall be of the type, size, and number called for in the plans. 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 plans 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 [Up to 50 Feet (15.2 m) Mounting Height]:

a. Light poles, anchor bolts, and all accessory hardware must comply with the *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.

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 internal to 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. (1) Connecting bolts for use with power-installed foundations shall be supplied by the foundation manufacturer.

(2) The bolts shall be galvanized.

(3) All other anchor bolts are detailed in the plans.

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 handhole and accessible through the handhole.

e. The Manufacturer shall furnish 8 sets of detailed drawings to the Engineer for approval. A certificate of compliance from the manufacturer stating that the poles and associated materials comply with the structural, wind loading, and galvanizing requirements is 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 must comply with the AASHTO *Standard Specifications for Structural Supports For Highway Signs, Luminaires and Traffic Signals*. The tower and its components shall be designed to withstand 80 mph (130 kph) AASHTO wind loading with a 1.3 gust factor. The light ring and towering system shall be capable of supporting 12 fixtures, but shall be designed to hold the number of fixtures shown in the plans for each particular tower.

b. Unless stated otherwise in the plans or special provisions, each new high mast tower shall be furnished complete with base plate, handhole 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. 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. Each individual tower section shall contain no more than 2 longitudinal welds and no transverse or circumferential splices, either mechanical or welded. Each tower section shall be galvanized after fabrication. 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.

The pole shaft shall have a single access door providing access to the winch, cable, cable drum(s), and electrical components. The door opening shall be reinforced to maintain the original strength of the pole. The door shall be mounted with a stainless steel loose joint butt hinge and a padlock hasp for securing.

d. (1) The bottom tower section shall contain a hand hole with cover to allow access to the winch, cable drum(s), motor and electrical components. The hand hole shall be sized and so arranged to permit removal of the lowering mechanism without excessive dismantling of the equipment.

(2) The hand hole shall have rounded corners and shall be reinforced to maintain the original strength of the tower shaft. The hand hole cover (door) shall be provided with a stainless steel loose joint butt hinge or other hinge arrangement acceptable to the Engineer. The hinge shall be heavy duty and suitable for 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 door shall be provided with a padlock hasp for securing the equipment within the tower from vandals.

e. The bottom tower section whall 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.

f. 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. The base plate will be drilled for the required anchor bolts. 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 percent penetration circumferential welds.

g. The base plate shall be designed to be supported solely by nuts. On towers of weathering steel, the space between the base plate and concrete foundation shall be left ungrouted and shall be enclosed with expanded aluminium mesh. On towers of galvanized steel, this space shall be filled with grout. 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. 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.

h. (1) The tower manufacturer shall provide all required anchor bolts. Each anchor bolt shall be provided with one leveling nut, one hold down nut, one lock nut (jam nut), and two hardened steel flat washers.

(2) The minimum anchorage design acceptable will be one detailing six-2 inch (50 mm) diameter anchor bolts of AASHTO M 314, Grade 55 Steel. The manufacturer's actual design may require a greater number of anchor bolts, anchor bolts of larger diameter, or both. In all cases, however, all anchor bolts must meet AASHTO M 314, Grade 55 requirements.

(3) 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 threaded end of the anchor bolt 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 Materials and Research Division.

(4) The heavy hex nuts for the anchor bolts shall meet the requirements of ASTM A-563, Grade C3 or DH3.

(5) The hardened steel washers shall conform to the requirements of ASTM F 436/436M. Only flat washers shall be used. Lock washers will not be allowed.

(6) The manufacturer of the anchor bolts and heavy hex nuts shall furnish certifications 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.

i. (1) (i) Only a two-drum bottom tethered lowering system or a single-drum top latching system will be accepted. All towers 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 drum(s) and winch assembly, Internal Power Unit, luminaire ring hoist cables (if applicable), winch cable(s), 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 3/16" (4.8 mm) galvanized or stainless steel aircraft cable of the non-twisting type with the three cable system having a safety factor of 5.

(iv) The winch cable shall be a ¼" (6.3 mm) galvanized or stainless steel anti-rotational aircraft cable with a safety factor of 3.

(v) All electrical components of the lowering assembly are to 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 be designed to withstand 80 mph (130 kph) AASHTO wind loading with a 1.3 gust factor. Each light ring and lowering system shall be capable of supporting twelve fixtures, but shall be

designed to hold the number of fixtures shown on the plans 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 whall 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 fabricatged 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 arrestor. The power cord shall be Type "G" 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, 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 drum(s) 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 tin 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) (i) 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.

(ii) The Internal Power Unit will not be paid for separately, but will be considered as part of the complete lowering system.

(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 will 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.

(iii) A manufacturer's representative shall be present, on site, to advise the contractor during the installation of at least one complete lowering system. Duties of the manufacturer's representative shall include, but not be limited to the following:

[1] Directing all adjustments to the lowering system to ensure positive latching and unlatching (this will consist of a minimum of three complete raising and lowering cycles).

[2] Educating the maintaining utility in (a) the methods of proper maintenance to avoid hoist malfunctions, (b) the proper procedures to follow in the event of a hoist malfunction.

(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).

(13) The contractor shall forward to the project engineer, eight (8) complete sets of design drawings and specifications covering the lowering system he proposes to install on the project. These documents will be reviewed and if found to meet specification requirements, will be approved and proper distribution made.

(14) No deviations, substitutions, additions or omissions from the above specification will be allowed without the lighting engineer's approval. The lighting engineer's decision in this matter will be final.

(15) 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 NDR Approved Products List.

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 plans.

b. Luminaire type, wattage, and ballast ratings shall be as shown in the plans.

c. Luminaires shall be supplied with lamps.

d. Luminaires must meet the design parameters shown in the plans.

8. Lighting Control Center :

a. Components comprising the various types of lighting control centers acceptable for use on State projects will be shown in the plans.

b. The lighting control center shall conform to the requirements shown in the plans.

9. Photoelectric Control:

a. Photoelectric controls acceptable for use on State projects will be shown in the plans.

b. Photoelectric controls shall conform to the requirements shown in the plans.

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 NDR Approved Products List.

b. Luminaire, ballast, lamp dimensions, and ratings shall be as prescribed in the plans.

c. The luminaire shall be furnished completely assembled and ready for mounting, connecting, and lamping.

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 plans 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 NDR 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 plans and special provisions, 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 with 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 plans.

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 plans. 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 percent 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 plans.

g. All LED signals shall be limited to those on the NDR 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 plans.

f. All LED signals shall be limited to those on the NDR Approved Products List.

21. Optically Programmed Traffic Signal:

Optically programmed traffic signals shall be limited to those on the NDR 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 plans.

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 plans, 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 Transportaation, 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 120VAC, 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 plans.

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 plans and the following requirements:

(1) The cabinet size shall be as stated in the plans. The manufacturer shall insure that not more than 60 percent 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 ft^3/min (2.83 m^3/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 exhaust 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 plans.

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 operation with a minimum rating of 50 amperes. It shall be equipped with a solderless 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 suppressor(s) (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 thyrectors 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 descrete 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 light(s) and detector amplifier output replay. 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/m^2) 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 indicator(s) 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 percent. Circuits employing printed circuits shall be of the highest quality with extra-heavy [2 oz/ft² (605 g/m^2) 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 therefrom. 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 plans. They shall be housed in a durable casting and be weathertight. 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 NDR 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 NDR 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 plans 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, handhole 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 handhole opening and shall not be allowed on the handhole frame.

(5) When specifically required by the plans, a transformer base shall be provided. In such case, the handhole 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. The 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 percent rise and a maximum 4 percent rise for each loaded signal arm or shall be adjustable in the field.

g. Handholes:

(1) All handholes shall be reinforced to maintain full strength of the steel shaft. Handholes shall have a minimum opening of 4 inches x 6 inches (100 mm x 150 mm). Handhole covers of a weatherproof design shall be supplied by the pole manufacturer.

(2) Mounting of the grounding nut on the handhole frame shall not be allowed.

(3) The bottom of the handhole 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 plans. 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 plans 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 m^2).

(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 plans 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 plans.

l. A certificate of compliance verifying the adequacy of the signal poles and their conformity to these *Specifications* shall be submitted to the NDR 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 plans.

b. The pedestal pole assembly shall have the characteristic of yielding under impact when struck by a motor vehicle to cause a minimum of decelerative 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 mm^2) 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 plans.

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 redried and have a moisture content of not more than 30 percent 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 percent 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 prescribed 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 #20AWG (7x28) stranded, tinned copper with 25 mil (630 μm) 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 um). 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

All items described in this Section are accepted as prescribed or as indicated in the NDR *Materials Sampling Guide*.

SECTION 1074 -- GABIONS AND REVET MATTRESSES

1074.01 -- Description

Gabions and revet mattresses are generally used for erosion and earth control.

1074.02 -- Material Characteristics

1. Wire coatings shall be as prescribed in the plans or special provisions.

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

Acceptable gabions and revet mattresses are shown on the NDR 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 herein described.

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, ½ 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 percent 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 ± 3.0 percent.

d. All timber and lumber to be used without preservation treatment shall contain not less than 85 percent 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 Standard C1 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 Standard C14 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 percent 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 percent 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 plans, 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. a. (1) All wood posts used in fencing, including those used for braces, shall be round.

(2) They 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 percent 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 two percent 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.

b. 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	

c. Untreated round fence posts when specified, shall be white or burr oak, black locust, osage orange, or red cedar.

d. (1) Round wood fence posts shall be of the dimensions shown in the plans.

(2) The size of a post will be specified by its top diameter in even inches (millimeters).

(3) 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).

(4) This diameter, after peeling, shall be determined with a circumference-diameter tape or by dividing the circumference measurement in inches (millimeters) by 3.14.

(5) Posts will be furnished in the length specified plus or minus 2.0 percent.

e. The preservative treatment shall conform to Paragraph 2. of Subsection 1075.02 (Paragraph 2.c. excluded).

f. Acceptance of fence posts and braces shall be as prescribed 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 percent 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 plans.

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 plans and be successfully crash tested according to NCHRP 230.

3. a. Dimensions. 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 calipered diameter shall vary from the diameter as determined with the circumference-diameter tape by ½ inch (12.5 mm).

c. Acceptance of round guardrail posts shall be as prescribed 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. General. 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, ± 3.0 percent. 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), Southern Yellow Pine (either major or minor species), or Ponderosa Pine.

c. Grade. 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:

Douglas Fir: Select Structural (graded as beams and stringers)

Southern Yellow Pine: Dense Structural 65

d. Offset blocks. 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 plans 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 prescribed in Paragraph 1. of Subsection 1075.07.

2. Guardrail Terminal Systems:

a. General. 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. Species. 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. Grade. Sawn wood guardrail posts and offset blocks shall be in accordance with the manufacturer's design requirements.

d. Composite Offsets Blocks. 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 plans and be successfully crash tested according to NCHRP 350.

e. Preservative Treatment. 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. Acceptance of sawn wood guardrail posts and offset blocks shall be as prescribed in Paragraph 2. of Subsection 1075.07.

1075.06 -- Sign Post Requirements

1. a. 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.

b. Sawn wood sign posts shall be Douglas Fir of the Coast Region.

c. Sawn wood sign posts shall be capable of a minimum working stress on the extreme fibers when subjected to bending as shown in the plans 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 inches x 4 inches (100 mm x 100 mm)	No. 1 & Btr.	Structural Light Framing	1725 psi (12 MPa)
4 inches x 6 inches (100 mm x 150 mm)	No. 1 & Btr., No. 1	Structural Joists and Planks	1495 psi (10 MPa)

2. 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 percent.

3. Acceptance of sawn wood sign posts shall be as prescribed 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, with the exception of grade dimension for guardrail offset blocks, will be inspected for grade, dimension, and treatment by an agency certified by the American Lumber Standards Committee Board of Review (ALSC).

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. (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), and the other 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 specie, grade, date, type of treatment, retention, and the treating plant identification logo.

e. The Contractor shall furnish the NDR 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 NDR 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 percent 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 percent copper metal by weight in a suitable petroleum solvent.

1076.02 -- Material Characteristics

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. Pentachorophenol 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

The paint color shall be as specified in the plans or special provisions.

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. a. 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.

b. 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

The paint materials and paint systems authorized for use shall be on the NDR Approved Products List.

INDEX