

City of Rapid City



Standard Specifications

for

Public Works Construction

2022 Edition

Specification Change Summary
2022 Edition
Rapid City Standard Specification
October 2022

The 2022 edition of the standard City specification has been created to update earlier versions of the standard specification. Most sections of the standard specifications have undergone updates, some are minor and some are major.

In order to assist the user, the following listing is a summary of the subjective extent of change in the various sections from the 2007 version of the specification. If change has occurred in a section, the user is strongly advised to study the section to become familiar with the extent of the change. Although the summary attempts to categorize the change as none, minor, major, or removed, the user must determine whether even a minor change affects their work. Not all changes are identified in the “Remarks” column of this summary. The specification user is also cautioned to carefully review all standard details as many have changed to reflect the changes in the standard specification.

Section number and title	extent of change	Remarks
007 – General Conditions	Minor	
008A – Water	Major	Name change, changes throughout
008B – Corrosion Protection – Plastic Pipe Systems	Major	New Section
009 – Sanitary Sewer	Major	Changes throughout
010 – Earthwork – Cleaning and Grubbing	Minor	Based on DOT Section 100 when applicable
011 – Utility Excavation & Backfill	Moderate changes	Changes throughout
012 – Roadway & drainage Excavation	Minor	Based on DOT Section 120 when applicable
013 – Removal Items	Minor	Based on DOT Section 110 when applicable
014 – Embankment	Removed	Incorporated into Section 12 when applicable
015 – Disposal of Surplus Excavation & Waste	Removed	Incorporated into Section 12 when applicable
016 – Optioned Borrow Excavation	Removed	Incorporated into Section 12 when applicable
017 – Salvage, Stockpiling, and Placing Topsoil	Minor	Based on DOT Section 230 when applicable
018 – Erosion and Water Pollution Control	Major	Changes throughout

019 – Incidental Work	Minor	
020 – Granular Bases and Surfacing	Minor	Based on DOT Section 260
031 – Asphalt Concrete – General	Minor	Based on DOT Section 320 when applicable
032 – Asphalt Concrete – Class E	Minor	
033 – Asphalt Concrete – Class G	Removed	
034 – Asphalt Concrete – Class S	Removed	
035 – Prime, Tack, Fog Seal and Flush Seal Coats	Major	Fog Seal requirements added
036 – Cold Asphalt Planing	None	
037 – Asphalt Surface Treatment	Minor	
038 – Recycled Asphalt Product (RAP)	Major	New Section
039 – Cold Mix Asphalt	None	
040 – Portland Cement Concrete Pavement	Minor	Based on DOT Section 380 when applicable
041 – Utility Trench Resurfacing	Minor	
050 – Precast Concrete	Major	New Section based on DOT Section 560 when applicable
051 – Structural Excavation	Minor	Based on DOT Section 420 when applicable
052 – Box, pipe, and Plate Culvert Undercutting	Removed	Combined with Section 58
053 – Drainage Fabric for Reinforced Concrete Box Culverts	Removed	Combined with Section 58
054 – Drainage Pipe Installation	Major	Name Changed
055 – Cast in Place Concrete Structures	Minor	Name Changed. Based on DOT Section 460 when applicable
056 – Class M6 Concrete for Curb & Gutter and Flatwork	Minor	Name Change
057 – Reinforcing Steel	Minor	Name Change
058 – Concrete Box Culvert	Major	Name Change
059 – Steel Beam Guard Rail	Minor	Based on DOT Section 630

060 – Concrete Curb and Gutter	Minor	
061 – Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces	Minor	Name Change
062 – Drop- Inlets	Minor	Based on DOT Section 670 when applicable
063 – Storm Sewer Junction Boxes and Manholes	Minor	Name Change, Based on DOT Section 671 when applicable
064 – Under-Drains	Minor	
065 – Riprap	Minor	Based on DOT Section 700 when applicable
066 – Gabions	Minor	Name Change, Based on DOT Section 720 when applicable
067 – Fabric Formed Concrete	Removed	
068 – Bank and Chanel Protection Rock Filled Wire Baskets	Removed	Incorporated into Section 66
069 – Bank Protection Gabions	Removed	Incorporated into Section 66
070 – Seeding	Major	Changes throughout
071 - Fertilizing	Major	Changes throughout
072 – Mulching	Major	Changes throughout
073 – Sodding	Minor	
074 – Planting Trees, Shrubs, and Vines	Major	Changes throughout
075 – Transplanting Trees and Shrubs	Minor	
076 – Compost	Minor	Name change
090 – Roadway Signs and Delineators	Major	Based on DOT Sections 632 and 982 when applicable
091 – Pavement Markings	Major	Based on DOT Section 633 and 983 when applicable
092 – Temporary Traffic Control	Major	Based on DOT Section 634 and 984
093 – Traffic Signals and Roadway Lighting	Major	Based on DOT Sections 630 and 985
100 – Portland Cement	Minor	Based on DOT Section 750 when applicable

101 – Air Entraining Admixtures	Minor	Based on DOT Section 751 when applicable
102 – Chemical Admixtures for Concrete	Minor	Based on DOT Section 752 when applicable
103 – Fly Ash	Major	New Section, Based on DOT Section 753 when applicable
104 – Water for Use in Portland Cement Concrete	Minor	Based on DOT Section 790 when applicable
105 – Fine Aggregate for Use in Portland Cement Concrete	Minor	Based on DOT Section 800 when applicable
106 – Masonry Mortar Sand	Minor	Based on DOT Section 810 when applicable
107 – Coarse Aggregate for Use in Portland Cement Concrete	Minor	Based on DOT Section 820 when applicable
108 – Concrete Curing Materials	Minor	Based on DOT Section 821 when applicable
109 – Riprap and Slope Materials	Removed	Incorporated into Section 65
111 – Crushed Aggregate for Maintenance (Travel Gravel)	Removed	
112 – Select Granular Backfill	Minor	
113 – Preformed Expansion Joint Filler for Concrete	Minor	Based on DOT Section 860 when applicable
114 – Concrete Joint Sealer	Minor	Based on DOT Section 870 when applicable
115 – Aggregates for Asphalt Concrete	Minor	Based on DOT Section 880 when applicable
116 – Aggregates for Asphalt Surface Treatments	Minor	Based on DOT Section 881 when applicable
117 – Aggregates for Granular Bases and Surfacing	Major	Based on DOT Section 882 when applicable
118 – Asphalt Material	Minor	Based on DOT Section 890 when applicable
120 – Drainage Pipe Material	Major	Name Change
121 – Corrugated Metal Pipe	Removed	Incorporated into Section 120
123 – Concrete Reinforcement	Minor	Based on DOT Section 1010 when applicable
124 – Fabric Formed Concrete Mat Material	Removed	Section Deleted
125 – Gabions	Removed	Incorporated into Section 66

126 – Wood Preservatives and Preservative Materials	Removed	Section Deleted
145 – Bridge Repainting	Removed	Section Deleted
146 – Erosion Treatment Material	Removed	Incorporated into Section 18
190 – Watering	Minor	
200 – Low Strength Material (Flowable Fill)	Minor	Based on DOT Section 464 when applicable
201 – Construction Stakes, Lines, Grades	Minor	
202 – Geosynthetics for Roadways	Major	Changes throughout
203 – Submittals	Major	New Section
205 – Televising	Major	New Section

**REQUEST TO REVISE THE CITY OF RAPID CITY
STANDARD SPECIFICATIONS FOR PUBLIC WORKS
CONSTRUCTION**

Please submit this form or a document with the following information to request a change to the "City of Rapid City Standard Specifications for Public Works Construction". The City of Rapid City will consider each request in its annual specification review process. Please be as specific as possible for each request. Proposed wording and supporting documentation for the proposed specification change will increase the chances for approval.

Requestor's Name:

Address:

Telephone Number:

E-mail Address:

Specification Section Proposed for Change: _____
(Please submit individual forms for each specification section proposed to be changed)

General description of proposed change:

Specific Wording for Proposed Specification Section Change:

Supporting documentation for proposed change such as AWWA Standard, SDDOT Standard, etc.

Does this proposed change impact or require changes to other specification sections or details:

Yes No

If yes, which sections are impacted?

Submit Request to:

Proposed Specification Revision
City of Rapid City
Engineering Services
300 Sixth Street
Rapid City, SD 57701

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GENERAL CONDITIONS

7.1 DEFINITIONS AND TERMS

That whenever any word or expression defined herein, or pronoun used in its stead, occurs in these specifications or other Contract documents, it shall have and is mutually understood to have the meaning herein given:

Addendum or Addenda: A change or changes to the bid proposal documents issued by the City of Rapid City prior to the time of opening of the proposals.

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

Anode: The electrode or metallic surface location where DC current is discharged into a surrounding electrolyte and corrosion (oxidation with a loss of electrons) occurs in a corrosion cell. The opposite of a cathode.

Appurtenances or Fittings: Items including but not limited to valves, fittings, elbows, tees, foster adaptors, service saddles, glands, angles, bends, blow offs, restrained joints, flanges, couplings, spool pieces, miscellaneous piping, tapping saddles, or hydrants, including metallic glands, etc.

As-Built Plans: Drawings that reflect changes made during the construction process, recording differences between the original design and the completed project.

Award: The acceptance of a bid proposal by the City of Rapid City Council.

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

Bidder: The individual, partnership, firm, corporation, or an acceptable combination thereof, such as a joint venture that is submitting a proposal.

Bid Proposal, Bid or Proposal: The written offer of a bidder, on the prescribed form, to perform the work at the prices quoted.

Bid Schedule: The list of bid items, together with estimated quantities appearing in the proposal form.

Bridge: A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, said structure having a length measured along the center of roadway of more than 20 feet between undercopings of abutments or extreme ends of

openings for multiple boxes and pipes where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Length: The greater dimension of a structure measured along the center of the roadway between backs of abutment, backwalls, or between ends of bridge floor.

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

Calendar Day(s): Unless herein otherwise expressly defined, shall mean a day or days of twenty-four hours each, beginning and ending at midnight.

Cathode: The electrode or metallic surface location where DC current is received or collected from a surrounding electrolyte and protection (reduction with a gain of electrons) occurs in a corrosion cell. The opposite of an anode.

Cathodic Protection, (Cathodic Protect, Cathodically Protected, etc.): An electrical method of reducing or eliminating corrosion by making previous anodic areas on a structure surface, turn into a cathode by creating a DC current flow to the structure surface.

Cathodic Protection Criteria: The NACE criteria for protected cathodic protection levels of a minimum of -0.85 volt to a copper/copper-sulfate reference electrode or a 100-millivolt polarization shift or more negative (instant off or IR accounted for) in accordance with NACE Standard SP0169. Selection of protective criteria per NACE Standard SP0169 to be at Engineer's discretion.

Cathodic Protection Station (CPS): An impressed current cathodic protection installation location usually consisting of a rectifier and groundbed.

Cathodic Protection System: Two common cathodic protection methods are galvanic anodes and impressed current cathodic protection systems. A galvanic anode system consists of galvanic anode materials (usually magnesium or zinc) that naturally corrodes or sacrifices itself and does not require an outside power source. An impressed current type system utilizes an outside power source usually a rectifier (that converts AC to DC current) and forces (impresses) current from a number of anodes (or groundbed) through the environment to the structure to be protected.

Change Order: A written order issued by the Engineer to the Contractor, covering changes in the plans, specifications, or quantities within the scope of the Contract and establishing the basis of payment and time adjustments for the work affected by the changes.

City: The City of Rapid City acting through its authorized representative(s).

Contract or Contract Documents: The written agreement between the Owner and the Contractor setting forth the obligations of the parties for the performance of the prescribed work.

Contract Date or words Equivalent Thereto: The date upon which this Contract, executed by the Contractor, is signed by the Owner.

Contract Item, Bid Item or Pay Item: A specific unit of work for which a price is provide in the Contract.

Contract Performance Bond: The security executed by the Contractor and furnished to the Owner to guarantee performance of the work in accordance with the Contract.

Contract Time or Contract Days: The number of working days allowed for performance and completion of the Contract or date work is to be completed, as stated in the Proposal and Contract.

Contractor, Prime Contractor or the words Party of the Second Part: The individual, partnership, firm, corporation, or joint venture contracting with the City of Rapid City for performance of the prescribed work covered by the Contract and his duly authorized agents or legal representatives.

Commercial Source: An established, lawful business operating in continual use as a source to the general public of materials or products relevant to the project.

Compensable Delay: Delay for which the Owner is liable in damages to the Contractor. Compensable delay is a subcategory of excusable delay, since all compensable delays will also be excusable delays. However, not all excusable delay is compensable.

Crew Foreman: See “Crew Superintendent” and “Contractor”.

Crew Superintendent: An employee of the Contractor or subcontractor that directs a group of employees working for the Contractor or subcontractor to complete a specific type of work.

Crushed Material: Granular material with one or more crushed faces on at least 30% of the particles retained on the #4 sieve, unless more stringent requirements are specified.

Culvert: A structure not classified as a bridge which provides an opening under the roadway.

Delay: An increase in the time required for completion of the contract work beyond that originally contemplated by the parties at the time the Contract was signed.

Developer: A private individual, person, or entity, or corporation; other than the City of Rapid City; constructing public and/or private improvements covered under the City of Rapid City’s jurisdiction and shall include his employees, contractors, successors, assigns, duly authorized agents and legal representatives.

Development Project(s) or Project: Project(s) to construct public and/or private improvements, within the jurisdiction of the City of Rapid City, in accordance with the Specifications, City approved plans and specifications, an or a permit issued by the City.

Distribution Main: A water main that is not a transmission main or a water service line that supplies one or more branch mains.

Drain Anode: A galvanic anode that is installed at foreign pipeline crossing locations with the intent that any interference current be discharged or drained from the affected pipeline by the drain anode.

Drawings: See “Plans”.

Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to or less than the sum of the resistance (ohms) of the pipe plus the maximum allowable bond resistance for each joint as specified in this section.

Electrically Continuous Wire: A wire that demonstrates the ability to conduct current and that has a linear resistance (ohms) equal to or less than printed literature values for the different wire gauges and wire types. Resistance of 1,000 feet of stranded copper wire at 77°F for No. 12 AWG wire is 1.65 ohms and for No. 10 AWG wire is 1.04 ohms.

Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings, etc.) and the environment as defined in NACE SP0286.

Employee: Any person working on the project, that is under the direction of, control of, or receives compensation from the Contractor or a subcontractor.

Engineer: The Public Works Director, who has been employed by the City of Rapid City for this work, acting directly or through his duly authorized agents, such agents acting severally within the scope of the particular duties entrusted to them, responsible for engineering and engineering inspection, on the City’s behalf.

Equipment: Machinery, tools, implements or apparatus together with supplies for maintenance and upkeep, necessary for the construction and completion of the work.

Erosion Control: Those items necessary to the completed work, which provide for the preservation of landscape materials and features. The rehabilitation and protection against erosion of areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers. Such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the project and adherence to water quality regulations.

Excusable Delay: Unforeseeable delay, which excuses the Contractor’s obligation to complete the work on time by extending performance time for contractually specified reasons.

Exothermic (Thermite) Welds: A metallurgical method of making electrical connections based on an exothermic reaction, which turns a mixture of copper oxide and aluminum into molten copper using specially designed graphite molds, steel or cast iron (ductile iron) charges, and wire sleeves.

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

Fasteners: To include but not be limited to bolts, nuts, washers, T-bolts, tie-rods, restraining devices, etc.

Ferrous or Metallic Pipe: Any pipe or fitting made of steel or iron, or pipe containing steel or iron as a principal structural material (such as steel, ductile iron, and cast iron), except reinforced concrete pipe or stainless steel.

Fire Hydrant Lead: That portion of the fire hydrant branch line from the main to the fire hydrant auxiliary valve.

Fire Service Line: Pipe and appurtenances delivering water from the City water distribution system to a building fire extinguishing system. Fire service lines may be located on private property or in public right of way (ROW) and are owned, operated, and maintained by the property being served.

Foreign Owned: Any buried pipe or cable not specifically owned or operated by the Owner.

Functional and Performance Testing: Tests necessary to demonstrate that installed equipment and systems function as specified and operate in the manner intended. Functional testing is a prerequisite to performance testing for equipment and systems specified to have a performance test.

Incidental Items or Incidental Work: Items of work, as shown on the plans and/or in the specifications, for which there are no bid items in the Bidder's Proposal. If no bid item for "Incidental Work" is included in the bid proposal, the cost of these items shall be included in the contract bid price for related work items. If a bid item for "Incidental Work" is included in the bid proposal, such work shall be included as a part of this work item.

Inexcusable Delay: Delay for which the Contractor is not entitled to a time extension or monetary compensation and may even be liable in damages to the Owner.

Inspector: The Engineer's authorized representative or representatives assigned to make detailed inspections of contract performance, limited to the particular duties entrusted to them.

Joint Bonds: A method of making the pipeline electrically continuous by connecting insulated copper wire(s) or strap(s) across each side of the pipe joint or fitting.

"L" length: The length of pipe from a fitting, valve, or feature that needs to have each pipe joint within that length restrained.

Lead, Lead Wire, Joint Bonds, Pipe Connecting Wires, Cable: Insulated copper conductor; the same as wire.

Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.

Materials: Substances specified for use in the construction of the project.

Mechanical Damage Protection: Any material or equipment used to eliminate or minimize damage to the piping system (as might be caused from soil stresses and damage caused from rocks, debris, or other outside forces) without inhibiting or interfering with cathodic protection. (e.g., rock shield / rock guard materials are typically protective polyethylene mesh that protects pipeline and fitting coatings from rock backfill, intrusions and abrasions without interfering with the protection system.)

Mils Dry Film Thickness (MDFT): The thickness, expressed in mils, of an applied and cured coating or mastic. Mil is equivalent to 0.001 inch.

Notice to Proceed: The written authorization to begin work on the project.

Owner, City, City of Rapid City, or Party of the First Part: The City of Rapid City acting through its authorized representatives.

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

Petrolatum: A purified mixture of semisolid hydrocarbons obtained from petroleum jelly.

Petroleum Wax: A refined mixture of solid hydrocarbons, paraffin in nature, obtained from petroleum. Provided as a refined paraffin wax or microcrystalline wax forms.

Pin Brazing: A metallurgical method of making electrical connections based on an electric-arc silver solder brazing method using a specially designed portable brazing unit and gun with a hollow brazing pin containing silver solder and flux.

Plans: The drawings which show the location, character, and dimensions of the prescribed work, including layouts, profiles, cross sections, and all drawings and working drawings submitted to the City of Rapid City, if and when approved by the Engineer by issuance of a permit or approval of the actual drawings and specifications. Plans include all drawings submitted to the Contractor during the progress of the work.

Plastic Reference Pipe: Plastic conduit or pipe placed in soil next to structure to allow a portable reference electrode to be inserted into for structure-to-reference electrode potential measurements.

Polyethylene Encasement: A flat sheet or tube of polyethylene plastic that is typically 4-mils or 8-mils thick and meets the requirements of AWWA C105. The polyethylene encasement is a type of loose bonded coating that is wrapped around a ductile iron pipe, fitting, or valve box riser for corrosion protection.

Polyethylene (PE) Pressure Pipe: Polyethylene pressure pipe or water service line pipe shall be referred to herein as high density polyethylene (HDPE) water service line pipe. This needs to be revised. This definition is a little confusing because it could imply that all service line pipe is polyethylene or HDPE.

Potential, Structure-to-Reference Electrode Potential (also Structure-To-Reference Electrode Voltage): Common method to determine corrosion protection levels by measuring the difference in voltage (potential) between the subject metallic structure and the electrolyte in which it is buried or submerged, as measured to the standard specified reference electrode (usually a copper/copper sulfate reference electrode) placed in contact with the electrolyte.

Private Fire Protection System: Hydrants, valves, water pipes, and appurtenances, sprinkler systems, hose connections, and other equipment constructed for the purpose of providing fire protection for a building or group of buildings and supplied with water from a public water supply system. Private Fire Protection Systems are located on private property, although some components may be located in public ROW, and are owned, operated, and maintained by the property being served.

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

Project: The work conducted in accordance with a contract with the City, approved plans and specifications, or the requirements of a permit.

Project Manager (City): The Director of Public Works, who has been employed by the City of Rapid City for this work, acting directly or through his duly authorized agents, such agents acting severally within the scope of the particular duties entrusted to them and is the designated decision making authority for the Engineer and the City.

Project Manager (Contractor): A contractor employee that is the designated decision making authority for the Contractor and subcontractors.

Project Superintendent: The Contractor's authorized representative in responsible charge of the contract work and directs the daily project operations.

Property Water Distribution System: For the purpose of this specification, Property Water Distribution System are those pipes within the building or the premises, which convey water from the water service pipe to the point of use. For purposes of this definition, the Property Water Distribution System begins 5 feet outside of the building and will usually be the same pipe material as the Water Service Line up to where it actually enters the building.

Provide: To both furnish and install.

Public Sanitary Sewer Main: Sewer pipes of at least 8 inches in diameter, which will be installed in public right-of-way or easements, will become a part of the City sewer system and will be owned, operated, and maintained by the City of Rapid City.

Public Water Main: Those pipes of at least 6 inches in diameter, which will be installed in public ROW or easements and will become a part of the City water distribution system and which will be owned, operated, and maintained by the City.

Raceways: Conduit, sheath, plastic or metal pipe, or electrical metallic conduit (EMT) for casing of electrical or cathodic protection cables.

Right-of-Way: A general term denoting the property interest acquired for or devoted to a highway use. May want to change for City reasons

Road: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

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

Roadside: A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

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

Sewer Service or Sanitary Sewer Service: The sanitary sewer line which connects a building to a public or private collection system and may include the service line directly outside the building to within five (5) feet of the building to the point where a connection to a public or private collection system occurs.

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

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

Special Provisions: Additions and revisions to the standard and supplemental specifications applicable to the individual project.

Specialty Items: Those items of work specified in the proposal requiring special equipment, materials, or skills not normally required in typical construction work.

Specifications: A general term applied to all directions, provisions, and requirements pertaining to performance of the work.

Standard Specifications: The most current version of a book of specifications approved by the City of Rapid City for general applications and repetitive use.

State: The State of South Dakota acting through its authorized representative.

Street: A general term denoting a public way for purposes of vehicular travel.

Structures: Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and other features which may be encountered in the work and not otherwise classified.

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

Subcontractor: An individual, partnership, firm, corporation, or joint venture, to which the Contractor sublets a portion of the Contract.

Subgrade: The top surface of a roadbed upon which the pavement structure and shoulders, including curbs, are constructed.

Submittals: All drawings, diagrams, descriptive literature, illustrations, instructions, schedules, safety plans, operating plans, performance and test data, product data sheets, material safety data sheets, and similar materials prepared by the Contractor or a supplier to illustrate material or equipment or some portion of the work.

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

Superstructure: The entire structure except the substructure.

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

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

Test Station: Insulated lead wire connections to the structure, which are brought to a test station terminal board or box in order to allow an electrical connection to be made to the structure for location, and corrosion and cathodic protection testing.

Tight Bonded Coatings: A dielectric coating that is bonded or physically attached to the pipe surface. Ductile iron pipe bituminous asphaltic shop coating does not qualify as an approved factory or shop applied tight bonded coating.

Traffic: Vehicles, pedestrians, and other modes of transportation.

Transmission Main: A water main that supplies many tributary branches, serves a large area, and has no or few service taps.

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

Work: The furnishing of all labor, materials, equipment, and other incidentals necessary to the successful completion of the project.

Working Day: A calendar day, other than holidays or Sundays, except as permitted in writing by the Engineer, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for at least five (5) hours, with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time.

Written Notice or Written Order: An order, issued in writing by the Engineer requiring performance by the Contractor without negotiation of any sort. Notice of a Written Order shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if Emailed, or delivered at or sent by registered mail to the last business address known to him who gives the notice.

That whenever in these Contract documents the words "as ordered," "as directed," "as required," "as permitted," "as allowed," or words or phrases of like import are used, it shall be understood that the order, direction, requirements, permission, or allowance of the Owner and the Engineer is intended.

Similarly, the words "approve," "reasonable," "suitable," or "acceptable," otherwise particularly specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the Owner and Engineer.

7.2 ABBREVIATIONS

Whenever the following abbreviations are used in these specifications or on other Contract Documents, they are to be construed the same as the respective expressions and to mean the code or standard that is in effect at the date of advertisement for bids:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ABS	Acrylonitrile Butadiene
AC	Asphalt Concrete
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute

AMPP	Association for Materials Protection and Performance
ANSI	American National Standards Institute
AOS	Apparent Opening Size
ARA	American Railway Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers' Association
AWWA	American Water Works Association
AWS	American Welding Society
BB	Beam Bolster
BBU	Beam Bolster Upper
CBR	California Bearing Ratio
CLSM	Controlled Low Strength Material
FHWA	Federal Highway Association
FAA	Federal Aviation Administration
FRP	Fiberglass Pipe
FSS	Federal Specifications and Standards
GAI-LAP	Geosynthetic Accreditation Institute Laboratory Accreditation Program
GSA	General Services Administration
GTX	Audit Program for Geotextiles
HDPE	High Density Polyethylene
HMA	Hot Mix Asphalt
ICC	Interstate Commerce Commission
ICEA	Insulated Cable Engineers Association, Inc.
IMSA	International Municipal Signal Association
ITE	Institute of Transportation Engineers
ITIS	Integrated Taxonomic Information System
ITS	Intelligent Transportation System
LED	Light-Emitting Diode
LRFD	Load Resistance Factor Design
MARV	Minimum Average Roll Value
MASH	Manual for Assessing Safety Hardware
MCG	Machine Control Grading
MPEG	Moving Picture Experts Group
MSE	Mechanically Stabilized Earth
MUTCD	Manual of Uniform Traffic Control Devices
NACE	National Association of Corrosion Engineers
NASSCO	National Association of Sewer Service Companies
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NIST	National Institute of Standards and Technology
NTCIP	National Transportation Communications for ITS Protocol
NTPEP	National Transportation Product Evaluation Program
OD	Outer Diameter
OSHA	Occupational Safety and Health Administration

PACP	Pipeline Assessment Certification Program
PCC	Portland Cement Concrete
PLS	Pure Live Seed
PP	Polypropylene
PSM	Plastic Sewer Main
Psf	Pounds per square foot
psi	Pounds per square inch
psig	Pounds per square inch Gauge
PVC	Polyvinyl Chloride
RAP	Recycled Asphalt Pavement
RCP	Reinforced Concrete Pipe
RETMA	Radio Electronic Television Manufacturer's Association
RECP	Rolled Erosion Control Product
ROW	Right-of-way
SAE	Society of Automotive Engineers
SB	Slab Bolster
SBR	Styrene-Butadiene Rubber
SBU	Slab Bolster Upper
SDDANR	South Dakota Department of Agriculture and Natural Resources
SDDOT	South Dakota Department of Transportation
SDR	Standard Dimension Ratio
SPE	Society of Plastic Engineers
SSPC	Steel Structures Painting Council
SY	Square Yard
UL	Underwriters Laboratory
UV	Ultraviolet
VOC	Volatile Organic Content

7.3 SUBHEADINGS AND TITLES

The titles or subheadings used in this contract and on the contract plans and drawings and in the specifications, are understood to be for convenience of reference only, and shall not be taken or considered as being a part thereof, or as having any bearing on the interpretation thereof.

7.4 NATURE AND LOCATION OF WORK

It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character of equipment and facilities needed preliminary to and during the execution of the work, the general and local conditions, and all other matters which can in any way affect the work under this Contract.

7.5 VERBAL STATEMENTS NOT BINDING

It is understood and agreed that the written terms and provisions of the Contract Documents shall supersede all verbal statements of the Engineer or other representatives

of the City, and such statements shall not be effective or be construed as entering into, or forming a part of, or altering in any way whatsoever the written Contract.

7.6 WRITTEN NOTICE OR WRITTEN ORDER

Notice of a Written Order shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if Emailed, or delivered at or sent by registered mail to the last business address known to him who gives the notice.

That whenever in these Contract documents the words "as ordered," "as directed," "as required," "as permitted," "as allowed," or words or phrases of like import are used, it shall be understood that the order, direction, requirements, permission, or allowance of the Owner and the Engineer is intended.

Similarly, the words "approve," "reasonable," "suitable," or "acceptable," otherwise particularly specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the Owner and Engineer.

7.7 SCOPE, NATURE, AND INTENT OF CONTRACT PLANS AND SPECIFICATIONS

The Contract shall include: Notice for Bids; Instructions to Bidders; Bid Proposal; Contract Form and Contract Bond; Notices; Insurance; Performance Bond; Special Conditions; General Conditions; Special Provisions; Standard Specifications; Detailed Specifications; Standard Drawings; Detailed Plans; Plans Drawings; Addendum; Change Orders; and agreements that are required to complete construction of the work, all of which constitute one instrument.

Detailed plans and/or specifications that are furnished by the Contractor to clarify or define the Owners contract must be approved by the Engineer prior to use. Upon approval, said plans and/or specifications shall be considered a part of this Contract.

The Contractor shall, in good and first-class workmanlike manner, and at his own cost and expense, furnish all of the labor, tools, materials, and equipment necessary to complete, ready for use, all of the work as designated and as described by the Contract Documents on file with the Finance Officer of the City of Rapid City, Rapid City, South Dakota.

The said specifications, plans, and contract are intended to supplement, but not necessarily duplicate, each other and together constitute one complete set, so that any work covered in the one and not in the other shall be executed just as if it had been set forth in the Contract, in order that the work shall be completed according to the complete design or designs as decided and determined by the Engineer. It is understood and agreed that the work shall be performed and completed according to the true spirit, meaning, and intent, of the contract and specifications.

The Contractor agrees that in undertaking to complete the work within the time herein fixed, he has taken into consideration and made allowances for all of the ordinary delays and hindrances incidental to such work, whether or not growing out of delays in securing

materials or equipment. Compensation for delays due to no fault of the Contractor may be negotiated.

The Contractor also agrees that all time limits stated in the Contract Documents are of the essence of the Contract.

All the work shall be done under the direct observation of the Engineer and to the entire satisfaction of the Engineer and the Owner and in accordance with the laws of the State of South Dakota and the Ordinances and Codes of the City of Rapid City.

7.8 DUTIES AND POWERS OF INSPECTORS

Properly authorized inspectors shall be considered to be the representatives of the Engineer, limited to the duties and powers entrusted to him. It shall be their duty to inspect the materials and workmanship of those portions of the work to which they are assigned, either individually or collectively, under instructions of the Engineer and to report any and all deviations from the plans, specifications, and other contract provisions which may come to their notice. Any Inspector shall have the right to order the work entrusted to his supervision stopped if in his opinion such action becomes necessary, until the Engineer is notified and he has determined and ordered that the work shall proceed in due fulfillment of all contract requirements. The Engineer and his representatives shall at all times have access to the work wherever it is in preparation or progress and the Contractor shall provide proper facilities for such access and for inspection.

7.9 SEPARATE CONTRACTS

The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate his work with theirs.

If any part of the Contractor's work depends for proper execution or results upon the work of any other contractor, the Contractor shall inspect and promptly report to the Engineer any defects in such work that render it unsuitable for such proper execution and results. His failure so to inspect and report shall constitute an acceptance of the other contractors work as fit and proper for the reception of his work, except as to defects which may develop in the other contractors work after the execution of his work.

To insure the proper execution of his subsequent work, the Contractor shall measure work already in place and shall at once report to the Engineer any discrepancy between the executed work and the Drawings.

7.10 CONTRACT EXECUTION

The selected Low Bidder agrees that he will execute the contract in accordance with the proposal as accepted and secure and furnish the required bonds and insurance within ten (10) calendar days from the date of mailing of said notice of bid award to him at his address as given on the proposal or within such additional time as may be allowed by the Engineer;

and that, upon his failure or refusal to do so within said time, the certified or cashier's check or bidder's bond accompanying this bid and the money payable thereon shall be forfeited to and become the property of the City of Rapid City as liquidated damages for such failure or refusal.

7.11 COPIES OF CONTRACT

Not less than two (2) copies (and as many more as may be required) of the bound volumes of the proposal, contract, and specifications shall be prepared, each shall contain an exact copy of the Contract signed by both parties thereto. Two (2) executed copies shall be filed with the City. Additional copies shall be filed where and as may be required.

7.12 RESPONSIBILITY OF CONTRACTOR

General Responsibility: The Contractor shall furnish all transportation, ways, works, machinery, and plant, and all suitable appliances required for the safe, proper, and lawful construction, maintenance, and use thereof. The Contractor shall be fully responsible for the materials and equipment used for the work and for safeguarding the work against damage or destruction until its final acceptance by the Engineer. The Contractor agrees to make no claims for damage to the work prior to final acceptance and will make no claims for damage to the materials except through negligence or willful act of the Owner.

Before the completion and acceptance of this Contract, Contractor shall be solely answerable for all damage to the Owner or the property of the Owner; to other Contractors, or other employees of the Owner; to the neighboring premises or to any private or personal property due to improper, illegal, or negligent conduct of himself or his subcontractors; employees or agents in and about said work or in the execution of the work covered by this Contract or any extra work undertaken herein provided; or to any defect in, or the improper use of, any scaffolding, shoring, apparatus, ways, works, machinery or plant. He shall indemnify and save harmless the Owner and its officers and agents from all claims relating to labor, materials, and methods used in executing the work.

7.13 PERSONS IN RESPONSIBLE CHARGE

The Contractor shall have on the site at all times a superintendent or a person in his employ who shall be in responsible charge of all work. The Contractor shall, in writing, give the Engineer the name of the person in responsible charge prior to beginning any work. Changes of persons in responsible charge during the course of performing the work shall be submitted, in writing, to the Engineer prior to instituting the change.

7.14 ORDER OF COMPLETION OF WORK

The Contractor shall, within ten (10) days after being instructed to do so in a written notice from the Engineer, commence the work to be done under this contract; and the rate of progress shall be such that work shall have been completed in accordance with the terms of this Contract, on or before the date of completion named in the proposal hereof.

7.15 CONTRACTOR TO CHECK SPECIFICATIONS AND SCHEDULE

The Contractor shall check all specifications, quantities, and schedules given to him by the Engineer and shall, upon discovery, notify the Engineer in writing of any discrepancy which he may discover between the plans and specifications or between either plans and specifications and physical site conditions; or if he observes site conditions not usually encountered on this type of work; or if he believes the plans and specifications require work which would violate laws, ordinances, or codes. Failure to follow this procedure shall preclude the Contractor from making any claim for damages resulting from the alleged discrepancy.

Should anything be omitted from the specifications, plans, and/or contract which is necessary to the clear understanding of the work, or should it appear various instructions are in conflict, then the Contractor shall secure written instructions from the Engineer before proceeding with the construction affected by such omissions or discrepancies. Failure to request written instructions shall constitute a waiver to any and all claims associated with the omission or conflict.

The Contractor will not be allowed to take advantage of any error or omission in the plans, specifications or contract documents, as full written instructions will be furnished by the Engineer, should such error or omission be discovered, and the Contractor shall carry out such instructions as if originally specified.

7.16 CALCULATED DIMENSIONS TO GOVERN

In case of discrepancy, calculated or written dimensions will govern over scaled dimensions.

7.17 DRAWINGS FURNISHED BY CONTRACTOR

The Contractor shall supply such working specifications and drawings of devices, castings and composite materials to be furnished under this Contract as are called for herein or are required by the Engineer to make clear the details of equipment and of devices.

7.18 PATENTS

It is further agreed that all royalties for patents or patent infringement claims, whether such patents are for processes or devices, that might be involved in the construction or use of the work, shall be included in the Contract amount and the Contractor shall satisfy all demands that may be made at any time for such, and shall be liable for any damages or claims for patent infringements; and the Contractor shall, at his own expense, defend any and all suits or proceedings that might be instituted at any time against the Owner for infringement or alleged infringement of any patent or patents involved in the work; and in case of an award of damages, the said Contractor shall pay such award; final payment to the Contractor by the Owner will not be made while any such suits or claims remain unsettled.

7.19 INDEMNITY

The Contractor shall indemnify and save harmless the Owner from and against all losses and all claims, demands, payments, suits, actions, recoveries, and judgments of every nature and description brought or recovered against him, by reason of any act or omission of the said Contractor, his agents or employees, in the execution of the work or in the guarding of it and this shall include acts or omission of subcontractor.

The Contractor shall, and is hereby authorized to, maintain any part for such insurance, issued in the name of the Owner, as will protect the Owner from his contingent liability under this Contract, and the Owners right to enforce against the Contractor any provision of this Section shall be contingent upon the full compliance by the Owner with the terms of applicable insurance policy or policies, a copy of which shall be deposited with the Owner.

7.20 INSURANCE

The Contractor shall secure policies of insurance in amounts, form and companies satisfactory to the Owner, and as specified in the Contract.

7.21 GUARANTEES

The Contractor and any sureties under the Performance Bond guarantee to complete the project as specified and agree that loss as a result of any occurrence including acts of God, shall not relieve them of their obligation.

7.22 CONTRACTOR LIABILITY INSURANCE

The Contractor shall maintain insurance as will protect him from claims under Workmen's compensation acts and from any other claims for damages for personal injury, including death, which may arise from or by any subcontractor or anyone directly or indirectly employed by either of them.

7.23 PERFORMANCE BOND

The surety bond executed by the Contractor, issued to the Owner, shall be a guarantee:

- A.** For the faithful performance and completion of the work in strict accordance with the terms of the contract, specifications, and detailed plans;
- B.** For the payment to the Owner of all sums due or which may become due by the terms of the contract; as well as by reason of any violation thereof by the Contractor;
- C.** For the payment of all bills, including the hire, rental or lease of equipment or machinery, and the operators thereof, used on the work, and for all materials, lubricants, oils and gasoline used in or consumed in the construction of such work and for all labor performed in such work whether by sub-contract or otherwise;

- D. The payment of any and all judgments and costs of suits and actions brought against the Owner or officials thereof, for any cause whatsoever, arising from or on account of any injuries or damages to life or property suffered or sustained by any person, firm or corporation, caused by the Contractor, his or its agents, servants or employees in the construction of said work, or by or in consequence of any negligence, carelessness or misconduct in guarding or protecting the same, or any act or omission of the said Contractor his agents, servants, employees;
- E. And for the protection of the Owner against all suits and claims for infringements or alleged infringements of patent rights processes.

This section shall in no way be construed as limiting the obligation under the Performance Bond actually furnished, but may be an addition thereto.

The Owner agrees to mail a notice to the Contractor, calling his attention to any failure to comply with the requirements of the bond, not more than ten (10) days before notifying his bondsmen of such failure to comply with the terms of said bond.

7.24 REEMPLOYMENT ASSISTANCE

The Contractor to whom the Contract is awarded, will pay South Dakota Department of Labor and Regulations, all contributions and interest due under the Unemployment Compensation Law of South Dakota. Further, it is required that the Contractor furnish a certificate, prior to final payment, from the Department of Manpower Affairs that all contributions and interest due to the department in performance of that Contract have been paid.

7.25 DISCRIMINATION

The Contractor will not discriminate against any employee or applicant for employment because of race, sex, creed, color or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated fairly during employment, without regard to their race, sex, creed, color, or national origin. Such action shall include, but is not limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

The Contractor will state, in all solicitations or advertisements for employees placed by or on behalf of the City, that all qualified applicants will receive consideration for employment without regard to race, sex, creed, color, or national origin.

The Contractor will send, to each labor union or representative or workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers representative of the contractor's commitments under Section 202 of Executive Order No.

11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

The Contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, of the rules, regulations, and relevant orders of the Secretary of Labor.

The Contractor will furnish all information and reports required by Executive order No. 11246 of September 24, 1965, and by the rules, regulations, and order of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

In the event of the Contractor's noncompliance with the discrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

The Contractor will include the provisions of Section 7.21 in every subcontract or purchase order unless exemption by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions including sanctions for noncompliance: provided, however, that in the event the Contractor becomes involved, in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States and the City to enter into such litigation to protect the interest of the United States and the City.

7.26 LABOR AND DISMISSAL OF EMPLOYEES

The Contractor shall employ only persons who are competent and skillful in their respective lines of work, and local labor shall be given preference. Whenever the Engineer shall notify the Contractor that any person on the work is, in his opinion, incompetent, unfaithful, disorderly or under the influence of intoxicating substances, or refuses to carry out the provisions of this contract or uses threatening or abusive language to any persons, shall be immediately discharged from the work and shall not be re-employed thereon except with the consent of the Engineer.

7.27 LAWS AND ORDINANCE

The Contractor shall keep himself fully informed of all existing and current regulations of the Owner, and County, State, and National Laws which in any way limit or control the actions or operations of those engaged upon the work, or affecting the materials supplied to or by them. He shall at all times observe and comply with, all ordinances, laws, rules and regulations and shall protect and indemnify the Owner and the Owner's officers and

agents against any claims or liability arising from or based on any violation of the same. The Contractor shall give all notices and comply with all laws, ordinances, rules, and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the Drawings and Specifications are at variance therewith, he shall promptly notify the Engineer in writing and any necessary changes shall be adjusted as provided in the Contract for changes in the work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules, and regulations and without such notice to the Engineer, he shall bear all costs arising therefrom. Such performance shall constitute a waiver of any and all claims associated with the work.

7.28 PERMITS AND LICENSES

Unless otherwise specified, permits and licenses of a temporary nature necessary for the prosecution of the work shall be secured and paid for by the Contractor. Permits, licenses, and easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the Owner, unless otherwise specified.

7.29 DIRT/DUST CONTROL

All activities associated with this contract shall conform to Pennington County Ordinance #12, "Fugitive Dust Regulation." The Contractor shall obtain a dust control permit from the County Planning Office and furnish a copy to the Owner before beginning work on the project.

The Contractor shall make every reasonable effort to minimize fugitive dirt or dust as a result of construction activities. The Engineer may require the Contractor to water or take other actions necessary to prevent blowing dirt and/or dust and other nuisance conditions, at no additional cost to the Owner.

Upon substantial completion of construction at a given site or at any time prior to final project acceptance as directed by the Engineer, the Contractor shall clean up the project area(s) and remove all dirt and debris from the street and sidewalk surfaces to the satisfaction of the Engineer. In general, removal of the dirt and debris shall be conducted in such a way and/or at such a time as to minimize nuisance conditions of dirt and dust in the air, on vehicles, sidewalks, and buildings.

Specifically, the streets shall be swept with an approved, enclosed mechanical or vacuum-type sweeper, which picks up the dirt and debris and stores it for hauling and disposal off-site. The Contractor shall utilize a private sweeper whenever possible. However, he may request that the City Street Department do the sweeping if a private sweeper is not available when required. When the Contractor elects to utilize the City sweeper, he shall give the Engineer at least 72 hours' notice prior to the time the sweeper is desired. If the City sweeper is utilized, the City Street Department will then bill the Contractor for the use of the sweeper at the current hourly rate for sweeper and operator. If, in the opinion of the Engineer, the Contractor fails to make reasonable effort to minimize fugitive dust as a result of his construction activities, or refuses to take action when requested by the Engineer, the Engineer may elect to schedule the City sweeper to provide cleanup. The

City street Department will bill the Contractor at one and one-half times (1 1/2) the current hourly rate for the sweeper and operator.

7.30 CLAIMS AND DAMAGES

Any claim for damage arising under this contract shall be made in writing to the party liable within ten (10) calendar days of the first observance of such damage, except as expressly stipulated otherwise, and shall be adjusted by agreement or by arbitration. Failure to comply with the notice requirement will result in denial of the claim.

In general, the Contractor may not recover for claims, which did not impact the critical path of the project.

The Contractor shall document his claim(s) in the following manner:

- A.** Provide an introduction and summary.
- B.** Provide a listing and explanation of subsurface information available in the bidding documents and/or through a reasonable site investigation.
- C.** Provide a report of the Contractor's site investigation.
- D.** Explain the conditions actually encountered.
- E.** Discuss the difference between actually encountered and anticipated conditions with emphasis on the impact of such things as delay, interference, disruption, changes in construction methods, and additional direct labor and equipment requirements.
- F.** Summarize the applicable laws and/or contract clauses.
- G.** Set forth the time extension claim with rational, detailed calculations.
- H.** Set forth the cost claim broken down to the smallest elements possible.

7.31 LIENS

Neither the final payment nor any part of the retained percentage shall become due until the Contractor, if required, shall deliver to the Owner a complete release of all liens arising out of this Contract, or receipts in full in lieu thereof and, if required in either case, an affidavit that so far as he has knowledge or information the releases and receipts include all labor and materials for which a lien could be filed; but the Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the Engineer, to indemnify the Owner against any lien. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

7.32 USE TAX LIABILITY

The Contractor shall be liable to pay the use tax on tangible personal property that is supplied by the City to the Contractor for performance of the Contractor. The value of said personal property will be as indicated in Section 2.20 of the Contract. The Contractor shall be liable to pay all Federal, State, County, or local taxes required for labor and/or materials included in this Contract.

7.33 WORK MODIFICATIONS

The Owner, without invalidating the Contract, may order extra work or make changes by altering, adding to, or deducting from the work, the Contract Sum being adjusted accordingly. All such work shall be executed under the conditions of the original Contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change.

In giving instructions, the Engineer shall have authority to verbally make minor changes in the work; but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Engineer, and no claim for an addition to the Contract Sum shall be valid unless so ordered and approved by the Council.

The value of any such extra work or change shall be determined in one or more of the following ways:

- A. By estimate and acceptance in a lump sum.
- B. By unit prices named in the Contract or subsequently agreed upon.
- C. By cost and percentage or by cost and a fixed fee.

If none of these methods is agreed upon, the Contractor, provided he receives an order as above, shall proceed with the work. In such case and also under case (c), he shall keep and present in such form as the Engineer may direct, a correct account of the net cost of labor and materials, together with vouchers. In any case, the Engineer shall certify to the amount including reasonable allowance for overhead and profit, due to the contract, or pending final determination of value, payments on account of changes shall be made on the Engineer's Estimate. Work done on a Force Account basis shall be as follows:

1. **Labor:** For labor and supervisor in direct charge of the specific operations, the Contractor shall receive the rate of wage agreed upon in writing before beginning work or the actual rate paid in the event it is less than the agreed rate, for each and every hour that said labor and supervisor are actually engaged in such work.

If a laborer or supervisor is paid for "overtime" during a calendar week in which he is employed for part of that period on force account work, the Owner will pay to the Contractor a percentage of that portion of the overtime payment. For each such

employee, this percentage will be the ratio, which the total hours he worked on force account during the week bears to the total hours he worked during that week.

Overtime incurred due to the City requiring the Contractor to do force account work, during periods not normally worked, will be paid one hundred percent (100%) by the City. In order that the Engineer may verify wages paid and pro-rate overtime, the Contractor shall furnish to the Engineer certified payrolls during the period force account work is in progress.

An amount equal to fifteen percent (15%) of the sum for labor will also be paid the Contractor as compensation for administrative and overhead costs.

2. **Bond, Insurance, and Tax:** For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions, excise taxes, and social security taxes on the force account work, the Contractor shall receive the actual cost, to which no percentage will be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance, and tax. In lieu of furnishing itemized statements to substantiate these costs, of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and Social Security tax, the Contractor may elect to receive an amount equal to twenty-five percent (25%) of the actual labor costs (excluding the fifteen percent [15%] for administrative and overhead costs) as compensation for those costs.
3. **Materials:** For materials accepted by the Engineer and incorporated into the project, the Contractor shall receive the actual cost of such materials delivered onto the worksite, including transportation charges paid (exclusive of machinery rentals as hereinafter set forth), to which cost fifteen percent (15%) will be added as compensation for administrative and overhead costs.
4. **Equipment:** For machinery or special equipment, including fuel and lubricants, plus transportation costs, the use of which has been directed or authorized by the Engineer, the Contractor shall be paid at an agreed upon rate; or, failing mutual agreement, in accordance with provisions and rates set forth in the current edition of the South Dakota Department of Transportation Equipment Rental Rates, for actual time such equipment is in operation on the work, except that standby costs will not be paid. Nor will additional amounts be added for administration and overhead cost.
5. **Miscellaneous:** Additional allowance will not be made for general superintendence, cost of maintaining home office, standby costs, or other costs for which no specific allowance is herein provided.
6. **Compensation:** The Contractor's representative and the Engineer shall compare records of the cost of work done as ordered on a force account basis.
7. **Statements:** Payment will be made for work performed by force account based on itemized statements of the cost of such force account work detailed as follows:

- a) Certified payrolls showing worker name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman;
- b) Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment;
- c) Quantities of materials, prices and extensions;
- d) Transportation of materials; and
- e) Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, and social security tax.

Statements shall be accompanied and supported by receipted invoices for materials used and transportation charges. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then, in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

- 8. To the sum of items A through C, shall be added ten percent (10%) for profit.

7.34 EXTRA WORK AS PART OF CONTRACT

If extra work orders are in accordance with the provisions of this Contract, such work shall be considered a part hereof and subject to each and all of its terms and requirements.

7.35 UNKNOWN OR CONCEALED CONDITIONS

Whenever, during excavating operations, the Contractor encounters a heretofore unknown underground utility or other unknown or unexpected physical condition, the existence of which could not have reasonably been foreseen or anticipated and which causes a significant delay and/or expense to the Contractor, he shall contact the Engineer, before such conditions are disturbed, for a determination as to whether compensation will be allowed.

Compensation may consist of a payment to the Contractor and/or an extension of contract time. However, no compensation will be allowed unless notice is given prior to disturbing the condition. Should the Engineer allow payment, he will pay for reasonable and justifiable costs involved in dealing with the condition as specified in Section 7.29 of these specifications.

Extra contract time shall be based on the actual time of the delay caused by encountering the condition.

7.36 SUSPENSION AND ANNULMENT OF CONTRACT

If the equipment, material, or work to be furnished under this contract shall be abandoned by the Contractor, or if this Contract shall be assigned or the work sublet by him, or if at any time the Engineer shall be of the opinion, and shall so certify in writing to the Owner, the performance of this Contract is unnecessarily delayed, or that the Contractor is willfully violating any of the conditions or covenants of this Contract or of the specifications, or is executing the same in bad faith or not in accordance with the terms of said Contract, or if the work be not fully completed within the time named in this Contract for its completion, or within the time to which the completion of this Contract may be extended, the Owner may notify the Contractor to discontinue all work, or any part thereof, then the Owner is hereby empowered to suspend or annul this Contract.

If this Contract be so annulled or suspended, the Contractor shall not be entitled to anything on account thereby, nor shall such annulment or suspension in any way affect the right of the owner to damages claimed by it on account of the failure of the Contractor, but such annulment must be ratified by the Owner before being of any force or effect. In the case of annulment of this Contract before completion from any cause whatever, the Contractor, if notified to do so by the Owner, shall promptly remove any part or all of this equipment and supplies from the property of the Owner, failing which, the Owner shall have the right to remove such equipment and supplies at the expense of the Contractor.

7.37 CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

If the work should be stopped under an order of any court, or other public authority, for a period of three months, through no act or fault of the Contractor or of anyone employed by him, then the Contractor may, upon seven (7) days' notice in writing to the Owner and the Engineer, stop work or terminate this Contract and recover from the Owner payment for all work executed and partially executed and reasonable profit.

7.38 ENGINEER'S RIGHT TO STOP WORK

Should traffic, weather, or conditions caused by the actions or inactions of the Contractor dictate, the Engineer may issue a Stop Work Order to the Contractor. Upon receiving a Stop Work Order, the Contractor shall stop working and shall backfill and compact all open holes and/or trenches, properly sign, identify, and clean up the project to the satisfaction of the Engineer. When conditions improve, the Engineer will issue a Notice to Proceed for the remainder of the project. The Contractor will then have a ten (10) day equipment-ready period before contract time resumes. Remaining work shall be completed within the contract time.

7.39 SUGGESTIONS TO CONTRACTOR ADOPTED AT HIS OWN RISK

Any plan or method of work suggested by the Engineer to the Contractor, not specified or required in the contract, adopted or followed by the Contractor in whole or in part, shall be used at the risk and responsibility of the Contractor; and the Engineer and the Owner shall assume no responsibility therefore.

7.40 SUBLETTING OF CONTRACT

The Contractor shall perform, with his own organization, work amounting to not less than fifty (50) percent of the original total contract price, except that any items designated by the City as "Specialty Items" so performed may be deducted from the original contract price before computing the amount of work required to be performed by the Contractor with his own organization.

Any items that have been selected as "Specialty Items" for the contract are listed as such in the proposal.

No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the Engineer. The Contractor shall request permission, in writing, to sublet, assign or otherwise dispose of any portion of the contract and shall list the names and addresses of proposed subcontractors. The Contractor shall provide a statement that the organization(s) which will perform the work is (are) particularly experienced and equipped for such work and shall provide proof that the proposed subcontractor(s) is (are) licensed to perform the work in South Dakota. The Contractor shall give assurance that all pertinent provisions of the prime contract, including the minimum wage for labor as stated in his proposal, shall apply to all work sublet, assigned or otherwise disposed of in any way. Such assurance shall be accomplished in the manner required by the Engineer. Consent to sublet, assign or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of any responsibility for the fulfillment of the Contract.

It will not be permissible for a Subcontractor to sublet work, but any work sublet to a Subcontractor can be canceled or reassigned upon request from the prime Contractor and approval of the Engineer.

The Contractor shall accept full responsibility for actions or omissions of his subcontractors and their employees as he would if they were his own. See paragraph 7.12 of these Specifications.

If evidence and investigation establish beyond reasonable doubt that a violation of the fifty percent (50%) subcontract rule is being or has been attempted through subterfuge whereby one Contractor's equipment is directly or indirectly leased to another Contractor, or whereby a significant part of one Contractor's regular working force is placed on the payroll of another Contractor, such a conclusion shall constitute a violation of the subcontract rule. This provision shall not be construed to include in the fifty percent (50%) limitation the lease of or use of equipment of a corporation or company wholly owned by the Prime Contractor.

In the case of violation of the subcontract rule, the Rapid City Council may suspend the bidding qualifications of such Contractors for a period of up to one year.

The value of work proposed for subcontract will be determined by multiplying that portion of the original contract item quantities to be sublet by the corresponding unit price as set forth in the contract.

If any phase of work involved on a contract item is sublet, the entire contract unit cost of the item will be used for determining the value of work. Materials provided by the

Contractor for a subcontractor on a particular work item will not qualify that item as work done by the Contractor.

Work performed with equipment not owned by the Prime Contractor will be considered subcontract work unless the origin of such equipment meets one of the following conditions:

- A. Equipment supplied by an established equipment dealer on a rental or rental purchase agreement.
- B. An occasional piece of equipment temporarily obtained from another Contractor or from an individual or company engaged in similar work.
- C. Special equipment, not normally owned for the type of work involved.
- D. Trucks used to haul gravel or other materials to the project.

Equipment used by a Subcontractor, must be owned by the Subcontractor or Prime Contractor, except that equipment listed above.

Should any subcontractor fail to perform in a satisfactory manner the work undertaken by him, such subcontract shall be immediately terminated by the Contractor upon written notice from the Owner.

Nothing contained in the contract documents will create a contractual relation between the City and any subcontractor.

7.41 PUBLIC SAFETY AND WORK PROTECTION

Whenever, in the opinion of the Engineer, the Contractor has not taken sufficient precaution for the safety of public or the protection of the work to be constructed under this contract, or of adjacent structures or property which may be injured by process of construction on account of such neglect, and whenever, in the opinion of the Engineer, an emergency shall arise and immediate action shall be considered necessary in order to protect the public or private personal property interest, then, the Engineer, with or without notice to the Contractor, may provide suitable protection to the said interests by causing such work to be done and material to be furnished and placed as the Engineer may consider necessary and adequate. The cost and expense of such work and material so furnished shall be borne by the Contractor, and if the same shall not be paid on presentation of the bills therefore, then such costs shall be deducted from any amounts due or to become due the Contractor. The performance of such emergency work under the direction of the Engineer shall in no way relieve the Contractor of responsibility for damages which may occur during or after such precaution has been duly taken by the Engineer.

7.42 BARRICADES AND WARNING SIGNS

The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices, and shall take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated during hours of darkness. Suitable signs shall be provided to properly control and direct traffic.

The Contractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road.

It shall be the Contractor's responsibility to clear the work area of private vehicles as necessary.

All barricades, warning signs, lights, temporary signals, and other protective devices must conform with the current Manual of Uniform Traffic Control Devices.

7.43 USE OF EXPLOSIVES

When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use of explosives and shall meet all local, State, and Federal laws and requirements pertaining to explosives as well as Title 29, Code of Federal Regulations, Part 1926, Occupational Safety and Health Act regulations for construction (OSHA), and Title 30, Code of Federal Regulations, Mineral Resources, whichever is most restrictive, in the use, loading, transportation, and storage of explosives and blasting agents.

The Contractor shall obtain a blasting permit from the Rapid City Fire Department prior to the use of any explosives. The Fire Department may impose restrictions on the quantities, methods, and materials utilized for blasting.

The Contractor shall notify property owners and public and private utility companies having structures or facilities in proximity to the site of the work of their intention to use explosive. Such notice shall be given sufficiently in advance to enable them to protect their property from injury. In no case shall notice be given less than five (5) calendar days prior to the desired date of usage.

The Engineer may require the Contractor to monitor certain properties during actual blasting in order to determine effects of blasting. In some cases, the Engineer may require the use of a seismograph to document the forces of blasting.

It is recommended that, prior to blasting, the Contractor document the condition of structures in the vicinity of the work.

7.44 PROTECTION OF UTILITIES AND PROPERTY

The type, size, location, and number of all known underground utilities are approximate when shown on the plans. The Contractor shall be responsible for determining and verifying the existence, depth, and location of all underground utilities within the work limits.

The Contractor shall give reasonable notice to the owner or owners of steam, gas, water, sewer, and other pipe lines, or conduits, overhead and underground wire or other structures, either public or private, railroads and other owners of property, when such property is liable to injury or damage of the execution of the work, in order that the owner or owners of such utility or other property may locate, relocate, remove or protect the same.

If the Owner or owners of any private or public property liable to be affected, endangered, or damaged by the construction of this work, does not protect its or their property, then the Contractor shall do so.

The Contractor shall use every precaution on the work to prevent harm or accident to the property, passengers, employees, or patrons of utilities, either publicly or privately owned, and to any other person legitimately employed on the premises, and the Contractor shall assume all liability for damages accruing from any accident, which may be due to his carelessness, omission or neglect; he shall pursue the work under and along and near such property as may be liable to damage thereby, as rapidly as possible when once the work is begun.

The Contractor shall satisfactorily shore, support and protect any and all pipe and other structures or utilities and shall not be entitled to any damage or extra pay on account of any postponement, interference, or delay caused by any such structures being on the line of the work, whether such structures are shown on the plans or not. Contractor shall save Owner harmless from any and all liability or expense for injuries, damages, or repair to any public or private property.

7.45 CONDEMNED MATERIALS AND STRUCTURES

The Contractor, at his own expense, shall remove from the site of the work, without delay, all rejected and condemned materials or structures of any kind whether or not incorporated into the work and shall promptly remove and re-execute all condemned work and will bear the expense of making good any work destroyed or damaged by removal of defective work, and upon his failure to do so or to make satisfactory progress in so doing, within forty-eight (48) hours after the service of a written notice for the Engineer ordering such removal, the condemned materials, work, or structure may be removed by the Owner and the cost of such removal be taken out of the money that may be due or may become due the Contractor on account of or by virtue of this contract. No such rejected or condemned material shall again be offered for use by the Contractor under this or other contract under this project.

7.46 MAIL BOXES

When necessary, mail boxes shall be removed and reset in a manner prescribed by the Postmaster of the Federal Post Office, Rapid City, South Dakota. A copy of the postal regulations can be obtained from the Postmaster.

It is expected that the Contractor shall give his full cooperation to the postal department concerning mail delivery during the construction of this project.

The owner of any structurally unsound mail box post shall furnish a new post at his expense. However, the Contractor shall not remove such a post until he has notified the project inspector.

Costs associated with this item shall be incidental to the project.

7.47 PROVIDING ACCESS

The Contractor shall conduct construction activities in such a manner as to provide continuous access to all affected properties during the duration of the project, unless the specific activity precludes continuous access. At no time shall the Contractor park equipment in front of or in any other way block a driveway or other entrance such that there is no means of ingress and/or egress to or from a property. Should such a situation occur, the Contractor shall take the necessary steps to provide immediate and safe access to or from the property.

Failure to provide access in a timely manner will cause the Owner to take the necessary action and bill the Contractor one and one-half (1 and 1/2) times the cost incurred.

7.48 SATURDAY, SUNDAY, HOLIDAY, AND NIGHT WORK

No work shall be done on Sundays and legal holidays, except such work as is necessary for the proper care and protection of work already performed, and, in any case only with the written permission of the Engineer; or, in case of emergency, which also requires the immediate notification of the Engineer. The Contractor shall request, and must receive, in writing, permission from the Engineer to enable work on Sundays and legal Holidays, except such work as noted above.

No work shall be done on Saturdays, except for emergencies, without the permission of the Engineer. The Contractor shall request permission from the Engineer to work on a given Saturday a minimum of 24 hours in advance, except such work as noted above.

No work, except for emergencies, shall be done between the hours of 9 P.M. and 6 A.M. unless the Contractor first obtains the written permission of the Engineer; such permission may be revoked at any time by the Engineer if the Contractor fails to maintain, at night, adequate force and equipment for reasonable prosecution and supervision of the work, or if Contractor's operations are unnecessarily disruptive to the public.

Holidays observed by the City of Rapid City include: The first day of January, commonly known as New Year's Day; the Friday immediately preceding Easter, commonly known as Good Friday; the last Monday in May, commonly known as Memorial Day; the fourth day

of July, commonly known as Independence Day; the first Monday in September, commonly known as Labor Day; the eleventh day of November, commonly known as Veteran's Day; the fourth Thursday in November, commonly known as Thanksgiving Day; the Friday immediately following Thanksgiving Day; the twenty-fifth of December, commonly known as Christmas Day; and any other day declared by the City to be a holiday.

If the day of observance of the foregoing holidays is changed by enacted laws of the City of Rapid City, such day will be the day of observance of such holiday. Whenever any of the foregoing holidays fall on Sunday, the Monday immediately following shall also be observed as a holiday. Whenever any of the foregoing holidays fall on Saturday, the Friday immediately preceding shall also be observed as a holiday. Saturdays and Sundays will be considered the same as Holidays.

7.49 WORK DONE WITHOUT LINES, GRADES, OR INSPECTION

Any work done without lines or grades or without the inspection of an Inspector or other representative of the Engineer may be ordered removed and replaced at the Contractor's cost and expense. In-place testing or other verification data can be requested by the Engineer at the Contractor's expense. Disregard of this requirement shall result in a Stop Work Order being issued until the Contractor provides the Engineer with an acceptable plan of prior notification procedures.

7.50 STAKING WORK

The Engineer shall furnish all necessary labor and materials to set the necessary stakes for grade and alignment for all work, but it will be the Contractor's responsibility to preserve such stakes after they are once set by the Engineer. Stakes removed, damaged, etc. by Contractor negligence shall be replaced at Contractor expense. The Engineer may require the Contractor to replace the stakes or may elect to replace the stakes and charge the Contractor for the associated costs.

All work done under this Contract shall be done to the lines and grades shown on the plans or as staked by the Engineer. The Contractor shall keep the Engineer informed, a reasonable time in advance, nominally a period of one (1) full working day, of the times and places at which he wishes to do work, in order that lines and grades may be furnished, and necessary measurements for record and payment may be made with the minimum of inconvenience to the Engineer and of delay to the Contractor. The Contractor shall determine the meaning and intent of all stakes, measurements, and marks prior to commencing work. Contractor shall be responsible for protecting stakes from displacement.

7.51 MATERIALS

A. General: The Contractor shall furnish only new and best commercial quality material, equipment, appliances, and supplies for the work. Bid prices shall include all sales and other taxes payable on all items incorporated in the permanent work.

Anything specified by manufacturer's name or proprietary name shall be furnished exactly as called for unless followed by the words "or approved equivalent". The decision of equity, will be made by the Engineer.

- B. Samples:** When requested by the Engineer, samples or test specimens of materials to be used or offered for use in connection with this work shall be prepared at the expense of the Contractor and furnished by him in such quantities and sizes as may be required for proper examination and test, with all carriage charges prepaid and with information as to their sources. All samples shall be submitted in ample time to permit the making of proper tests, analyses, or examination before the time at which it is desired to incorporate the material into the work. The cost of making all tests, and the cost of materials used in such tests, shall be paid by the Contractor, unless otherwise specified. Tests other than those which can be made in the field by the Engineer or can be arranged to be made by him elsewhere, shall be made by a properly equipped laboratory of established reputation. Reports of all tests shall be mailed to the Owner, to the Engineer, and to the Contractor.
- C. Warranty:** The Contractor warrants to the Owner that all materials and equipment furnished and installed under this contract will be new unless otherwise specified, and shall be of good quality, free from defects, and in conformance with the plans and specifications. All materials not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. If required by the Engineer, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

7.52 CLEANUP AND RESTORATION

The Contractor shall not allow the site of the work to become littered with trash and waste material, but shall maintain the same in a neat and orderly condition throughout the construction period. The Engineer shall have the right to determine what is or is not waste material or rubbish and the manner and place of disposal.

The Owner reserves the right to require the Contractor to clean up all or any portion(s) of the project at any time prior to final project acceptance.

On or before the end of contract time, the Contractor shall, at his own expense, dismantle and/or remove all temporary structures built or furnished by him and shall replace or repair all areas disturbed as a result of this project to original condition or better.

If all other work has been completed, and winter weather, availability of materials such as hot mix asphalt or sod, or other conditions prevent complete cleanup and restoration, the Contractor shall clean up the project area(s) to the satisfaction of the Engineer prior to suspending work. After cleanup has been approved, the Engineer will issue a Stop Work Order, and contract time will stop. When conditions are once again suitable and/or materials are available, the Engineer will issue a Notice to Proceed, giving the Contractor ten (10) calendar days to resume cleanup and restoration.

All cleanup and restoration shall be completed within the remaining Contract time. If additional contract time is necessary, the Contractor shall request a time extension as set forth in these General Conditions.

If complete cleanup and restoration is not possible, for whatever reason, the Contractor will be responsible for satisfactorily maintaining all disturbed areas until such time as they are restored. Should any maintenance work be required on any portion of the project prior to issuance of the acceptance letter, the Contractor shall do so within forty-eight (48) hours of receiving notice from the Engineer. Failure to do so will cause the Owner to do the necessary work and bill the Contractor one and one-half (1 1/2) times the cost incurred.

7.53 TESTING OF COMPLETED WORK

Before final acceptance, all parts of the work shall be tested and each part shall be in good condition and proper working order or shall be placed in such condition and order at the expense of the Contractor, unless otherwise specified. All tests of completed work required under this contract shall be made under the direction of the Engineer by and at the expense of the Contractor, who shall repair at his own expense all damage resulting therefrom.

7.54 PLACING WORK IN SERVICE

If desired by the Owner, portions of the work, as substantially completed, may be placed in service, the Contractor to give proper access to the work for this purpose; but such use and operation shall not constitute an acceptance of the work, and the Contractor shall warrant the work as specified in Section 7.51. If such prior use increases the cost of or delays the work, the Contractor shall be entitled to such extra compensation, or extension of time, or both, as the Owner may determine.

7.55 COMPLETION AND ACCEPTANCE OF WORK

The Engineer, upon completion of the contract work, shall satisfy himself by examination and test that the work has been finally and fully completed in accordance with the Specifications and Contract, and report such completion to the Owner.

7.56 ESTIMATED QUANTITIES

The Contractor agrees that the quantities of work as stated in the Bid Proposal or indicated on the plans are only approximate, and that during the progress of the work the Owner may find it advisable, and shall have the right to omit portions of the work and to increase or decrease the quantities, and that the Owner reserves the right to add or to take from any items as may be deemed necessary or desirable. Under no circumstances or conditions will the Contractor be paid anything on account of anticipated profits upon the work or any portion thereof covered by this contract, which is not actually performed and which has not actually entered into the construction of said improvement.

7.57 METHOD OF MEASUREMENT

Unless specifically stated otherwise in this Contract, no extra measurement or measurements according to local custom of any kind shall be allowed in measuring the work under this Contract, but only the length, area, solid contents, number, weight, or time in standard units, as the case may be, shall be considered. The Contractor will be required at his expense to furnish all scales and equipment to properly weigh and measure the various units.

7.58 PAYMENT

A. General: In consideration of the faithful performance by the Contractor and of all the conditions, provisions, and covenants of this Contract and the Specifications to the satisfaction of the Owner, the Owner shall pay and the Contractor shall receive the prices stipulated in his Bid Proposal attached hereto and made a part hereof, as full compensation for everything furnished or done by the Contractor under this Contract. The Owner also agrees to pay in addition such amounts as may be agreed upon for alteration in accordance with Section 7.32 and for extra work in accordance with Section 7.33.

Unless otherwise specified, lump sum bid items will be paid for in one lump sum following 100 percent (100%) completion and acceptance of the item by the Engineer.

B. Mobilization: When there is a bid item for "Mobilization" in the Bid Proposal, payment for this item will be made for preparatory work and operations performed by the Contractor, including, but not limited to those necessary for the movement of his personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for work on the project; and for other work operations that must be performed, or for cost incurred before beginning work on the various items on the project site.

Cost of premiums on bonds and insurance for the contract are not to be included in mobilization. No separate measurement will be made for this item. Partial payment, when allowed, shall be made according to the following schedule:

1. Twenty-five percent (25%) of the amount bid for mobilization shall be paid when five percent (5%) of the original contract amount is paid.
2. An additional twenty-five percent (25%) of the amount bid for mobilization will be paid when ten percent (10%) of the original contract amount is paid.
3. An additional ten percent (10%) of the amount bid for mobilization will be paid when twenty-five percent (25%) of the original contract amount is paid.
4. The remaining forty percent (40%) of the amount bid for mobilization will be paid when fifty percent (50%) of the original contract amount is paid.

When no bid item for "Mobilization" is included in the Bid Proposal, such costs shall be considered incidental to the various work items. In such case, no additional payment will be made for mobilization.

7.59 PROJECT PAYMENT

- A. Partial Payment Project:** For a project specified as a Partial Payment Project in Section 2, INFORMATION AND INSTRUCTIONS TO BIDDERS, payments will be made once each month as the work progresses or as requested by the Contractor, whichever is longer. Said payments will be based upon estimates prepared by the Engineer of the value of the work performed and materials complete, in place, and for materials delivered, in accordance with the Contract.

No partial payment will be made when the total value of the work done since the last estimate amounts to less than \$2,500.00.

From the total of the amounts ascertained as payable, an amount equivalent to 12% of the amount on the Contract up to \$50,000.00; 5% of the next \$200,000.00; and 2 1/2% of the amount of the Contract in excess of \$250,000.00 will be deducted and retained by the City until after completion of the entire Contract in an acceptable manner. The balance, less all previous payment, shall be certified for payment.

When the work under Contract has been completed and accepted, and it is anticipated that preparation of the final estimate will not be completed within ninety (90) days of when the work has been substantially completed to the extent that only minor or incidental operations remain to fully complete all of the work under the Contract. If the completion of such work is deferred or delayed in compliance with Contract provisions or, upon order of the Engineer, suspending operations by virtue of weather or climactic conditions or because of seasonal restrictions provided for in the Contract, upon written request of the Contractor and consent of the surety provider, the Engineer may prepare an estimate as figured from Contract unit prices.

Payment, either in full or partial, for materials delivered to or stockpiled on the project and not yet incorporated in the work in their final position shall be as specified in Section 2, INFORMATION AND INSTRUCTION TO BIDDERS.

Partial progress payments will be made upon written request by the Contractor on specific items, as listed herein, which are stockpiled in a manner and location satisfactory to the Engineer.

- B. Single Payment - Assessed Projects:** For a project specified as a Single Payment - Assessed Project in Section 2, INFORMATION AND INSTRUCTIONS TO BIDDERS, there will be no partial payments under the Contract, but only one final payment when the work is fully completed; accepted by the Owner; final estimate determined; assessment roll issued and approved; and the assessment bonds issued by the Owner to cover the entire cost of the project.

As soon as the work has reached a point where the Engineer can finally determine the exact cost of the construction, the Engineer will make out his final estimate and assessment roll and determine the full costs of the work and submit them for approval.

After the final approval of the final estimate and assessment roll, the Owner shall, as quickly as practical, sell the special assessment bond for the work.

After the above-outlined procedures have been completed, and upon full completion of the work by the Contractor and acceptance of the work by the Engineer as filed with the Owner, the Owner shall pay to the Contractor, in cash, the full amount of his final estimate

- C. Single Payment - Non-Assessed Projects:** For a project specified as a Single Payment - Non-Assessed Project in Section 2, INFORMATION AND INSTRUCTIONS TO BIDDERS, one (1) lump sum final payment will be made after completion of the work, acceptance by the Engineer, and formal acceptance by the Owner.

7.60 DEDUCTION FOR UNCORRECTED WORK

If the Engineer determines it inexpedient to correct damaged or nonconforming work, an equitable deduction from the contract price can be made upon certification of the amount by the Engineer.

7.61 PAYMENTS WITHHELD

The Owner may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any pay certificate to such extent as may be necessary to protect himself from loss on account of:

- A.** Defective work not remedied.
- B.** Claims or liens filed or reasonable evidence indicating probable filing of claims or liens.
- C.** Failure of the Contractor to make payments properly to subcontractors or for material, labor, or equipment.
- D.** A reasonable doubt that the Contract can be completed for the balance then unpaid.
- E.** Damage to another Contractor, work, or property.
- F.** Reasonable doubt that Contractor can complete the work within the stipulated contracted time.
- G.** The cost to the Owner resulting from failure to complete the work on time.
- H.** Failure to provide revised project schedules when requested by the Engineer.
- I.** Failure to provide acceptable construction and labor rate schedules.
- J.** Failure to provide a job superintendent who is in responsible charge of all work of the project and is on the job site when work is being performed.

When the above grounds are removed, payment shall be made for amounts withheld because of them.

7.62 VALUE ENGINEERING INCENTIVE

- A.** General: Value Engineering Incentive applies to those cost reduction proposals initiated and developed by the Contractor for changing the drawings, designs, specifications, or other requirements of the contract. It does not apply to such proposal unless it is identified by the Contractor at the time of submission to the Owner as a Value Engineering Incentive proposal.

The cost reduction proposals contemplated are those that:

1. Would require a change order to this contract.
 2. Would result in savings to the City by providing less costly items or methods than those specified in the contract without impairing any of their essential functions and characteristics such as service life, reliability, economy of operation, ease of maintenance, and necessary standardized features.
- B.** Cost reduction proposals shall be processed in the same manner as prescribed for any proposal, which would require a change order. As a minimum, the following information shall be, submitted by the Contractor with each proposal:
1. A statement that this proposal is submitted as a Value Engineering Incentive.
 2. A description of the proposal.
 3. An itemization of the requirements of the contract, which would require a change and a recommendation of how to make each change.
 4. An estimate of the reduction in performance costs that will result from adoption of the proposal.
 5. A prediction of any effects the proposed change would have on other costs to the City.
 6. A statement of the time the change order must be issued to obtain the maximum cost reduction during the remainder of the contract and the reason for this time schedule.
 7. The dates of any previous submission of the proposals, including contract numbers and the actions of the City.
 8. A statement as to the effect the proposal would have on the time for completion of the project.

- C. The City shall not be liable for delay in acting upon a proposal submitted. The decision of the Engineer as to the acceptance of any such proposal shall be final and shall not be subject to Section (5.17). The Engineer may accept, in whole or in part, cost reduction proposals submitted by issuing a change order.

If a cost reduction proposal is accepted, an equitable price adjustment in the contract price and in other affected provisions of this contract shall be made in accordance with this Specification or other applicable provisions in this contract. The equitable adjustment shall be established by determining the effect of the proposal on the Contractor's cost of performance. When the cost of performance of this contract is decreased as a result of the change, the contract price shall be reduced by the following amount: The total estimated decrease in the Contractor's cost of performance less fifty percent (50%) of the difference between the amount of such total estimated decrease and net increase to the City which must reasonably be incurred as a result of application of the cost reduction proposal to this contract. If the change order results in an increase in the cost of performing the contract, this Specification shall not apply, and the increase shall be determined in accordance with Section 4.

- D. The substitution of one bid item for another bid item resulting in a decrease in the contract amount will not be considered as a saving under Value Engineering Incentive. When change involves the increase of one bid item and the decrease of another bid item, the change order will be made in conformance with the applicable clauses of Section 7.
- E. The Contractor may restrict the City's right to use or disclose the information submitted with a Value Engineering proposal for other purposes. Such restrictions must be in writing and be submitted with the proposal.
- F. If the proposal is accepted, this restriction shall be void, and the City may use, duplicate, or disclose, in whole or in part, data necessary to utilize such proposal.

7.63 DETERMINATION AND EXTENSION OF CONTRACT TIME

The "Contract Time," or number of days allowed for the performance and completion of the work included in the contract, will be stated in the proposal and contract.

When the contract time is on a working day basis, the contract time will begin on the date determined in the Notice to Proceed and continue at the rate of one contract day charged for each day of the normal working week, Monday through Friday, except as described herein, until the work is complete. Holidays, Saturdays, and Sundays will not be included in the count of working days, except those days the Contractor has requested and been granted permission to work. No working day shall be charged when conditions beyond the control of the Contractor preclude prosecution of the work. Working days will be charged if the Contractor permits construction operations to proceed for five (5) or more hours of the day during the normal working week, or if the Contractor has requested, and been granted, permission to work on Holidays, Saturdays, or Sundays, and if, in the opinion of the

Engineer, conditions allow progress of work on items essential to the completion of the project for a period of five (5) or more hours of the day.

When the contract is on a calendar day basis, contract time shall be the time from the date determined in the Notice To Proceed to the date on which all work on the project shall be completed. Holidays, Saturdays and Sundays will be included in the count of calendar days. No calendar day shall be charged when conditions beyond the control of the contractor preclude prosecution of the work. Calendar days will be charged if the Contractor permits construction operations to proceed for five (5) or more hours of the day or if, in the opinion of the Engineer, conditions allow progress of work on items essential to the completion of the project for a period of five (5) or more hours of the day.

The Engineer will, upon written request, furnish the Contractor a statement showing the number of days charged to the contract. The Contractor will be allowed seven (7) calendar days from receipt in which to file a written protest setting forth in what respect said statement is incorrect; otherwise, the statement shall be deemed to have been accepted by the Contractor as correct. If the Engineer and the Contractor fail to reach an agreement on any statement of working days, the Engineer shall refer the statement in question to the Director of Public Works for his review and final decision.

When the contract completion time is a fixed calendar date, it shall be the date on which all work on the project shall be substantially completed. If work is not completed by the date specified, the Engineer will keep a record of working days charged after that date and will charge the Contractor on a working day basis.

Holidays, Saturdays, and Sundays will be excluded from the count of working days unless the Contractor has been granted permission to and/or utilizes such a day for construction work for five (5) or more hours of the day or if, in the opinion of the Engineer, conditions allow progress of work on items essential to the completion of the project for a period of five (5) or more hours of the day. The Contractor shall not carry on construction operations on Sundays or holidays without written permission from the Engineer, except for purposes of making emergency repairs and providing proper protection of the work, such as curing of concrete.

Days on which the work has been suspended by an action, non-action, or an omission made by the City, but through no fault of the Contractor, and days not worked because of strikes, lockouts, unusual delays in transportation, or any condition over which the Contractor has no control, shall not be counted against the contract time.

The number of days for performance allowed in the contract as awarded is based on the original quantities as outlined in the Bidder's Proposal. If satisfactory fulfillment of the contract requires performance of extra work or work on items with an increase in quantities that will take additional time to complete, the number of days allowed for performance shall be increased in the same proportion as the cost of increased work bears to the total original contract amount. Should the Contractor feel that the extension based on a monetary basis is insufficient for the increased work involved, he may submit written information, which will justify additional time. Such information must show how the increased work delays the overall completion of the entire project. Information shall be

submitted as soon as possible after the increased work has been performed. If, in the opinion of the Engineer, the information submitted justifies additional time, a Construction Change Order increasing the contract time will be prepared.

When the Contractor wishes to suspend contract time due to weather, he shall make a written request to the Engineer within ten (10) working days of the first weather day for which he desires a time suspension. Failure to comply with this notice requirement could result in denial of that request.

If the Contractor finds it impossible, for reasons beyond his control, fault, or negligence, to complete the work within the contract time as specified or as extended in accordance with the provisions of this subsection, he may, at any time, request to the Engineer for an extension of time, setting forth therein the reasons which he believes will justify the granting of his request. Such request shall be submitted within ten (10) days of the start of each occurrence for which an extension is desired. Failure to comply with notice requirements shall constitute a waiver, and failure to file a claim for additional compensation due to the delay at the time the Contractor requests the time extension bars him from claiming additional compensation for it.

The Contractor's plea that insufficient time was specified is not a valid reason for extension of time.

If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, he may extend the time for completion in such amount as the conditions justify. Extension of contract time will be made when unanticipated delays (beyond the control of the Contractor) in delivery of critical materials results in a delay of the work. The Contractor shall notify the Engineer immediately when it becomes evident that there will be a delay in obtaining critical materials. The extended time for completion shall then be in force and effect the same as though it were the original time for completion.

When final acceptance has been duly made as prescribed in Section 7.55, the daily time charge will cease.

7.64 LIQUIDATED DAMAGES

For each working day, as specified, that any work shall remain uncompleted after the contract time specified for the completion of the work provided for in the contract, the sum specified in the following schedule will be deducted from any money due the Contractor not as a penalty but as liquidated damages; provided, however, that due amount will be taken off any adjustment of the contract time. Liquidated damages shall be understood to be compensation to the Owner for costs incurred directly by the Owner or indirectly by the users of the facility for the delay in completion of the work. These costs include, but are not limited to, increased travel times; loss of access to homes or businesses; inconvenience from loss of sewer or water uses; fire protection, etc., beyond those circumstances anticipated for timely completion of the work.

SCHEDULE OF LIQUIDATED DAMAGES

ORIGINAL CONTRACT AMOUNT		AMOUNT OF LIQUIDATED DAMAGES PER WORKING DAY
From more than:	To and including:	
\$ 0	\$ 50,000	\$ 200.00
\$ 50,000	\$ 100,000	\$ 250.00
\$ 100,000	\$ 500,000	\$ 450.00
\$ 500,000	\$ 1,000,000	\$ 650.00
\$ 1,000,000	\$ 2,000,000	\$ 800.00
\$ 2,000,000	and up	\$ 1,300.00

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Owner of any of its rights under the Contract.

The Council may waive such portion of the liquidated damages as may accrue after the work is in condition for safe and convenient use by the public.

7.65 PROJECT ACCEPTANCE AND WARRANTY PERIOD

Final acceptance of the project by the Owner will be documented by the issuance of an acceptance letter, which is issued according to the following criteria:

- A.** Construction has been completed and the facilities can be put to their intended use.
- B.** All testing has been completed, and the required results have been met.
- C.** A warranty bond, or other equivalent surety, in an amount equivalent to ten percent (10%) of the total cost of the project/improvement has been provided to the City to secure the warranty for a period of two years.
- D.** As-Built plans have been submitted to the City.

The date of the acceptance letter documents the start of the two-year warranty period, during which the Contractor / Subdivider / Developer shall be notified in writing of any defects in the project and shall submit to the Public Works Dept. a construction schedule to correct the defects at their expense within ten (10) days of receipt of the notice. Failure to correct or undertake, with due diligence, to correct the deficiencies within the specified time may cause the Owner to make the necessary repairs and bill the Contractor / Subdivider / Developer one and one-half (1 1/2) times the costs incurred; providing, however, that in case of an emergency, where, in the judgment of the Owner, delay would cause serious loss or damage, repairs may be made without notice being sent to the Contractor / Subdivider / Developer, and the Contractor / Subdivider / Developer shall pay the cost thereof.

The Owner reserves the right to extend the warranty period if excessive problems are apparent during the initial two-year period.

During a period of two years after the completion of the work covered by this contract and the final acceptance in writing thereof by the Owner, the Contractor shall make all needed repairs arising out of defective workmanship or materials furnished by the Contractor; or both, which in the judgment of the Owner shall become necessary during said period. The Owner is hereby authorized to make such repairs at the Contractor's expense, if within ten days after the receipt of a written notice to the Contractor, or his agent, the said Contractor shall neglect to make, or undertake with due diligence to make, the aforesaid repairs; providing, however, that in case of an emergency, where in the judgment of the Owner, delay would cause serious loss or damage, repairs may be made without notice being sent to the Contractor and the Contractor shall pay the cost thereof.

7.66 RELEASE OF LIABILITY

No person, firm, or corporation other than the signer of this Contract as Contractor, now has any interest hereunder, and no claims shall be valid, and neither the Owner or any employee or agent thereof, shall be liable or held to pay any money except as herein provided. The acceptance by the Contractor of the payment shall operate as, and shall be a release to the Owner and every officer and agent thereof, from all claims and liability to the Contractor for anything done or furnished for or relating to the work or for any act or neglect of the Owner or any person relating to or affecting the work.

7.67 DETAIL DRAWINGS AND INSTRUCTIONS

The Engineer shall furnish with reasonable promptness, additional instructions, by means of drawings or otherwise, necessary for the proper execution of the work. All such drawings and instructions shall be consistent with the Contract Documents.

Unless otherwise provided in the Contract Documents, the Engineer, if requested, will furnish to the Contractor, free of charge, five (5) copies of drawings and specifications necessary for the execution of the work. The Contractor shall pay the Engineer for the cost of printing any additional copies of drawings and specifications to be furnished by the Engineer and requested by the Contractor.

The Contractor shall keep one copy of all drawings and specifications on the work site, in good order, available to the Engineer and to his representatives.

The drawings, specifications, and copies thereof furnished by the Engineer are his property. They are not to be used on other work, and with the exception of the signed Contract set, are to be returned to him on request, at the completion of the work.

7.68 WAIVER OF RIGHTS

Neither the inspection by the Owner or Engineer or any of their employees, nor any order by the Owner for payment of money, nor any payment for, or acceptance of, the whole or any part of the equipment, material, or work by the Owner or Engineer, nor any extension

of time, nor any possession taken by the Owner or its employees, shall operate as a waiver of any provision of this Contract, or of any power herein reserved to the Owner or any right to damages herein provided, nor shall any waiver of any breach in this Contract be held to be a waiver of any other or subsequent breach.

7.69 RAPID CITY INFRASTRUCTURE DESIGN CRITERIA MANUAL

Unless otherwise specified herein, all work done by the Contractor under this contract shall meet the applicable requirements of the Rapid City Infrastructure Design Criteria Manual.

7.70 PRECONSTRUCTION MEETING

Before the Contractor begins work under a City contract and before issuance of a Notice to Proceed, the Engineer will conduct a preconstruction meeting with the Contractor to establish project schedules and administrative requirements.

At the preconstruction meeting, the Contractor shall submit an acceptable written schedule, tentatively detailing the timing and sequence of major project components and showing critical construction activities and their interdependence. The Contractor, upon signing of the contract shall be required to furnish the Engineer a tentative schedule setting forth in detail the procedure he proposes to follow and giving the dates on which he expects to start and to complete separate portions of the work. If, at any time, in the opinion of the Engineer, proper progress is not being maintained, such changes shall be made in the schedule of operations as the Engineer shall direct or approve.

In addition, the Contractor shall submit a labor rate schedule for all anticipated personnel to be utilized on the project. The rate schedule shall be valid for the duration of the contract.

Submission of acceptable construction and labor rate schedules shall be a prerequisite for processing the first pay request.

The Contractor shall submit revised construction schedules periodically as directed by the Engineer to allow for changes in scheduling or whenever the present project status of critical path work items differs from the existing project schedule by more than one week. Revised schedules shall be submitted as a prerequisite for processing the subsequent pay request.

END OF SECTION

SECTION 8A

WATER

8A.1 DESCRIPTION

- A. General:** This work consists of furnishing and installing water mains, water service lines, and appurtenances. This includes all equipment, tools, materials, labor, and other incidentals to provide water mains and water service lines complete and ready for immediate and continuous use. The work includes all necessary excavation, backfilling, compaction, testing, clean up, and restoration required for a complete installation of water mains, water service lines, and appurtenances. **All connections to the City water system, directly or indirectly, need to be designed and constructed in accordance with City Criteria.**

Standard specifications for corrosion protection of metallic fittings, valves, hydrants and other miscellaneous metallic pieces associated with the installation of plastic pipe are provided in Section 8B Corrosion Protection – Plastic Pipe Systems. Specifications regarding tracer wire, coatings for metallic pieces, for fasteners and for field coating repairs are included in Section 8B Corrosion Protection – Plastic Pipe Systems.

B. Related Work:

Section 7	General Conditions
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 18	Erosion Sediment and Water Pollution Control
Section 19	Incidental Work
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb and Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals

- C. License and Permit Requirements:** Shall comply with Section 7 General Conditions.

Water main flushing activities shall be conducted in accordance with this Section and in accordance with the following additional requirements.

Water main flushing activities shall be conducted in compliance with the "General Surface Water Discharge Permit for Temporary Discharge Activities Under The South Dakota Surface Water Discharge System (SDG07000)". A copy of the permit is available through the South Dakota Department of Agriculture and Natural Resources

(SD DANR). The contractor is required to furnish the "Notice of Intent (NOI) To Obtain Coverage under the SWD General Permit for Temporary Discharge Activities and A Temporary Water Rights Use Permit" to SD DANR as required under the permit, obtain SD DANR authorization, and furnish a separate copy of the authorization to the respective owner and Public Works Director at the preconstruction conference.

The contractor is responsible for performing any self-monitoring activities including sampling, testing and reporting as may be determined to be required under the authorization. Payment for obtaining the necessary authorization to discharge, and for all compliance activities and obligations by the contractor shall be absorbed into the item to which it relates. No additional payment will be made.

D. Submittals: Shall comply with Section 203 Submittals

Submittals shall be required unless otherwise specified in the Construction Plans, Detailed Specifications or Special Provisions.

8A.2 MATERIALS

A. Compliance Requirements Between Section 8A Water and Section 8B Corrosion Protection - Plastic Pipe Systems: All materials specified within this specification shall meet the requirements of Section 8B Corrosion Protection - Plastic Pipe Systems. Materials referenced within specification Section 8A Water do not imply that the stock material item is in compliance with Section 8B Corrosion Protection - Plastic Pipe Systems. The supplier and Contractor are responsible for complying with specification Section 8A Water and Section 8B Corrosion Protection - Plastic Pipe Systems collectively.

B. Pipe: Water pipe shall be polyvinyl chloride (PVC) up to and including 24 inches in diameter, unless another water pipe material is pre-approved for use by the Public Works Director. Water pipe larger than 24-inches in diameter shall be ductile iron pipe or steel pipe unless indicated otherwise.

1. PVC Pressure Pipe, 4 Inches Through 24 Inches: Shall conform to the requirements of AWWA Specification C900, pipe thickness dimension ratio (DR) DR18 (235 psi pressure class) or DR14 (305 psi pressure class), cast iron outer diameter (CIOD) as designed and called for in the approved construction plans and meet one of the below standards. Installation procedures shall conform to AWWA C-605 standards.

a) PVC Bell and Spigot Pipe: PVC bell and spigot pipe shall have bell ends with elastomeric gaskets. Pipe joints shall use the Rieber joining system, which has the gasket formed into the pipe during the pipe manufacturing process. Every pipe and coupling shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, AWWA C900/IB PVC Pressure Pipe;

- JM Eagle, Blue Brute™ C900;
- Diamond Plastics, C900 or C900/Trans-21™;
- Northern pipe Products C-900;
- Or approved equal.

b) Restrained Joint Coupling PVC Pipe: Utilize non-metallic couplings with locking splines. High strength, flexible thermoplastic splines shall be inserted into mating, precision machined grooves in the pipe and coupling to provide full 360-degree restraint with evenly distributed loading. Couplings shall be designed for use at or above the pressure class of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the zero leakage test requirements of ASTM D 3139. Every pipe and coupling shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJ;
- Or approved equal.

c) Restrained Joint Integral Bell (RJIB) PVC Pipe: Shall have integral bells with a non-corrosive joint restraint mechanism that is specifically designed and constructed to restrain the bell/spigot pipe joint. The joint restraint mechanism shall provide full 360 restraint with evenly distributed loading. Fluid-Tite™ profile shaped gaskets meeting the requirements of ASTM F477 shall be utilized. Every pipe shall pass the AWWA C900 hydrostatic proof test requirements.

Acceptable Products:

- NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJIB;
- Or approved equal.

d) Restrained Joint Thermally-Fused PVC Pipe: Shall have been pre-approved for use by the Public Works Director and shall conform to the construction plans and detailed specifications prepared by the Engineer of Record. Pipe fusion process shall be in accordance with the Engineer as well as the manufacturer of the pipe. Pipe joints shall be designed to meet the zero leakage test requirements of ASTM D 3139. Fusion joints shall have met all the qualification requirements of AWWA C900. Fusible pipe shall comply with all AWWA C900 hydrostatic pressure integrity test requirements. All fusible pipe shall be marked in accordance with the requirements of AWWA C900 and the manufacturer's requirements. Unless otherwise specified, fusible PVC pipe lengths shall be assembled by means of thermal butt-fusion per the pipe supplier's written instructions.

Acceptable Products:

- Underground Solutions, Inc., Fusible PVC® Pipe;
- Or approved equal.

2. **Ductile Iron Pipe:** Shall have been pre-approved for use by the Public Works Director and shall conform to detailed specifications prepared by the Engineer of Record including cathodic protection requirements. Ductile iron pipe shall conform to the requirements of AWWA Specifications C150 and C151, Pressure Class 350 for 3 inches through 12 inches diameter, Pressure Class 250, or greater for 14 inches through 20 inches diameter, and Pressure Class 200, or greater for 24 inches and larger diameter, unless specified otherwise on the plans or Detailed Specifications. Ductile iron pipe shall be coated on the outside with a minimum bituminous coating thickness of 1-mil unless coating or thickness is otherwise specified within the contract documents. Ductile iron pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be full thickness to the end of the spigot and to the seat of the bell, or shall be tapered for a length of not more than two inches.
 - a) Bituminous coating is not corrosion protection coating.
 - b) Rubber gasket joints for all Ductile Iron pipe shall meet the requirements of AWWA C111. Installation procedures shall conform to AWWA C600 Standards.
3. **Steel Pipe:** Shall have been pre-approved for use by the Public Works Director and shall conform to detailed specifications prepared by the Engineer of Record including cathodic protection requirements.
4. **Water Service Line Pipe:** Water service line pipe 1-inch minimum through 2-inch maximum diameter pipe size shall be:
 - a) **Type "K" Soft Copper Tubing:** Shall be US Government Type K Soft Tubing in minimum 60 - foot single or double pancake coils for 1 inch and 1 ½ inch diameter material. The minimum center coil diameter shall not be less than 16 inches. Tubing material for 2-inch material shall be supplied in 20 - foot lengths with ends of tubing to be cut off evenly. The use of 2-Inch coiled material requires prior approval by exception by the Public Works Director.
 - 1) **Tracer Wire:** Tracer wire is required to be connected via heavy duty cast bronze ground clamp to the customer side water service line in accordance with the Section 8B Corrosion Protection - Plastic Pipe Systems.
 - 2) **Tracer Wire Access Box:** Tracer wire access box is required in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems.
 - b) **High Density Polyethylene Pipe (HDPE):** HDPE shall conform to the applicable requirements of the current versions of AWWA C901, ASTM D2737, ASTM D2239, ASTM D3350, ASTM D4976, NSF 61, and shall meet the following:
 - 1) **Size:**

- I. 1-1/2-inch, and 2-inch Copper Tubing Size (CTS) pipe. 1-inch CTS HDPE pipe is no longer approved for buried water service line because the inner diameter is less than the inner diameter of 1-inch copper as specified.
- II. 1-inch, 1-1/2-inch, and 2-inch Iron Pipe Size (IPS) pipe. IPS pipe may be used provided all appurtenant water service line fittings including curb stops and corporation stops are appropriately sized for the use of IPS pipe.

2) Material:

- I. **CTS:** Polyethylene HDPE Standard Dimension Ratio (SDR) 9 for CTS pipe, PE4710, 250 psi water service line pipe.
- II. **IPS:** Polyethylene HDPE, Standard Inside Dimension Ratio, (SIDR) 7 for IPS pipe, PE4710, 250 psi water service line pipe.

3) Pipe Marking: Shall include the minimum of the following:

- I. **CTS:** HDPE, DR9, CTS, 250 psi, PE4710, AWWA C901, ASTM D2737, NSF61.
- II. **IPS:** HDPE, SIDR7, IPS, 250 psi, PE4710, AWWA C901, ASTM D2239, NSF61.

4) Color:

- I. **CTS:** Blue with white lettering.
- II. **IPS:** Blue with white lettering.

5) Stainless Steel Solid Sleeve Stiffener Inserts: Are required at all HDPE water service line connections whenever HDPE is inserted into a compression fitting. Stiffeners shall be appropriately sized for use of CTS and IPS. City shall inspect all HDPE pipe ends for presence of stiffeners prior to final installation in the appurtenance.

6) Tracer Wire: Is required in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

7) Tracer Wire Access Box: Is required in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

8) Bedding Material: Shall comply with Section 11 Utility Excavation and Backfill.

- 9) Certifications Manufacturer:** Shall certify that the materials used to manufacture HDPE Water service line meets the above requirements.

Acceptable Products:

- Centennial Plastics, CenCore;
- Cresline CE Blue®;
- JM Eagle Pure-Core;
- ADS Polyflex® Potable water service pipe;
- Or approved equal.

- 5. Water Service Pipe, Larger Than 2 Inches:** Shall meet the specifications for PVC water pipe or ductile iron pipe as specified for water pipes in this specification.

- C. Fittings:** Fitting types applicable to this specification include but are not limited to bends, crosses, tees, reducers/increasers, plugs, caps, couplings, sleeves, and clamps.

- 1. Ductile Iron Water Main Fittings:** Shall be ductile iron with 350-psi pressure rating and rubber gasket joints meeting all applicable requirements of the latest edition of AWWA C110, C111, and C153. Push-on joint fittings shall be furnished with restraining lugs. The lug pattern for all sizes shall accommodate gripper-type restrainers. All internal and external ferrous surfaces shall be coated per Section 8B Corrosion Protection - Plastic Pipe Systems. Unless specified otherwise in the plans or detailed specifications the following fitting joint shall be provided:

- a) Fittings 8 inches and smaller shall be push-on joint. If the fitting is required to be restrained per the construction plans, then the fitting may be mechanical joint.
- b) Fittings 10 inches and 12 inches shall be push-on joint or mechanical joint. If the fitting is going to be restrained then it shall be a mechanical joint.
- c) Fittings 14 inches and larger shall be mechanical joint.

- 2. PVC Water Main Fittings:** May be used in-lieu of ductile iron fittings for PVC pipe installations 12-inch and smaller. PVC fittings shall not be used for Ductile iron pipe or PVC pipe greater than 14-inch. PVC fittings shall meet all applicable requirements of the latest edition of AWWA C900 pipe thickness DR18 (235 psi pressure class) or DR14 (305 psi pressure class), CIOD and AWWA C907. Fitting DR shall correspond to the pipe DR. The PVC fitting bell ends shall have elastomeric gaskets. Installation procedures shall conform to AWWA C605 Standards.

- 3. Couplings:** Straight, transition, repair, and restrained couplings may be used as necessary. Type of coupling shall be in accordance with the pipe material being coupled, as designed and called for in the approved construction plans and in

accordance with the manufacturer's written instructions and shall be coated and cathodically protected in accordance with the Standard Specifications including Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- a) Romac Style 501 as manufactured by Romac Industries, Inc., shall have ductile iron center rings and end rings meeting ASTM A536-80, Grade 65-45-12. Center rings shall be epoxy coated. Gaskets shall be styrene-butadiene rubber (SBR) or Nitrile, both of which shall be compounded for water service. Materials shall be NSF/ANSI Standard 61 approved for water service.
 - b) Hymax®2 Cathodic or Hymax Grip® Cathodic Coupling as manufactured Krausz for various uses, shall be an epoxy coated sleeve type design meeting the requirements of AWWA C219-17. End rings shall be either one or two bolt design. Gaskets shall be multi-range ethylene-propylene diene monomer (EPDM) or Nitrile, both of which shall be compounded for water service. Coupling working pressure shall be a minimum of 230 psi. Materials shall be NSF/ANSI-Standard 61 approved for water service.
 - c) 421 Top Bolt by Smith-Blair, 422 Top Bolt as manufactured by Smith-Blair, shall be an epoxy coated sleeve type design meeting the requirements of AWWA C219-17. Gaskets shall be SBR or Nitrile, both of which shall be compounded for water service. Coupling working pressure shall be a minimum of 260 psi. Materials shall be NSF/ANSI-Standard 61 approved for water service.
 - d) NAPCO Pipe & Fittings, LLC Certa-Lok™ C900/RJ Restrained Joint PVC pipe shall use non-metallic couplings specifically designed by the manufacturer for use with their pipe. Couplings for 12-inch and larger pipe shall be a minimum 12 inches in length. Restrained couplings are reserved for use with corresponding restrained pipe or fitting.
 - e) Solid DI MJ sleeve coupling shall comply with the Ductile Iron Water main fittings product requirements of this section;
 - f) Or approved equal.
4. **Tapping Sleeve:** Shall be stainless steel, flanged branch ends, with test plugs for pressure testing. The sleeve shall be approved for use at pressures equaling or exceeding those of the pipe classification being installed. Stainless steel tapping sleeves shall have a 300 Series stainless steel shell with SBR or Nitrile gaskets, both of which shall be compounded for water service, a stainless-steel flange, and shall have 304 stainless steel nuts, bolts, and washers. Materials shall be NSF/ANSI-Standard 61 approved for water service.

Acceptable Products:

- Romac SSTIII;

- Smith Blair model 665;
- Robar 6606BB;
- Ford style FTSS;
- PowerSeal 3490-AS/CS;
- Or approved equal.

5. **Foster Adapters:** Are acceptable for uses as called for in the construction plans and as approved by the manufacturer except between the fire hydrant and auxiliary valve and shall be NSF 61, fusion bonded epoxy coated.

Acceptable Products:

- INFACT Corporation (Epoxy Coated);
- Or approved equal.

6. **Repair Clamps:** For use on water service line abandonments up to 2 inches only and shall be stainless steel single or multiple section clamps as required for the repair. The clamps shall be approved for use at pressures equaling or exceeding those of the pipe classification being installed. The clamps shall be used for repair of tap holes in accordance with the manufacturer's requirements. Stainless steel repair clamps shall be 300 series stainless steel with SBR or Nitrile gaskets, both of which shall be compounded for water service and shall have 304 stainless steel nuts bolts and washers.

Acceptable Products:

- Romac SS1, SS3;
- Smith Blair 261;
- Robar 5616, 5626, 5636;
- Ford FS1;
- PowerSeal;
- Or approved equal.

- D. **Valves: General:** Valves 24 inches and smaller shall be gate valves. Valves 30 inches and larger shall be butterfly valves or gate valves as specified on the construction plans or detailed specifications. All internal and external ferrous surfaces shall be epoxy coated. Restraint accessories shall be factory installed. 24-inch and larger gate valves shall be positioned horizontally with 90-degree operator nuts. All valves shall meet applicable requirements as set forth in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems.

1. **Gate Valves:** Shall conform to the requirements of AWWA Standard C509 and C515 with a minimum 250-psi pressure rating and shall have a ductile iron-body and bonnet, be resilient seated, utilize mechanical joints including gaskets and bolts, and include all accessories. Gate valves shall have ductile iron wedge fully encapsulated with a SBR rubber or Nitrile elastomer coating. Stems shall be non-rising, one-piece cast, forged or rolled bronze. Valves shall have 2-inch ductile iron operating nuts and shall open left, counterclockwise. Bonnet bolts and nuts shall be Series 300 stainless steel and shall be rust proofed after threading and final

tightening. Gate valves utilizing the ALPHA™ restrained joint in lieu of a mechanical joint are acceptable for use with 4-inch to and including 12-inch resilient wedge valves. Restraint accessories shall be factory installed. Gate valves utilizing the ALPHA™ restrained joint shall meet all other requirements for gate valves as specified in this specification.

2. **Butterfly Valves:** Shall conform to the requirements of AWWA C504, Class 250B pressure rating for buried installation. Butterfly valve box body and disk shall be ductile iron ASTM A-536. Shaft shall be stainless steel. Seat shall be Buna-N, field replaceable without special tools and shall provide tight shutoff as required by AWWA C504. Mating surfaces shall be stainless steel. Bearings shall be self-lubricating, corrosion-resistant, and shall be designed for horizontal and/or vertical shaft loading. Shaft seals shall be designed for the use of bi-directional, self-adjusting packing, replaceable without removing the valve shaft.

Actuator shall be designed for buried service and shall be grease-packed, totally sealed. Actuator shall be equipped with a mechanical stop-limiting device to prevent over-travel of the valve disc in the open and closed positions. Actuator shall be sized in accordance with the needs of the valve being actuated and shall be equipped with 2-inch operating nut, which is hex-mated to the input stem and shall open by turning counterclockwise. Actuator shall be calibrated to close and seal completely prior to bury.

E. Valve Boxes:

1. **Valve Box for Gate Valves 12 Inches and Smaller and All Butterfly Valves:** Shall be a 2-piece screw-type construction with five and one-fourth (5 1/4) inches riser and shall be adjustable from four and one half (4 1/2) feet to 6-feet, with the top section to be at least 24 inches in length. Drop lids shall be marked "Water" and are to be of all-metal construction.

Acceptable Products:

- Tyler 6850-666-S series heavy duty valve box with adapter;
- Or approved equal.

2. **Valve box for Gate Valves 14-inch to and Including 24-inch:** Shall be a 2-piece screw-type construction with five and one-fourth (5 1/4) inches riser and shall be adjustable from three (3) feet to four and one half (4 1/2) feet, with the top section at least 24 inches in length. Drop lids shall be marked "Water" and are to be of all-metal construction.

Acceptable Products:

- Tyler 6860 Series heavy duty valve box with #6 base and adapter;
- Or approved equal.

3. **Valve Box Adaptor:** A valve box adaptor shall be installed on the valve bonnet prior to installing the valve box. The valve box adaptor eliminates shifting of the valve box, protects the coatings, centers the valve box, and seals the valve box

with a resilient material. The valve box adaptor shall be installed per the manufacturer's recommendations.

Acceptable Products:

- Valve Box Adaptor II as manufactured by Adaptor Inc., for valves 12 inches and smaller and all Butterfly valves, or approved equal.
- #6 Base Adapter as manufactured by Adaptor Inc. for Valves greater than 14 inches and greater, or approved equal.

F. Fire Hydrants: Shall meet AWWA C502 and shall have 6-inch mechanical joint inlets. Hydrants shall have 5 ¼-inch minimum valve openings, having O-ring packings and oil chamber to hold soft oil for stem thread lubrication, and shall have all operating parts, including valve seat, removable through the barrel. Barrel and upper standpipe shall be ductile iron with breaker flange and operating stem at ground level. A steel breakaway coupling shall be installed on the operating stem so that, in case of breakage, no damage will result to the fire hydrant other than safety breakers.

Fire Hydrants utilizing the ALPHA™ design hydrant inlet base are acceptable for use. Restraint accessories shall be factory installed. Fire Hydrants utilizing the ALPHA™ design hydrant inlet base shall meet all other requirements for fire hydrants as specified in this specification and in Section 8B Corrosion Protection - Plastic Pipe Systems.

All internal and external ferrous surfaces shall be epoxy coated.

All hydrants shall be capable of being extended in 6-inch increments. However, the minimum hydrant adjustment shall be 12 inches.

Hydrants shall be constructed so that they will close with the existing water pressure acting on the hydrant. Drain valves shall be bronze and shall be positively operated by the main operating rod. All threads shall be National Standard threads. Operating nuts shall be 1 ½ inches point-to-flat, pentagon (National Standard). Hydrants shall open left, counterclockwise. Fire Hydrants shall have an internal travel stop nut.

Hydrants shall have two, 2 ½-inch nozzles and one, 4 ½-inch steamer nozzle, all with National Standard threads. The minimum distance from the hydrant breaker flange to the centerline of the lower nozzle shall be 16 inches. Caps shall be nut type and shall be provided with chains. Hydrants shall be epoxy coated fire hydrant red.

All Fire Hydrants shall have a minimum bury depth of 6 ft from the ground line to the top of connecting pipe (6 ½-foot distance from ground line to connecting pipe invert). All fire hydrants shall have a maximum bury depth of 8 ft from the ground line to the top of connecting pipe (8 ½-foot distance from ground line to the connecting pipe invert) to facilitate their installation per the grades and lines shown on the construction plans. Vertical adjustments along the hydrant lead shall be accomplished using vertical bends (45-degree, 22½-degree, or 11¼-degree).

The use of a Fire Hydrant Extension will not be an acceptable method of adjustment

for a new fire hydrant, provided the necessary information was communicated on the construction plans. If this information was communicated, and the hydrant requires adjustment for final grade, then the Contractor shall replace the fire hydrant with a new fire hydrant with the correct barrel length or install the appropriate vertical bends on the hydrant lead.

In cases where a fire hydrant extension will be installed, the Contractor shall furnish the appropriate extension and notify the City Utility Maintenance Department for installation. City crews shall install all fire hydrant extensions.

Acceptable Products:

- Mueller A-423;
- American Darling B-84-B-5;
- American AVK Series 27;
- Waterous Pacer, traffic model.

G. Water Service Line Valves and Fittings: Shall meet AWWA Standard C800. If HDPE water service line pipe material is being utilized, Contractor shall ensure that the appropriately sized appurtenances (curb stops, corporation stops, valves, fittings, etc.) are provided for the service line size (CTS or IPS) being installed. Water service line transition couplings from CTS to IPS shall not be used unless directly connected to the appurtenant fitting. Plastic HDPE valves and fittings are not allowed.

1. Water Service Line Copper Splicing Couplings: Shall be flared or compression style in CTS or IPS. Soldered joints shall not be used for water service lines installed underground. For new installations (not repairs) 1-inch through 1½-inch water service lines shall avoid the use of couplings except as required at fittings.

Acceptable Products:

- Mueller 110 Conductive Compression;
- Hayes-Tite;
- Or approved equal.

2. HDPE Transition and Repair Couplings: Shall be compression by compression style in CTS or IPS.

3. Curb Stop Valves: Shall be a ball valve type with a 300-psig working pressure rating. A double O-ring port seal shall be provided in the stem and the O-rings shall be supported in precision-machined grooves. The end pieces shall be O-ring sealed to provide additional protection against leaking. 90-degree valve operation, with internal movement restraint, is required. Drains are not permitted on valves. Buffalo type valve boxes are required and therefore the Minneapolis Pattern threads on the valve are not a requirement. All Curb stops that are connected to copper water service lines shall incorporate isolators per Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- Mueller 300 Curb Ball Valve with Mueller 110 Conductive Compression Connection (CTS or IPS);
 - Y. McDonald Minneapolis Pattern Ball Valves - 300 PSIG Water;
 - Ford B44 Series;
 - Or approved equal.
- 4. Corporation Stops:** Shall be ball valve type with a 300 pound per square inch (psi) working pressure rating. The inlet shall have a taper thread (AWWA Standard) and the outlet shall be a conductive compression connection. Corporation stops that are used to connect copper water services to metallic water mains shall be insulated per Section 8B Corrosion Protection - Plastic Pipe Systems.

Acceptable Products:

- Mueller 300 Corporation Ball Valve with Mueller 110 Conductive Compression Connection (CTS or IPS);
 - Y. McDonald Ball Valves - 300 PSIG Water with A.Y. McDonald McQuick Compression-Q Series;
 - Ford FB1000 Series;
 - Or approved equal.
- 5. Service Saddles:** For 1-inch through 2-inch water service pipe shall utilize a wide band/strap with a minimum of 2 bolts and nuts, per width of the band/strap, for securing the band/strap to the main. The saddle shall provide full support around the circumference of the pipe. Nuts and bolts shall be rolled thread stainless steel or silicone bronze. Gaskets shall be SBR, EPDM, or Nitrile compounded for water service. It shall be the Contractor's responsibility to ensure that saddles and corporation stops are compatible with the pipe on which they are to be installed. If a compatibility question arises, the Contractor shall inform the Engineer immediately.
- a) Saddles for 6-inch to 12-inch Mains:** Shall utilize a stainless steel, cast brass per ASTM B62, or bronze body. Stainless steel saddles shall be cathodically protected in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Cast brass or bronze saddles, including those which have stainless steel straps, shall be protected by being wrapped with petrolatum system coating in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Saddles shall be pre-sized if required or recommended by the saddle or pipe manufacturer. Pre-sized saddles will conform to the pipe outer diameter (O.D.) without placing undue stress on the PVC pipe. Not all of the following indicated saddles are pre-sized and it is the responsibility of the Contractor and supplier to ensure that the saddle is pre-sized if required or recommended by the saddle or pipe supplier.

Acceptable Products for Saddles for 6-inch to 12-inch Water Mains Shall Be:

1-inch Service Taps: Provide a minimum total band/strap width of 2 inches

along the axis of the pipe. Saddles for 1-inch taps on 6-inch to 12-inch mains shall be:

- Ford Style FS313, FS323;
- Romac Style 306, Style and 202BS with stainless steel straps;
- A.Y. McDonald Model 3845;
- Mueller BR2W series with double studs;
- Or approved equal.

1½-inch and 2-inch Service Taps: Provide a minimum total band/strap width of 3¼ inches along the axis of the pipe. Saddles for 1½-inch and 2-inch taps on 6-inch to 12-inch pipe shall be:

- Ford Style FS313, FS323;
- Romac Style 306, Style and 202BS with stainless steel straps;
- A. Y. McDonald Model 3845;
- Mueller BR2W series with double studs;
- Or approved equal.

- b) Saddles for 14-inch and Larger Water Mains:** Saddles for 14-inch and larger water mains shall utilize cast brass per ASTM B62 or bronze, stainless steel, or a high strength ductile iron body with a minimum 12 mils of fusion applied epoxy or Nylon 11 coating and a stainless steel band. Stainless steel and ductile iron saddles with stainless steel straps shall be cathodically protected in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Cast brass or bronze saddles, including those which have stainless steel straps shall be protected by being wrapped with petrolatum system coating in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. Saddles shall be pre-sized if required or recommended by the saddle or pipe manufacturer. Pre-sized saddles will conform to the pipe outer O.D. without placing undue stress on the PVC pipe. Not all of the following indicated saddles are pre-sized and it is the responsibility of the Contractor and manufacturer to ensure that the saddle is pre-sized if required or recommended by the saddle or pipe supplier.

Acceptable Products for Saddles for 14-inch and larger water mains shall be:

1-inch Service Taps: Provide a minimum total band/strap width of 2 inches along the axis of the pipe. Saddles for 1-inch taps on 14-inch and larger pipe shall be:

- Ford Style FS323, FS333, and FC202;
- Romac Style 202B, 202BS, and 202NS;
- Mueller BR2S, BR2W, and DR2S with SS straps;
- Or approved equal.

1½-inch and 2-inch Service Taps: Provide a minimum total band/strap width of 3 inches along the axis of the pipe. Saddles for 1½-inch and 2-inch taps on 14-inch and larger pipe shall be:

- Ford Style FS323, FS333, and FC202;

- Romac Style 202B and 202BS, 202NS;
- Mueller BR2S, BR2W, and DR2S with SS straps;
- Or approved equal.

- c) Curb Boxes:** Shall be cast-iron. The box shall be capable of telescoping at a minimum, from 5 feet to a length of 6 feet. Lid shall be marked "water" and have a 13/16 inches (point to flat) pentagon brass nut. Risers shall be a minimum of 2 ½ inches in diameter.

Acceptable Products:

- Tyler 6500 Series, Buffalo Type;
- Or approved Equal.

- d) Tapping Sleeves and Valve:** Shall be used for water service lines 4-inch and larger and shall comply with the requirements of this specification.

- H. Concrete Thrust Blocks:** Shall be M-6 concrete as specified in Section 56 of the Standard Specifications. For fittings and joint restraining devices which utilize thrust blocks, incorporate an 8-mil thickness of polyethylene meeting AWWA C105 as a bond breaker. Joint tape for polyethylene shall be 3M Scotchwrap 50, or approved equal.

I. Joint Restraining Devices:

- 1. Joint Restraint Devices at Fittings:** Shall be as follows:

- a) Push-On (Ductile Iron Pipe to Ductile Iron Push-on Fitting) Acceptable Products:**

- 1) EBAA Series 15PF00TD Tru-Dual®, (Split Ring);
- 2) Or approved equal.

- b) Mechanical Joint (Ductile Iron Pipe to Ductile Iron Mechanical Joint fitting) Acceptable Products:**

- 1) EBAA Series 1100 MEGALUG®, (Solid Ring), or approved equal.
- 2) EBAA series 1100SD Split MEGALUG®, (Split Ring) (use only for connection to existing ductile iron pipe), or approved equal.

- c) Push-On (PVC Pipe to Ductile Iron Push-on Fittings) Acceptable Products:**

- 1) EBAA Series 15PF00, (Split Ring);
- 2) Or approved equal.

- d) Mechanical Joint (PVC Pipe to Ductile Iron Mechanical Joint Fittings)**

Acceptable Products:

- 1) EBAA Series 2000PV MEGALUG®, (Solid Ring), or approved equal.
- 2) EBAA Series 2000SV MEGALUG® Split Restraint, (Split Ring), (use only for connecting to existing PVC pipe), or approved equal.

e) Push-on (PVC Pipe to PVC Push-on Fittings) Acceptable Products:

- 1) EBAA Series 2500 Restraint Harness for C900 PVC Fittings, (Split Ring);
- 2) Or approved equal.

2. Joint Restraint Devices at Pipe Bells: Also referred to as bell restraints, shall be as follows:**a) For Ductile Iron Pipe Acceptable Products:**

- 1) EBAA Series 1700 MEGALUG® Harness, (Solid Ring/ Split Ring) or approved equal.
- 2) In lieu of bell restraint devices, push on joints with the American Fastite Joint system with Fast Grip Gasket, or approved equal may be used when approved by the Engineer.

b) For PVC Pipe 4" to 12" Acceptable Products:

- 1) EBAA Series 1600 Split Serrated Restraint harness, (Split Rings);
- 2) Or approved equal.

c) For PVC pipe 14" to 30" Acceptable Products:

- 1) EBAA Series 2800 MEGALUG® Restraint Harness, (Solid Ring);
- 2) Or approved equal.

J. Insulation: Shall comply with Section 11 Utility Excavation and Backfill.**K. Temporary Water Service/Water Main Bypass Pipe:** And associated appurtenances that may come into contact with water shall meet the requirements of NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 372.

All PVC piping systems shall be manufactured in conformance with the most current edition of AWWA C900-16 Standards and shall meet NSF/ANSI Standard 61: Drinking Water System Components-Health Effects and NSF/ANSI 372.

L. Air Release Valves: Shall be as specified by the Engineer of Record.

8A.3 Construction Requirements

A. Materials Handling and Storage: The Contractor shall be responsible for the safe handling and storage of all materials furnished by them and shall replace, at their expense, all such materials found defective in manufacture or damaged in transportation, handling, or storage. Pipe, fittings, and accessories shall be loaded and unloaded by lifting with hoists or palletized to avoid shock or damage. Under no circumstances shall such materials be dropped. All material shall be stored in a neat and orderly manner.

Pipe shall be stored, to the greatest extent possible, in unit packages or bundles and shall be handled to prevent stress to bell joints and prevent damage to bevel ends. In addition, materials shall be handled and stored in accordance with manufacturer's recommendations.

The Contractor shall cover all PVC pipe and fittings in accordance with manufacturer recommendations. In the absence of manufacturer recommendations to cover, PVC pipe and fittings shall be stored to minimize direct rays of sun and UV exposure. This may be accomplished with a minimum of a light opaque material covering the pipe. The covering shall be positioned to allow adequate ventilation to prevent heat buildup. The submittal for this material shall identify the proposed method of storage. Pipe material that shows signs of UV impact including impacts such as chalking, faded colors will be removed from use on the project.

If, in the opinion of the Engineer, damage or defects to the factory applied external coatings on steel or ductile iron pipe and fittings (including fire hydrants) cannot be repaired, then the Contractor shall replace the damaged items with new materials. If in the opinion of the Engineer damage or defects to the factory applied external coatings on steel or ductile iron pipe and fittings (including fire hydrants) can be repaired, then the Contractor shall make repairs to damaged coating per Section 8B – Corrosion Protection – Plastic Pipe Systems.

B. Alignment and Grade: Pipe shall be laid true to the line and grade established on the construction plans. Where the construction plans indicate that the finished ground surface elevations are to be modified from the existing elevations by current or future construction, the Contractor shall exercise care to ensure that pipe, fittings, hydrants, valves and valve boxes are placed to the elevations indicated on the plans. Tolerances shall be within 0.5 feet for alignment and within 0.2-feet of the specified grade.

C. Underground Obstructions: The Contractor shall expose existing underground obstructions shown on the plans or located in the field and shall determine their elevations far enough in advance of pipe laying that the proposed water main can be installed without the use of fittings at or near the points of crossing. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere with the proposed horizontal or vertical alignment of the pipeline, the Engineer will change the plans and order a deviation in the line and/or grade, or may

arrange for the removal or relocation of the obstructions. The Contractor shall not deviate from plan line or grade without the Engineer's approval.

- D. Contaminated Materials:** If contaminated materials are encountered as defined in Section 11 "Unsuitable Backfill Material Excavation", Contractor shall immediately contact the Engineer of Record to confirm suitability of pipe materials and appurtenances.
- E. Water Main and Sewer Main/Storm Sewer Separation:** Shall comply with Section 11 Utility Excavation and Backfill.

F. Installation:

1. **Trenching:** Shall comply with Section 11, Utility Excavation and Backfill for Trenching Requirements.
2. **Minimum Cover:** Depth from top of pipe to finished grade shall be as follows:

Size of Pipe (In.)	Minimum Cover (Ft.)
12 or less	6
14 to 18	5 ½
20 or larger	5

In the event adequate cover cannot be achieved by alignment or grade adjustment, then, with prior approval of the Public Works Director, the water pipe may be insulated. Insulation shall comply with Section 11 and the Insulation Standard Detail in cases where minimum cover cannot be provided. Insulation may also be required if adequate separation between a storm sewer or culvert and the water pipe cannot be achieved.

3. **Cleaning:** Shall be done as necessary so that the interior of all water pipe and fittings is free from all dirt, concrete, or other foreign material before installation.
4. **Pipe Cutting:** Shall be done without damage to the pipe with saw or abrasive wheel and shall be smooth, straight, and at right angles to the pipe axis. Ends of pipe shall be dressed and beveled to remove roughness and sharp corners.
5. **Laying and Joining of Pipe:** Shall be in accordance with AWWA C900, AWWA C605, and with the pipe manufacturer's instructions, unless specifically required otherwise by these specifications. Laying and joining of ductile iron pipe shall be in accordance with AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances, and with the pipe manufacturer's instructions, unless specifically required otherwise by these Specifications.

In most applications, pipe shall be laid with bell ends facing in the direction of laying. Each pipe length shall be inspected for defects prior to being lowered into the trench. All pipe and fittings shall be carefully lowered into the trench piece by

piece by means of pipe slings to prevent damage to the pipe and/or coating. Full lengths of pipe shall be installed except where connecting to appurtenances and fittings. The Contractor shall leave an appurtenance or fitting with a full length of pipe whenever possible.

Water main pipe shall not be installed in frozen ground or in water, and no water shall be allowed to run into or through the pipe.

During the course of construction, a water tight plug shall be kept in the end of the pipe so as to prevent any dirt and or water from entering during the progress of the work at all times. Any dirt, loose material or cement mortar, which may accumulate in the pipe, shall be removed as the work progresses.

- a) **Push-on Joints:** The spigot end of field-cut piping shall be cut square and then beveled. Joint surfaces shall be cleaned and lubricated immediately before completing the joint.
 - b) **Certa-Lok C900/RJ Coupling:** Certa-Lok C900/RJ grooved end pipe shall be inserted into Certa-Lok C900/RJ couplings only. Only insert plain-end pipe into Certa-Lok C900/RJ couplings outside of the restrained "L" length for the pipe system or utilize thrust blocking or other approved joint restraint devices.
 - c) **Restrained Joint Integral Bell (RJIB) PVC Pipe Joints:** The pipe end shall be cut off to remove the groove and the pipe end shall be beveled when connecting RJIB PVC pipe to connections including fittings, couplings, or mechanical joint bells.
 - d) **Mechanical Joints:** Joints shall not be over-tightened; if an effective seal is not obtained the joint shall be disassembled, cleaned thoroughly and reassembled. Where joint restraint devices are used with a mechanical joint, the holes shall be carefully aligned to permit installation of harness bolts. At mechanical joints, a beveled PVC spigot may not be used. Rather a non-beveled spigot shall be used for insertion into mechanical joint.
6. **Protection of the Work:** Whenever pipe laying operations are stopped temporarily during the work day or at the end of the work day, the contractor shall plug, with a water tight plug, all open ends, to prevent soil, water, or other matter from entering the pipe.
7. **Pipe Deflection:** Deflection or bending of the pipe or deflection of the pipe joint (bell and spigot) shall not be permitted except as approved by the Engineer. Changes in horizontal and vertical direction shall be achieved using standard fittings, fabricated fittings, and Couplings specifically designed and approved for use in joint deflection.

The Engineer may approve deflection of 12-inch diameter or smaller pipe or pipe joints if the Engineer of Record specifically designed for the deflection and the deflection is approved in writing by the pipe manufacturer specifically for the

project. A condition of approval is the City of Rapid City receiving a letter from the pipe manufacturer stating they have reviewed the proposed pipe or pipe joint deflections for (state the project name and City tracking number) and they approve and warranty the pipe for the proposed deflections. Deflection of pipe or pipe joints for diameters greater than 12 inch is strictly prohibited.

Restrained joint pipe and couplings may be deflected in accordance with the manufacturer's written recommendations. The Engineer of Record shall specifically indicate the use of restrained joint pipe and indicate the designed deflections on the construction plans.

8. **Fittings:** Bends and tees shall be placed on a stable foundation, which may require the use of concrete pads of equal size or larger than specified for valves. Fittings shall be provided with thrust blocks, as specified herein.
9. **Couplings:** Shall be placed on a stable foundation, which may require the use of concrete pads of equal size or larger than specified for valves. Couplings shall be approved by the pipe manufacturer for the use with the pipe and shall be installed according to the coupling manufacturer's recommendations.
10. **Thrust Blocks:** Concrete thrust blocks are required at the locations indicated in the specifications unless there is an exception not to use them. If restrained joint pipe is being used, thrust blocks are still required at the locations indicated in the specifications unless there is an exception not to use them. Thrust blocks and joint restraints as redundant systems are not a requirement of the specification unless the construction plans call for redundant systems. Concrete thrust blocks shall be provided at tees, crosses, horizontal bends, plugs, caps, and fire hydrants, whether specifically indicated on the construction plans or not. Refer to the subsection "Joint Restraining Device Installations" for fittings that allow the use of joint restraints in-lieu of concrete thrust blocks.

Concrete thrust blocks shall have a thickness at the fitting equal to at least half the diameter of the pipe being installed but shall not be less than six (6) inches thick under any circumstances. They shall extend from the fitting to the undisturbed wall of the excavation. The Contractor shall insure that the concrete does not cover or render inoperable nuts or bolts on the fittings. All metal fittings, valves, or appurtenances shall have a polyethylene bond breaker (separation barrier) between the fitting and the concrete.

Concrete Thrust blocks shall be allowed to cure for 48 hours prior to activating the water main. If the water main needs to be activated prior to the concrete curing (48 hours), then the water main shall be restrained using joint restraining devices. Under this circumstance, the thrust block is still required and the cost of furnishing and installing the joint restraint device is incidental. If the water main needs to be activated prior to the concrete curing (48 hours) and joint restraints are applied, then thrust blocks shall be allowed to cure for a minimum of 4 hours prior to

backfilling.

Thrust Blocks shall be installed as shown on the construction plans and shall meet or exceed the minimum volume or bearing area requirements as specified on the construction plans or specifications for the water pressures and soil conditions.

In muck, peat, or similar weak soils, thrust loads shall be restrained by using joint restraining devices and thrust blocks, or by removal of the soil and replacement with a material of sufficient stability to resist thrust loads as determined by the Engineer.

11. Joint Restraining Device Installations: Shall be installed per the manufacturer's recommendations and for the appropriate water pressures and soil conditions as shown on the construction plans and/or described in the Detailed Specifications. Refer to Section 7 for the definition of "L" length for Joint restraining devices. Joint Restraining Devices shall be used at the following locations:

- a) All Valves and pipe joints within their corresponding "L" lengths shall be restrained with joint restraining devices;
- b) All Reducers/Increases and their corresponding "L" lengths shall be restrained with joint restraining devices;
- c) All Vertical Bends and pipe joints within their corresponding "L" lengths shall be restrained with joint restraining devices; and
- d) All Water Main Lowering and pipe joints shall be restrained. Water main lowering restraint shall include restraining all joints within the fitting's corresponding "L" length plus restraining all pipe joints which lie between the start of the lowering and the end of the lowering, regardless of whether or not the pipe joint is located within the fitting's "L" length.

12. Insulation: Shall comply with Section 11 Utility Excavation and Backfill.

13. Fire Hydrants and Auxiliary Valves: Fire Hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the street, with the pumper nozzle facing the street. At intersections, the pumper nozzle shall face the higher classification street. Hydrants shall be set with the bottom of the breaker flange 2 inches above the finished ground elevation as shown on the Standard Details, resulting in the centerline of the lowest nozzle being at least 18 inches above finished grade. In no case shall hydrants be set closer than 4-feet from curb or edge of pavement, measured from outside of hydrant barrel to back of curb or edge of pavement. In no case shall hydrants be set closer than 1-foot from the edge of a sidewalk, measured from outside of hydrant barrel to edge of sidewalk.

The Contractor shall set each fire hydrant on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness and shall place a minimum of 1/3 cubic yard of Type 1 Bedding Material around the lower part of the hydrant to at least 6 inches above

the drain port to provide a drainage area for the hydrant barrel. The Contractor shall insure that the drain port at the base of the hydrant is open to allow for the hydrant to drain properly when closed. Cast in place concrete may be used in lieu of the pre-cast pad if the hydrant lead is not charged for at least 48 hours, the drainage ports are maintained and 4 hours cure time is allowed before backfilling. An appropriately sized thrust block shall be installed between the hydrant and the undisturbed trench wall. The thrust block shall meet the thrust block requirements on the construction plans and herein.

An auxiliary valve matching the size of the fire hydrant lead and a valve box shall be installed on the fire hydrant lead. Auxiliary valves shall be installed as detailed on the standard detail and shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness, and shall be fitted with a joint restraining device as approved by the Engineer. Cast in place concrete may be used in lieu of the pre-cast pad if the hydrant and hydrant lead are not charged for 48 hours, and 4 hours cure time is allowed before backfilling. If the auxiliary valve needs to be moved away from the fire hydrant to avoid a conflict it may be moved up to 7 feet away from the hydrant.

Tracer wire conduit shall be attached to the fire hydrant barrel section prior to backfill. The tracer wire access box may be installed after initial backfill. Refer to Section 8B – Corrosion Protection for Plastic Pipe Systems for tracer wire installation requirements.

In cases where a fire hydrant needs to be rotated or an extension needs to be installed, City Utility maintenance staff shall perform the work. Refer to Section 8A.2. "Materials" for further information regarding the use of hydrant extensions.

- 14. Valves:** Valve interiors and adjacent piping shall be cleaned of foreign material prior to making valve to pipe connection. Pipe/valve joints shall be straight and without deflection. All valves shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness, and centered on the valve. Cast in place concrete may be used in lieu of the pre-cast pad if the pipe and valve is not charged for 48 hours, and 4 hours cure time is allowed before backfilling. Valves shall be backfilled with Type 1 bedding material to one (1) foot above the valve. The Contractor shall check all operating mechanisms for proper functioning; valves, which do not operate easily or are otherwise defective, shall be replaced at the Contractor's expense.

When butterfly valves are being installed, the actuator shall be calibrated to close and seal completely prior to bury. Engineer shall inspect the butterfly valve for complete closure prior to bury. This inspection does not constitute final acceptance of the valve.

- 15. Valve Boxes:** Shall be installed straight and plumb directly over the valve stem and placed over a valve box adaptor. The top of the valve box shall be placed flush to $\frac{1}{4}$ inches below flush with the surfacing in paved or graveled areas and shall be flush with the finished grade in grass surfaced areas. Where the construction plans

indicate that the future grade at the valve location will be higher or lower than the existing grade at the time of valve installation, the Contractor shall provide the correct combination of extension pieces so that the valve box can be adjusted to the future finished grade without replacing the valve box.

A Valve Box Adaptor shall be installed on the valve bonnet prior to installing the valve box.

The Valve box shall be wrapped with polyethylene in accordance with Section 8B – Corrosion Protection for Plastic Pipe Systems details.

16. Tapping Sleeves and Valves for Taps 4 Inches and Larger: Where new 4-inch or larger water service lines or mains are to be connected to a main, the Contractor shall furnish all material necessary for connection to the water main, as specified herein. The Tapping Sleeve and valve shall be assembled in accordance with the manufacturer's instructions. Tapping Sleeves and valves shall be supported independently from the pipe prior to tapping and shall be provided with thrust restraint as specified for other fittings. The Tapping Sleeve requires the installation of a thrust block per specifications.

City Utility maintenance will perform all taps and the Contractor shall schedule all 4 inch and larger taps between 7:30 AM and 12:30 PM, Monday through Thursday, or as alternately scheduled by the City Utility Maintenance Group.

The Contractor shall obtain and pay for all applicable permits and fees.

17. Corrosion Protection: Shall be completed per Section 8B - Corrosion Protection for Plastic Pipe Systems or as outlined in the Detailed Specifications.

18. Dewatering: Shall be accomplished per Section 11 Utility Excavation and Backfill.

G. Disinfection: Disinfection shall comply with the requirements of AWWA C600, C605, and C651. All new water mains and appurtenances shall be disinfected before they are placed in service. All water mains taken out of service for inspecting, repairing, or other activity that might lead to contamination shall be disinfected before they are returned to service.

Unless specified otherwise in the detailed specifications or construction plans, or required by other provisions of this specification, disinfection shall be accomplished by the tablet method. The Contractor shall obtain the Engineer's approval prior to using a method other than the tablet method. The slug disinfection method, continuous feed method, or spray method shall be as specified by the Engineer of Record in accordance with AWWA C651. In the event that a condition arises during construction that triggers the need for one of these methods, the contractor shall refer to AWWA C651.

A submittal will be required to be submitted by the Contractor for approval by the

Engineer of the use of any of these methods.

1. **Preventative Methods:** The tablet method specified below may be used only if the pipes and appurtenances are kept clean and dry during construction. Therefore, the Contractor shall take precautions to protect the interiors of pipes, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize the entrance of foreign material.

If dirt enters the pipe, it shall be removed and the interior of the pipe surface swabbed with a 1-percent to 5-percent hypochlorite disinfecting solution. If a water main is contaminated with sediment or debris, flushing will not be allowed as a method of cleaning the sediment or debris. If, in the opinion of the Engineer, the sediment and debris cannot adequately be removed by the Contractor, then the Contractor shall clean the interior of the pipe by mechanical means, such as a hydraulically propelled foam pig. Following mechanical cleaning the Contractor shall flush the line achieving minimum flushing velocities of at least 3.0 ft/s and shall then disinfect the pipe using either the continuous-feed or the slug method per AWWA C651.

All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks, meal periods, or weather events. If water accumulates in the trench, the plugs shall remain in place until the trench is dry. If, for any reason, the water pipe is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the water main is clean. The section exposed to floodwater shall then be filled with chlorinated potable water that, at the end of a 24-hour holding period, will have a free chlorine residual of not less than 25 milligrams per liter (mg/l). The chlorinated water shall then be flushed from the water main and after construction is completed, the main shall be disinfected using the continuous-feed or slug method.

2. **Disinfectant:** The tablet method requires that the pipes and appurtenances be kept clean and dry. This method may not be used if the pipes and appurtenances are not kept clean and dry. In the event the pipes and appurtenances are not kept clean and dry, the Engineer must be contacted.

Tablets shall be 5-gram calcium hypochlorite tablets conforming to AWWA B300 and shall contain between 65-percent and 70-percent available chlorine. Tablets shall be fresh and shall be stored in a cool, dry, and dark environment to prevent loss of strength, which occurs upon exposure to the atmosphere.

The contractor shall not use calcium hypochlorite intended for swimming pool disinfection, because this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

3. **Dosage:** Unless otherwise specified, the Contractor shall place calcium hypochlorite tablets in each section of water pipe installed, including the hydrant branch, according to Table 8-1, below.

Table 8A-1
NUMBER OF 5-GRAM CALCIUM HYPOCHLORITE
TABLETS REQUIRED
(50 mg/l Dose)

Length of Pipe Section (Ft.)	Diameter of Pipe (In.)						
	4	6	8	10	12	14	16
13 or less	1	2	2	3	5	6	8
13 - 18	1	2	3	5	6	8	11
18 - 20	1	2	3	5	7	9	12
20 - 30	2	3	5	7	10	14	18
30 - 40	2	4	6	9	14	18	24

For pipes larger than 16 inches, refer to construction plans or detailed specifications for disinfection requirements. The Engineer of Record is responsible for establishing the disinfection requirements for pipes larger than 16 inches.

4. **Placing Tablets:** Tablets shall be adhered to the inside top section of each pipe length using a food-grade adhesive. Adhesives shall meet the requirements of a food-grade adhesive per either NSF/ANSI 51-2005: Food Equipment Materials or NSF/ANSI 61-2005: Drinking Water System Components - Health Effects. NSF/ANSI 61 lists several adhesives that are approved for drinking water contact. It is recommended to use an adhesive that sets quickly and isn't reactive with the water main's composition or with the disinfectant tablet. There shall be no adhesive on the tablet except on the broad side attached to the surface of the pipe. If the tablets are attached before the pipe section is placed in the trench, the tablets' position shall be marked on the pipe section to indicate the pipe has been installed with the tablets at the top.
5. **Filling and Contact:** The water main shall be filled slowly so that the water velocity is no greater than 1-foot per second (fps). Precautions shall be taken to assure that air pockets are eliminated. The water shall be allowed to stand in the pipe for at least 24 hours. Valves shall be positioned so that the strong chlorine solution in the treated main will not flow into water mains in active service. The Contractor shall not fill a main without the Engineer being present.
The chlorinated water shall remain in the pipe for at least 24 hours. The Contractor shall notify the Engineer at the end of the 24-hour retention period prior to flushing to allow the Engineer to check the chlorine residual in the pipe. If the chlorine residual is less than 25 mg/l, the Contractor shall, at his expense, disinfect the water main again by the continuous-feed method or the slug method, as approved by the Engineer.
6. **Flushing:** Within 48 hours of the end of the 24-hour retention period, the Contractor shall flush the heavily-chlorinated water from the main until the chlorine concentration in the water leaving the main is no higher than that prevailing in the system or is less than 1 part per million (ppm) as determined by the Engineer. In addition to the above requirements, a minimum flushing velocity of 3.0 fps and flushing duration of one minute per 100 feet of pipe being flushed shall be achieved

per Table 8A-2.

Table 8A-2

REQUIRED FLOW AND MINIMUM FLOW DURATION TO FLUSH PIPELINES

Pipe Diameter (In.)	Flow required to produce 3.0 fps Velocity in Main*	Fire Hydrants		Minimum Flushing Duration (minutes per 100 feet of pipe)
		Number of Fire Hydrants	Outlet Size (In.)	
4	120	1	2-1/2	1
6	280	1	2-1/2	1
8	480	1	2-1/2	1
10	740	1	2-1/2	1
12	1100	2	2-1/2	1**
14	1450	2	2-1/2	1**
16	1950	3	2-1/2	1**

Table 8A-2 shows the rates of flow required to produce a velocity of 3.0 fps in pipes of various sizes and the minimum flushing duration per 100 feet of pipe length.

For pipes larger than 16-inch, refer to construction plans or detailed specifications for requirements. The Engineer of Record is responsible for establishing flushing requirements for pipes larger than 16 inches.

* Requires a minimum 40-psi pressure in the main and the hydrant flowing to atmosphere.

** Assumes that the corresponding flow rate is being met.

Flushing shall be done in accordance with AWWA C651. Flushing shall be accomplished through use of hydrants or temporary fittings installed for the purpose; flushing through corporations and/or water service lines is prohibited. The Contractor shall obtain the Engineer's approval prior to installing special fittings for flushing.

Heavily-Chlorinated water used to disinfect water mains shall be neutralized prior to release. The Heavily-Chlorinated water shall be neutralized at the discharge from a hydrant using approved dechlorination equipment and materials. At the option of the Contractor, the Heavily-Chlorinated water may be contained and transported to an approved location for land application. The contractor shall remain responsible for meeting all the requirements of the Standard Specifications for required flow and minimum flow duration to flush pipelines and surface water quality standards. Neutralization of Heavily-Chlorinated water shall be incidental to the installation of all water mains.

Flushing shall be conducted in such a way as to prevent contamination of existing water mains and/or water service lines and to minimize traffic and pedestrian hazards and nuisance conditions. When possible, flushing shall be to the nearest storm sewer or drainage way. Flushing to the sanitary sewer is prohibited.

The Contractor will be responsible for any damage to fish and/or aquatic life caused by the chlorine residual. If Chlorine reaches or is detected in a stream,

river, or other waterway the Contractor will be in violation for that discharge. For more information, contact SD DANR Surface Water Quality Program at (605) 773-3351. Refer to section below, "Disposal of Chlorinated Water" for additional information regarding neutralizing chlorine residual.

7. **Sampling:** Per AWWA C651, the contractor shall sample for coliform bacteria contamination. After the water lines have been flushed, the contractor shall sample the water mains. Two consecutive samples of water from the end of the disinfected/flushed water main must be collected at least 16 hours apart. These samples must be submitted to the State Health Laboratory in Pierre, or another laboratory acceptable to the SD DANR and the Engineer. At least one set of samples shall be collected from every 1,200 feet of new water main, plus one set from the end of the main and at least one set from each branch. The samples shall be collected in the presence of the Engineer.

The samples must show the absence of coliform bacteria contamination before any taps may be made to the main or the main is activated and placed into service. Copies of all sample results shall be submitted to the Engineer within 48 hours of receipt thereof.

Because of the high risk of contamination during sampling, the Contractor shall use certified lab personnel or a trained sampler to collect all samples submitted for testing.

8. **Disposal of Chlorinated Water:** The Contractor shall apply a neutralizing chemical to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water as listed in Appendix B of AWWA C651. The Contractor will be responsible for any damage to fish and/or aquatic life caused by the chlorine residual. If Chlorine reaches or is detected in a stream, river, or other waterway the Contractor will be in violation for that discharge. For more information, contact SD DANR Surface Water Quality Program at (605) 773-3351.

H. **Pressure and Leakage Test for Mains and Water Service Lines 4 Inches or Larger:**

1. **General:** Pressure and leakage tests shall be performed on all newly installed water mains. The "Simultaneous Pressure and Leakage Tests" will be used unless otherwise specified. The testing methods specified in this section are specific for water pressure testing only; air pressure testing is prohibited due to the catastrophic nature of failure should failure occur.
2. **Test Restrictions:** The pressure shall be 150-percent of the working pressure at the point of test, but not less than 125-percent of normal working pressure at the highest elevation, whichever is greater. Test pressure shall not exceed pipe, valve, or thrust-restraint design pressures and shall not vary by more than 5 psi (plus 5 psi or minus 5 psi) for the duration of the test. The duration of the hydrostatic test shall be a minimum of 2 hours.

The Contractor shall anticipate the need to conduct multiple tests in areas of varying topography and shall conduct testing in such a manner and sequence that the pressure requirements indicated above are achieved.

3. **Pressurization:** Before applying the specified test pressure, each valved section of pipe to be tested shall be slowly filled with potable water and all air expelled from the pipe, valves, fittings, and hydrants. Where City water is not available, the Contractor shall furnish sufficient potable water to fill and test the pipe. The specified test pressure, based on the elevation of the lowest point of the section under test and corrected to the elevation of the test gauge, shall then be applied by means of a suitable pump connected to the pipe in a manner satisfactory to the Engineer and shall be sustained for the specified time.

The test pump shall be equipped with two (2) accurate pressure gauges, between the pump shut-off valve and water main being tested, both to show the line pressure reading during testing. When hydrants are in the test section, the test shall be made against closed hydrant valves. Pressure gauges shall have graduation marks, at minimum, for every 2 psi and be capable of interpreting pressure readings within 1 psi. The pressure reading deviation between the two pressure gauges shall not be greater than 2.0 psi. During the pressure test the pressure loss indicated between the two gauges shall not deviate more than 0.5 psi between the two gauges.

4. **Leakage:** Shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by the decrease in pressure for a test section over a period of time.
5. **Allowable Leakage for PVC Pipe and Ductile Iron Pipe:** The PVC pipe shall be pressure and leakage tested in accordance with AWWA C605. The ductile iron pipe shall be pressure and leakage tested in accordance with AWWA C600. No pipe installation, PVC pipe or ductile iron pipe will be accepted if the leakage is greater than that indicated in Table 8A-3.

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Table 8A-3
ALLOWABLE LEAKAGE IN GALLONS
PER HOUR PER 1000 FT OF PIPE
(GPH)

Pipe. Dia. (in.)	Average Test Pressure (PSI)					
	50 psi (gph)	100 psi (gph)	150 psi (gph)	200 psi (gph)	250 psi (gph)	300 psi (gph)
4	0.19	0.27	0.33	0.38	0.43	0.47
6	0.29	0.41	0.50	0.57	0.64	0.70
8	0.38	0.54	0.66	0.76	0.85	0.94
10	0.48	0.68	0.83	0.96	1.07	1.17
12	0.57	0.81	0.99	1.15	1.28	1.40
14	0.67	0.95	1.16	1.34	1.50	1.64
16	0.76	1.08	1.32	1.53	1.71	1.87
18	0.86	1.22	1.49	1.72	1.92	2.11
20	0.96	1.35	1.66	1.91	2.14	2.34
24	1.15	1.62	1.99	2.29	2.56	2.81
30	1.43	2.03	2.48	2.87	3.21	3.51
36	1.72	2.43	2.98	3.44	3.85	4.21

- 6. Acceptance:** Shall be determined on the basis of allowable leakage. If any test of installed pipe discloses leakage greater than that specified in Table 8A-3, the contractor shall, at the contractor's own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance. All visible leaks shall be repaired, regardless of the amount of leakage.

Any damaged or defective pipe, fittings, valves, hydrants, or joints discovered following the pressure test shall be repaired or replaced with approved material at the Contractor's expense, and the test shall be repeated until it is within the specified allowance.

- 7. Example:** A pipe segment is required to be tested at 140 psi. At the start of the test, pressure gauge number (#) 1 indicates an initial pressure of 141 psi and pressure gauge #2 indicates an initial pressure of 143 psi. Both gauges are recording the test pressure within 2 psi, and, therefore, the test may proceed. After completing the 2-hour test duration, pressure gauge #1 indicates a pressure of 134 psi and pressure gauge #2 indicates a pressure of 136.5 psi. The pressure decrease for pressure gauge #1 is 7 psi and the decrease for pressure gauge #2 is 6.5 psi. The 2 gauges record a pressure decrease within 0.5 psi of each other therefore the deviation of the pressure reading between the two gauges is acceptable.

If the pressure test had indicated a pressure loss of less than 5 psi then the "Pressure and Leakage Test" would have been considered as passing. Because in this example, the pressure loss is more than 5 psi, the Contractor may elect to re-pressurize the system and repeat the two-hour test or the Contractor may elect to measure the quantity of water required to pressurize the pipe segment so that the pressure loss is less than 5 psi. For this example, if the quantity of water required to pressurize the pipe segment so that pressure gauge #1 indicates a pressure of 137 psi (loss of 4 psi) and pressure gauge #2 indicates a pressure of

137.5 psi (loss of 4.5 psi), is within the quantity of water allowed per Table 8A-3 then the test would be considered as passing without having to repeat pressure test for 2 hours.

I. Pressure and Leakage Test for Water Service Lines Less Than 4 Inches: Pressure and leakage tests shall be performed on all newly installed water service lines if the water service line has one or more couplings installed between the corporation and the curb stop and/or one or more couplings installed between the curb stop and the Property Water Distribution System. The testing method shall be as specified in the currently adopted version of the Plumbing Code with the exception that air pressure testing is prohibited.

J. Water Main Closures and Temporary Service:

1. Water Main Closures: Shall be scheduled to minimize the inconvenience to the public. Consequently, water main closures shall be scheduled between 8:00 A.M. and 4:00 P.M. Monday through Thursday, when possible. Short duration closures (closures scheduled to last no longer than 2 hours) may be scheduled on Friday between the hours of 8:00 AM and 11:30 AM. Water main closures scheduled to begin prior to or continue beyond those times listed above, will require approval from the Engineer. In any case, water main closures will not be allowed until the Engineer gives his approval.

Temporary water for private residences affected shall be provided by the Contractor when the water main closure will exceed 8 hours. The Contractor shall notify all affected businesses that temporary water service shall be provided to them, if requested, regardless of the length of closure. When temporary service is to be provided to businesses, the Contractor shall obtain the name and phone number of a responsible contact person at each affected business and submit the information to the Engineer at least 48 hours prior to closure.

The Contractor shall obtain notification of closure cards from the Engineer and shall deliver the closure cards by hand to the affected properties at least 48 hours prior to closure of any water main, unless a shorter time of notice is approved by the Engineer.

Water main closures shall be considered incidental to the project and no separate payment will be made.

2. Temporary Water Service/Water Main Bypass Pipe: Piping shall be as specified and approved by the Engineer of Record. In the event that a condition arises during construction that triggers the need for temporary water service, Contractor shall be responsible for plan development and obtaining approval from the Engineer to commence this work. No additional payment shall be provided for temporary water and this work shall be considered incidental the water distribution pipe being installed unless specifically called out as a pay item by the Engineer of Record.

The work shall include a minimum of the following:

- a) The Contractor must provide a 24-hour contact person who has adequate parts and equipment on hand to make necessary repairs to temporary water service in a timely manner.
 - b) Temporary water main is required to be pressure tested, disinfected, flushed, and sampled prior to any service connections being made in accordance with AWWA C651 and this specification.
 - c) Temporary service connections shall be connected at the curb stop.
 - d) Provisions for freeze protection of the temporary system shall be provided if weather requires it.
 - e) Provisions for tamper protection shall be provided.
 - f) Adequate pipe supports shall be provided to prevent tipping, movement, or pipe deflection and shall be spaced so as to limit pipe deflection. Any deflection of the piping shall be limited to manufacturer recommendations.
 - g) Contractor shall provide a submittal for approval to outline the products and procedures to be used for the Temporary water service/water main bypass piping. The submittal shall be submitted with the requirements of this specification for approval. Submittal shall include temporary water main layout, sequence of operations, and all material and fitting specifications to be used in the temporary water setup. The submittal shall also include detail for temporary water mains crossing roads and driveway approaches as well as provisions for freeze and vandal protection.
 - h) When in service, the entire length of temporary water service/water main bypass piping shall be inspected by the contractor a minimum of 2 times per day. Documentation of this inspection shall be delivered to the Engineer upon request.
- 3. Operation of Valves:** Only City personnel shall operate valves on existing water mains. The Contractor may operate valves on newly installed water mains that are under his control, until such time as, they are accepted by the City for operation and maintenance.
- K. Air Release Valves:** Shall be constructed in accordance with the detailed construction plans and specifications.
- L. Abandonment and/or Salvage of Water Main and Appurtenances:**
- 1. **Water Mains:** The Contractor shall seal all open ends of water mains to be abandoned with a concrete plug having a length equal to the diameter of the pipe being plugged. All open pipe ends shall be abandoned and plugged. Maximum

pipe length between abandonments shall not exceed 450 feet.

2. **Fire Hydrants:** Fire hydrants and auxiliary valves are to be removed and salvaged, unless indicated otherwise on the construction plans or Detailed Specifications, and shall be delivered by the Contractor to the City Utility Maintenance Shop in good working condition. Any damage to the hydrant and/or appurtenances as a result of removing, salvaging, and delivering, shall be repaired by the Contractor at no cost to the City.
3. **Valves:** Unless indicated otherwise on the construction plans or Detailed Specifications, valves and valve boxes are to be removed, salvaged, and delivered by the Contractor to the City Utility Maintenance Shop in good working condition. Any damage to the valve as a result of removing, salvaging, and delivering, shall be repaired by the Contractor at no cost to the City.
4. **Valve (Authorized) to be Abandoned in Place:** Prior approval from the Engineer is required to abandon a valve in place. Valves shall not be abandoned in place on a water main that is in service and not abandoned. Valves indicated on the plans to be abandoned in-place shall be abandoned by closing the valve and removing the top valve box sections. The valve box sections shall be delivered to the City Utility Maintenance Shop. The resulting holes shall be backfilled with either low strength concrete material or material acceptable to the Engineer that prohibits settlement of the hole and shall be resurfaced with the appropriate material; i.e. seed, sod, asphalt, concrete, etc.
5. **Water Main Branch Connections:** Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the branch connection at the water main, and remove section of water main pipe containing the branch connection and all branch water main appurtenances such as Tapping Sleeves, in line tees or crosses, valves, etc. in its entirety. The contractor shall disconnect the branch pipe and plug the branch pipe per the specification for the abandonment of water mains. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the in-line water main with new PVC pipe of the same size and equivalent pressure class and appurtenant coupling connections suitable for use as specified in this section. Couplings shall be restrained unless sufficient demonstration can be provided that the water main being repaired is unrestrained. This demonstration is the responsibility of the contractor. Corrosion protection continuity and tracing continuity shall be maintained with the abandonment in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. City shall be present to inspect the repair prior to backfill.

Abandonments of water main branch connections on Steel water mains shall be as called for in approved construction plans and specified by the Engineer.

6. **Others:** When the construction plans indicate items are to be removed or salvaged, the Contractor shall deliver the items to the City Utility Maintenance Shop in good working condition. Any damage to the items as a result of removing,

salvaging, and delivering, shall be repaired by the Contractor at no cost to the City. Unless an item is indicated as salvaged, the item will be considered a Contractor obligation to remove and dispose of.

M. Water Service Lines and Fittings: Refer to Specification Section 8B Corrosion Protection - Plastic Pipe Systems for water service line cathodic protection requirements.

1. Permits: Will be required for all connections to the City's water distribution system and are obtainable from City Utility Maintenance.

2. Service Pipe:

a) Copper pipe shall be laid with sufficient waving as to prevent rupture in settlement. A "goose-neck" shape shall be constructed in the copper pipe leading from the corporation stop. Copper splicing couplings shall be as described in this specification.

b) PVC and ductile iron service pipe shall be laid in accordance with this specification for water mains. Minimum cover depth for water service lines shall be 6 feet.

c) HDPE water service line pipe shall be laid horizontally in a "snake-like" laying configuration to allow for both expansion/contraction movement of the pipe in the trench. Installation of the HDPE water service line shall be per these specifications, as specified in AWWA M55, and in accordance with the pipe manufacturers recommendations. HDPE shall not be placed in contact with concrete without the use of a sleeve. Tracer wire in accordance with Specification Section 8B Corrosion Protection - Plastic Pipe Systems shall be extended the entire length of the HDPE service.

1) New: HDPE may be used for new water service lines for installations either/both between the corporation stop and the curb stop and between the curb stop and the structure. New HDPE water service line installations shall not use couplings but shall be continuous for the length of the service. A HDPE stub that is installed in anticipation of future connection (for example, underneath a common utility trench) is considered new and may not be connected to via couplings. When HDPE is used for the water service line material, a roll of HDPE of sufficient length to serve the structure may be connected and stored for future use to avoid excavation back to the curb stop.

2) Repairs: A copper water service line may be replaced in its entirety with an HDPE water service line between the corporation stop and the curb stop or between the curb stop and the structure. Existing HDPE Water service lines may be repaired, and couplings may be used. Splicing couplings shall be as described in this specification. HDPE shall not be used for repair of existing copper water service lines if there will be remaining copper water

service line between the curb stop and the structure. HDPE shall not be used for repair of copper water service line if there will be remaining copper water service line between the corporation stop and the curb stop.

3. **Service Line Bedding:** Copper and HDPE service lines shall be bedded in accordance with Section 11 Utility Excavation and Backfill.
4. **Water Service Line Separation:** Shall be in accordance with Section 11 Utility Excavation and Backfill.
5. **Service Saddles:** Shall be installed for all connections to water mains. Unless specified otherwise on the Construction plans or Detailed Specifications, the Contractor shall furnish and install all service saddles.
6. **Corporation Stops:** Shall be provided by the Contractor, except for 1-inch corporation stops, which the City provides. The Contractor shall communicate the water main material type and size to Utility Maintenance at the time a tap is requested. Corporation stops that are used to connect copper water services to metallic water mains shall be the isolator style. City personnel, in all cases, will tap the water main and install all corporation stops. If a Contractor is installing a copper water service on private property but is not replacing the service to the main and the copper water services connects to a metallic water main then an insulating union for copper water services shall be installed near the curb stop or at the location where the new copper connects to the existing copper. This is only required for copper water services connecting to metallic mains.
7. **Water Service Lines Larger Than 2 Inches Diameter:** Shall be connected to the main with either an appropriately sized tapping sleeve and valve or a ductile iron tee as specified for water main fittings elsewhere in these specifications.
8. **Curb Stops and Boxes:** Shall be installed on all water service lines and shall be located entirely within the public ROW. The curb stop and box shall be located between the property line and 7-feet from the property line in the ROW, unless otherwise approved by the Engineer. Curb stop must be accessible and access to the curb stop shall not be limited by any fencing. If any curb box is farther from the property line than 7.1 feet, measured to the center of the box, then the box shall be reset to within the allowable tolerance. Curb Stop interiors and adjacent piping shall be cleaned of foreign material prior to making curb stop to pipe connection. Pipe/valve joints shall be straight and without deflection. All curb stops shall be placed on an 8-inch by 16-inch precast concrete pad with a 4-inch thickness and centered on the curb stop. Curb stops shall be backfilled to one (1) foot above the curb stop with the same material required to bed the water service line. The Contractor shall check all operating mechanisms for proper functioning. Curb stops, which do not operate easily or are otherwise defective, shall be replaced at the Contractor's expense. Curb boxes shall be installed straight and plumb directly over the curb stop. The curb box shall be wrapped with polyethylene in accordance with Section 8B – Corrosion Protection for Plastic Pipe Systems details. The top of the curb box shall be placed flush to ¼-inch below flush with the surfacing in

paved or graveled areas and 1-inch to 2 inches above finished grade in grass surfaced areas. Where the Construction plans indicate that the future grade at the curb box will be higher or lower than the existing grade at the time of installation, the Contractor shall provide a curb box that is applicable for the future finished grade without having to replace the curb box.

9. Water Service New Connections: Water service lines shall be laid directly from the premises served to the City's main and shall not be extended across one premises to another. Notwithstanding this subsection, and notwithstanding the normal exception process contained in this document, the Public Works Director may allow water service lines to be located in a manner that crosses premises if, and only if, the conditions of Ordinance 13.12 are satisfied.

- a) Where new water service lines are to be installed for undeveloped property or future buildings or additional services added to an existing building, the Contractor shall furnish all materials necessary for connection of new water service lines to the water main, except 1-inch corporation stops, as specified herein and shall obtain and pay permits and tapping fees as established by Ordinance.
- b) Where the new water service line is terminated, the water service line shall be capped and plugged water tight to prevent leakage if the curb stop is inadvertently opened. New service connections shall have curb stops left turned off at the time of installation and the termination point shall be marked with a minimum three 3-foot long steel fence post. The steel post shall be buried below the surface at least 8 inches. The post needs to be steel to facilitate location by magnetic locators.
- c) City personnel shall tap all City water mains. The Contractor shall schedule all service taps as follows:
 - 1) Winter Schedule: Between 7:30 AM to 3:00 PM, Monday through Friday.
 - 2) Summer Schedule: Between 6:30 AM to 4:00 PM, Tuesday through Friday.
 - 3) It is the Contractors responsibility to call Utility Maintenance to determine which schedule they are following if there are questions.
- d) Water Service New Connections for water service lines 4 inches or larger shall be made as described in the section for Tapping Sleeves.

10. Water Service Reconnections: Water service lines shall be laid directly from the premises served to the City's main and shall not be extended across one lot to another. Notwithstanding this subsection, and notwithstanding the normal exception process contained in this document, the Public Works Director may allow water service lines to be located in a manner that crosses lot lines if, and only if, the conditions of Ordinance 13.12 are satisfied.

- a) The Contractor shall furnish all materials necessary for reconnecting water service lines existing prior to reconstruction of a water main, except 1-inch corporation stops as specified herein. On City projects, all permits and tapping fees will be waived; however, the Contractor shall obtain a no-charge permit to work in the ROW. Permits will be required for all reconNECTIONS to the Rapid City water system and are obtainable from City Utility Maintenance. On non-City projects, the new account set-up / inspection permit (tap permit) will be waived. However, the Right-to-Work permit and tapping fees are still applicable and are obtainable from City Utility Maintenance.
- b) City personnel shall tap all city water mains. The Contractor shall schedule all service taps as follows:
 - 1) Winter Schedule: Between 7:30 AM to 3:00 PM, Monday through Friday.
 - 2) Summer Schedule: Between 6:30 AM to 4:00 PM, Tuesday through Friday.

It is the Contractors responsibility to call Utility Maintenance to determine which schedule they are following if there are questions.

- c) Water service reconNECTIONS for water service lines 4 inches or larger shall be made as described in the section for Tapping Sleeves.

11. Inspection: All water service installations and abandonments, regardless of whether or not the service is located on private property or in public ROW, shall be inspected by the City Utility Maintenance Group prior to the Contractor backfilling the trench. The Contractor shall notify the City Utility Maintenance Group a minimum of four (4) hours prior to the time he needs the inspection. Any trench backfilled without being inspected and approved by authorized City personnel shall be re-excavated by the Contractor to expose the work for the required inspection. Discrepancies shall be corrected by the Contractor and re-inspected by City personnel.

N. Abandonments of Water Service Lines and Appurtenances, 2 Inches and Smaller: Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the service connection at the water main and remove the service saddle and corporation stop in its entirety. The contractor shall disconnect the service from the corporation stop and crimp or plug the water service line openings. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the water main with a repair clamp as specified and in accordance with the manufacturer's requirements. If there is a condition of the water main that prevents the use of a repair clamp, repair in accordance with "Abandonments of Water Service lines and Appurtenances, larger than 2-inch." City shall be present to inspect the repair prior to backfill.

The contractor shall expose the water service line at the curb stop and remove the curb stop and curb box in its' entirety. The Contractor shall disconnect the service from

the curb stop and crimp or plug the water service line openings. All open water service line pipe ends shall be crimped or plugged.

- O. Abandonments of Water Service Lines and Appurtenances, Larger Than 2-Inches:** Contractor shall coordinate all water main closures necessary to carry out this work with Utility Maintenance in accordance with this specification. Contractor shall expose the service connection at the water main, and remove section of water main pipe containing the service connection and all water service line appurtenances such as Tapping Sleeves, in line tees or crosses, service valves, etc. in its entirety. The contractor shall disconnect the service pipe and plug per the specification for the abandonment of water mains. All debris associated with the abandonment shall be removed in its entirety. Contractor shall repair the water main with new PVC pipe of the same size and equivalent pressure class of the water main being repaired and appurtenant coupling connections suitable for use as specified in this section. Couplings shall be restrained unless sufficient demonstration can be provided that the water main being repaired is unrestrained. This demonstration is the responsibility of the contractor. Corrosion protection continuity and tracing continuity shall be maintained with the abandonment in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems. City shall be present to inspect the repair prior to backfill.

The contractor shall expose the water service line at the curb stop or valve and remove the curb stop and curb box or valve and valve box in its' entirety. The Contractor shall disconnect the service from the curb stop or valve and plug the water service line openings in accordance with the specification for the abandonment of water mains.

Abandonments of Water Service Lines and Appurtenances, Larger than 2-Inch on Steel water mains shall be as called for in approved construction plans and specified by the Engineer.

- P. Reuse of Water Service Line Tap Hole, 2 Inches and Smaller:** In the case of a "Water Service Reconnection", where the existing water service line tap can be reused, the Contractor may do so by placing a new service saddle of equivalent service hole size over the existing service hole. If the service connection is $\frac{3}{4}$ -inch, a 1-inch service saddle shall be used over the existing service hole. The service hole will remain the original tapping size and shall not be drilled to a larger size. If the condition of the hole prevents the use of a new service saddle, the hole may not be reused and shall be abandoned in accordance with "Abandonments of Water Service Lines and Appurtenances, larger than 2-inch".
- Q. Water Service Repairs:** Service pipe of conforming material shall be repaired with like material, pressure class and size, unless minimum existing size is not approved for use by the current version of the adopted Plumbing code.
- R. Acceptance of Curb Stops and Main Valves:** As a condition for project acceptance, all curb stops and water main valves within the project boundaries shall be in proper operating condition. City personnel will inspect and operate each curb stop and water main valve as part of the final inspection. The Contractor shall correct any deficiencies discovered during the inspection.

8A.4 METHOD OF MEASUREMENT

- A. Water Main Pipe:** Installed pipe quantities shall be determined by measuring from centerline to centerline of all pipe and fittings. Measurements shall be to the nearest whole foot.
- B. Water Main Fittings and Couplings:** Fittings furnished and installed shall be counted on a per each basis. Measurement for concrete thrust blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- C. Valves:** Shall be counted on a per each basis. Valve boxes and valve box adapters shall be included with the valves as a complete unit. Measurement for concrete blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- D. Fire Hydrant and Auxiliary Valve:** Fire hydrants will be counted on a per each basis. Auxiliary valve, valve box, and valve box adapter shall be included with the hydrant as a complete unit. No separate payment will be made for auxiliary valves, boxes and adapters. Measurement for concrete thrust blocks, cable and rods, and thrust restraint devices will not be made; such work shall be incidental to the respective work item. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- E. Fire Hydrant Lead:** The pipe for the hydrant lead from the main to the fire hydrant shall be measured from centerline to centerline of pipe and fittings. Measurements shall be to the nearest whole foot.
- F. Fire Hydrant Extensions:** Fire hydrant extension quantities shall be determined by measuring the vertical length of the extension. Measurement shall be to the nearest half foot.
- G. Fire Hydrant Bollards:** Fire Hydrant Bollards shall be counted on a per each basis. All materials for a complete installation shall considered as incidental to the respective work item.
- H. New Water Main Connections:** New water main connections shall be counted on a per each basis and shall include such items including but not limited to fittings, pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the new water main connection per the standard specification. The bid item, New Water Main Connections, is intended for use where a tapping sleeve and valve is not used and where an in-line

tee must be cut into an existing main, a pipe is being connected to, or where a cap/plug with thrust block must be removed prior to connecting.

- I. **Water Service Lines:** Installed pipe quantities shall be determined by measuring from centerline to centerline of all pipe and fittings. Measurements shall be to the nearest whole foot.
- J. **Service Saddles:** Service saddles furnished and installed will be counted on a per each basis.
- K. **Service Corporation Stops:** Service corporation stops furnished by the Contractor will be counted on a per each basis. No measurement will be made for service corporation stops furnished by the City.
- L. **Curb Stops and Boxes:** Curb stops and boxes furnished and installed, will be counted on a per each basis.
- M. **Water Service New Connections:** New water service connections will be counted on a per each basis. The pipe used for connections shall be measured and paid for under the bid item for water service pipe.
- N. **Water Service Reconnections:** Water service reconnections will be counted on a per each basis. The pipe used for reconnections shall be measured and paid for under the bid item for water service pipe.
- O. **Thrust Blocks and Joint Restraints:** No separate measurement will be made for thrust blocks or joint restraint devices, such work will be incidental to the pipe.
- P. **Polyethylene Bond Breaker:** No separate measurement will be made for polyethylene bond breaker such work will be incidental to the pipe and fittings.
- Q. **Tapping Sleeves and Valves (Includes Tee, Valve, and Thrust Block):** Tapping Sleeves and valves furnished and installed will be counted on a per each basis.
- R. **Adjust Valve Box:** Adjust valve box shall be counted on a per each basis.
- S. **Adjust Curb Stop Box:** Adjust curb stop box shall be counted on a per each basis.
- T. **Abandonment of Water Main and Appurtenances:** No separate measurement will be made for abandonment of water mains and appurtenances, when called for on the construction plans; such work will be incidental to the project unless otherwise specified.
- U. **Abandonment Water Main and Appurtenances, Water Main Branch Connections:** Abandonment of Branch water main connections will be counted on a per each basis and shall include such items including but not limited to repair pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the abandonment per the

standard specification.

- V. Salvaging Fire Hydrants, Valves and Valve Boxes:** No separate measurement will be made for salvaging and delivering salvaged materials including fire hydrants, auxiliary valves, valves and boxes; such work will be incidental to the project unless otherwise specified.
- W. Removal and Disposal of Pipe:** No separate measurement will be made for the removal of pipe materials to facilitate the progression of the work; such work will be incidental to the project unless otherwise specified.
- X. Abandonment of Water Services and Appurtenances, 2 Inches and Smaller:** Abandonment of Water Services and Appurtenances will be counted on a per each basis and shall include such items including but not limited to repair clamp, tracer wire, cathodic protection, and all other appurtenant materials to facilitate the abandonment per the standard specification.
- Y. Abandonment of Water Services and Appurtenances, Larger than 2 Inches:** Abandonment of Water Services and Appurtenances will be counted on a per each basis and shall include such items including but not limited to repair pipe, couplings, joint restraints, thrust blocks, concrete blocks, tracer wire, cathodic protection and all other appurtenant materials to facilitate the abandonment per the standard specification.
- Z. Reuse of Water Tap Hole, 2 Inches and Smaller:** Reuse of Water tap hole, 2 inches and smaller will be counted on a per each basis and shall include such items including but not limited to removal and disposal of existing saddle and furnish and install new service saddle.

8A.5 BASIS OF PAYMENT

- A. Water Main Pipe:** Payment will be at the unit price bid for the appropriate size of water pipe, furnished and installed, including trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, pressure and leakage testing, disinfection. Unless otherwise specified, no extra payment will be made for excavation deeper than that required to provide minimum specified cover. The cost of providing temporary water service and plugging abandoned water mains shall be incidental to the project.
- B. Water Main Fittings and Couplings:** Payment will be made at the unit price bid for the appropriate fitting, furnished and installed, including polyethylene bond breaker, and thrust blocks and/or restraints. Corrosion protection devices and appurtenances tied to fittings shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.
- C. Valves:** Payment will be made at the unit price bid for the appropriately sized valve, furnished and installed, including valve box, valve box adapter, concrete blocks, cable and rods, and thrust restraint devices. Corrosion protection devices and

appurtenances tied to valves shall be in accordance with Section 8B Corrosion Protection - Plastic Pipe Systems and are incidental to the respective work item.

- D. Fire Hydrant and Auxiliary Valve:** Payment will be made at the unit bid price, complete, furnished and installed, including trenching, excavation and backfilling, dewatering, sheeting or shoring, and disinfection. Auxiliary valve, valve box, and valve box adapter shall be included with the hydrant as a complete unit and no separate payment will be made.
- E. Fire Hydrant Lead:** The pipe for the hydrant lead (branch) from the main to the fire hydrant shall be at the unit price bid for the appropriate size of water pipe, furnished and installed, including trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, pressure and leakage testing, disinfection. Unless otherwise specified, no extra payment will be made for excavation deeper than that required to provide minimum specified cover. The cost of providing temporary water service and plugging abandoned water mains shall be incidental to the project.
- F. Fire Hydrant Extension:** When a fire hydrant extension is necessary due to no fault of the Contractor, as specified herein, payment will be made under the bid item for the fire hydrant extension per price bid. City personnel shall install all Fire Hydrant Extensions. However, if the hydrant could have been installed or ordered with the correct barrel length such that an extension was not necessary, the Contractor shall furnish and install a new Fire Hydrant with the correct barrel length. Hydrant Extensions in these cases will not be permitted.
- G. Fire Hydrant Bollards:** Payment for Fire Hydrant Bollards will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- H. New Water Main Connection:** Payment for new water main connection will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- I. Water Service Lines:** Payment will be made at the unit price bid for the appropriately sized pipe, furnished and installed, including trenching, excavation and backfilling, compacting, dewatering, and sheeting or shoring. The cost for any connections between the new water service line and existing water service lines shall be included in the unit price bid for the appropriately sized pipe.
- J. Service Saddles:** Payment will be made at the unit price bid for the appropriately sized service saddle, furnished and installed.
- K. Service Corporation Stops:** Payment for Contractor furnished corporation stops will be made at the unit price bid for the appropriately sized corporation stops. No payment will be made for 1-inch corporation stops, which shall be furnished by the City Utility Maintenance Group. The Utility Maintenance Group will also furnish one-inch

isolator/insulated corporation ball valves when required.

- L. Curb Stops and Boxes:** Payment will be made at the unit price bid for the appropriately sized curb stop and box, complete, furnished and installed.
- M. Water Service New Connection:** Payment will be made at the unit price bid for connecting new water services up to 2 inches in diameter to the new water main, including fittings necessary to connect the water service line to the corporation stop. The cost of connecting water service lines 2 inches or greater shall be included in the unit price bid for the fitting required to connect the water service lines to the water main. Payment for Water Service New Connection shall include Right to Work permit, New Account Setup/Inspection permit (tap permit) and tapping fees, unless otherwise specified in the Detailed Specifications.
- N. Water Service Reconnection:** Payment will be made at the unit price bid for reconnecting existing water services up to 2 inches in diameter to the new water main, including fittings necessary to reconnect the water service line to the corporation stop. The cost of reconnecting water service lines 2 inches or greater shall be included in the unit price bid for the fitting required to connect the water service lines to the water main. On City projects, all permits and tapping fees will be waived. On non-City projects the New Account Setup/Inspection permit will be waived, however the Right-to-Work permit and tapping fees are still applicable.
- O. Thrust Blocks and Joint Restraints:** No separate payment will be made for thrust blocks or joint restraint devices, such work will be incidental to the pipe.
- P. Polyethylene Bond Breaker:** No separate payment will be made for polyethylene bond breaker such work will be incidental to the pipe and fittings.
- Q. Tapping Sleeves and Valves (Includes Tee, Valve, and Thrust Block):** Payment for Tapping Sleeves and valves will be at the bid price per each including sleeve and valve, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item. Exploratory excavation to determine the existing pipe material and outside diameter of the pipe being tapped shall be considered as incidental to this bid item. The Contractor shall include payment for the "right to work" Permit, (tap permit), if applicable, and tapping fees in this bid item.
- R. Adjust Valve Box:** Payment for adjust valve box will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- S. Adjust Curb Stop Box:** Will be at the bid price per each, complete and shall be considered full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the item.
- T. Abandonment of Water Main and Appurtenances:** No separate payment will be made for abandonment of water mains and appurtenances, when called for on the

construction plans; such work will be incidental to the project unless otherwise specified.

- U. Abandonment of Water Main and Appurtenances, Water Main Branch Connections:** Shall be paid for under the per each entitled "Abandonment of Water Main and Appurtenances Branch Connection".
- V. Salvaging Fire Hydrants, Valves and Valve Boxes:** No separate payment will be made for salvaging and delivering salvaged materials including fire hydrants, auxiliary valves, valves and boxes; such work will be incidental to the project unless otherwise specified.
- W. Removal and disposal of Pipe:** No separate payment will be made for the removal of pipe materials to facilitate the progression of the work; such work will be incidental to the project unless otherwise specified.
- X. Abandonment of Water Services and Appurtenances, 2 Inches and Smaller:** Will be paid for under the per each entitled "Abandonment of Water Services and Appurtenances, 2 inch and smaller".
- Y. Abandonment of Water Services and Appurtenances, Larger than 2 Inches:** Will be paid for under the per each entitled "Abandonment of Water Services and Appurtenances, Larger than 2 inches".
- Z. Reuse of Water Tap Hole, 2 Inches and Smaller:** Reuse of Water tap hole, 2 inches and smaller will paid for as "Reuse water tap hole, 2 inches and smaller".

END OF SECTION

SECTION 8B

CORROSION PROTECTION – PLASTIC PIPE SYSTEMS

8B.1 DESCRIPTION

A. General: This work consists of furnishing and installing cathodic protection for all water mains, service lines, and appurtenances. This includes all equipment, tools, materials, labor and other incidentals to provide a complete system ready for immediate and continuous use. The work includes, but is not limited to the following:

1. Coatings on all ferrous metal (steel, ductile iron, cast iron) piping and fittings;
2. Galvanic anodes, joint bonds, insulating joints, test stations, and tracer wire to form an electrically continuous piping network;
3. Labeling, marking, and testing of cathodic protection system.

B. Related Work:

Section 7	General Conditions
Section 8A	Water
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals

C. Reference Standards: The latest revision of the following minimum standards shall apply to the materials and installation included in this specification, except where more stringent standards are applicable. In case of conflict, the most stringent requirements shall apply.

1. American National Standards Institute (ANSI):

- a) C80.1-90, Rigid Steel Conduit-Zinc Coated
- b) ANSI/NSF Standard 61 Drinking Water System Components – Health Effects

2. American Society for Testing and Materials (ASTM):

- a) ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems
- b) ASTM A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

- c) ASTM B418, Standard Specification for Cast and Wrought Galvanic Zinc Anodes
- d) ASTM B843, Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
- e) ASTM G97, Laboratory Evaluation of Magnesium Anode Test Specimens for Underground Application

3. American Water Works Association (AWWA):

- a) AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
- b) AWWA C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- c) AWWA C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines
- d) AWWA C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
- e) AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines
- f) AWWA C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- g) AWWA C217, Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- h) AWWA C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe
- i) AWWA C550, Protective Epoxy Interior Coatings for Valves and Hydrants

4. Association for Materials Protection and Performance (AMPP):

- a) National Association of Corrosion Engineers (NACE) Standard Practice (SP), SP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- b) NACE Standard Practice, SP0286, Electrical Isolation of Cathodically Protected Pipelines

5. National Electrical Manufacturers Association (NEMA):

- a) I-10, Type 3R and 4X Enclosures
- b) TC 2, Electrical Polyvinyl Chloride (PVC) Conduit
- c) WC 70-09 / ICEA S-95-658-09, Power Cables Rated 2000V or Less for the Distribution of Electrical Energy

6. National Fire Protection Association (NFPA), National Electrical Code (NEC), NFPA 70
7. Occupational Safety and Health Administration (OSHA)
8. Underwriters Laboratories (UL) ANSI/UL 467 "Grounding and Bonding Equipment."

D. Submittals:

1. Provide catalog cuts and other information for all proposed products proposed for use that shows compliance of those materials with these Specifications. Contractor submittals shall be made in accordance with Section 203 - Submittals. In addition, the following specific information shall be provided.
2. Submittal information shall clearly show manufacturer's name and model number of specified item to be provided, not just supplier name, if only supplier name is provided, then entire submittal shall be rejected and a new resubmittal will be required. Materials provided with only supplier's name shall be relabeled with original manufacturer's name, model number, etc., or be returned at Engineer's discretion at no additional cost to Owner.
3. Contractor shall submit required information on a system-by-system basis with items clearly marked for specific products or models to be used. Indiscriminate submittal of manufacturer's literature only is not acceptable.
4. Contractor shall submit installation, material, and safety requirements for thermite weld wire or pin brazing type connections.
5. Contractor shall submit a list of test equipment (make and model) to be provided. Test equipment shall be approved and at project site prior to start of pipe installation.
6. Contractor shall submit tracer wire continuity test equipment (make and model) and proposed tracer wire continuity test procedure.
7. **Quality Assurance Submittals:**
 - a) Manufacturer's Certificates of Compliance
 - b) Field Test Reports
 - c) Certificate of Compliance for Galvanic Anodes (Independent laboratory analysis required.)
 - d) Record Drawings shall include RECORD location of all cathodic protection test stations and tracer wire access box locations moved during construction and buried wire splices in either Station-Offset or x- and y- coordinates consistent with the project horizontal datum.
8. Submit Certificate of Compliance from fitting and appurtenance manufacturer and supplier verifying that bolting, fasteners, nuts, and washers proposed for the project meet the specifications provided herein.
9. **Contract Closeout Submittals:** Special guarantees as specified hereinafter:

- a) Submit record drawings and field test report information to the Engineer at end of project.
- b) The cathodic protection system and corrosion control monitoring systems including but not limited to joint bonding, test stations, insulators, galvanic anodes, etc. shall be fully operational upon completion of pipe installation and a functional test performed prior to acceptance of the project.
- c) The tracer wire system including tracer wire access boxes and continuity testing shall be fully operational upon completion of pipe installation. A functional test shall be performed prior to acceptance of the project.
- d) Test station and junction box wire labeling, color coding and Contractor functional testing results shall be submitted to the Engineer upon completion of functional testing and prior to acceptance of the project.

E. Quality Assurance:

- 1. The Contractor shall provide at all times a thoroughly experienced and competent field foreman, who will be present to supervise this portion of construction at the site. This person shall be responsible for the field test reports and have the authority to represent the Contractor and shall be the point of contact with the Engineer for this section of the specifications.
- 2. Functional testing shall be completed by the Contractor only in the Engineer representative's presence on the installed cathodic protection, corrosion protection items and tracer wire continuity.
- 3. The final testing shall be completed by the Engineer.

F. Observation Of Work:

- 1. Provide access to the project site for Owner, Engineer, and manufacturer at all times during installation and to observe finished work.
- 2. All materials and installations shall be subject to observation for suitability as the Engineer may elect, prior to, during, or after incorporation into the work. Observation or testing by the Engineer or the waiver of observation or testing of any particular portion of the work shall not be construed to relieve the Contractor of his responsibility to correctly perform the work and testing required in accordance with these specifications and the product manufacturer's recommendations.
- 3. The Contractor is in charge of and solely responsible for all of the quality control and final inspections required. Observation of or spot testing by the Engineer or product manufacturer does not meet the quality control inspection requirement or relieve the Contractor from doing the quality control testing required by the product manufacturer, this specification, or the Contractor's quality control program.
- 4. The Engineer reserves the right to reject all work that does not meet the minimum requirement of this specification. This may be done either during or after completion of the

work, during subsequent observations or testing, warranty inspection testing, or at any time when discovered during the warranty period.

- G. Record Drawings:** Contractor shall maintain an accurate record of the cathodic protection devices, tracer wire access boxes, and field-coated and/or repair coated pipe segments in redline fashion on a project plan set. Items on redline plans shall include, but are not limited to:
1. Galvanic anode type, size and as-constructed location to each fitting, valve or other metallic pieces;
 2. Test station and tracer wire access box locations;
 3. Tracer wire color coding for each wire segment within the project if different than that provided in this Specification;
 4. Record drawings shall include RECORD location of all cathodic protection test stations and tracer wire access box locations moved during construction and buried wire splices in either Station-Offset or x- and y- coordinates consistent with the project horizontal datum.
- H. Special Guarantee:** The Contractor, corrosion subcontractor, and product manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years or longer if required by the General Conditions commencing on the date of final acceptance of the work.
1. Functional and final testing and warranty inspection(s) of the corrosion protection systems shall be made at the end of the project and within the warranty period, respectively. The Contractor, subcontractor, and/or product manufacturer's representatives at their option may be present during the functional or final testing or warranty inspections by the Engineer and Owner.
 2. Any construction defects identified by the Engineer during energizing and testing or during warranty inspections shall be located and corrected by the Contractor at his sole expense including all additional Engineering time, full time inspection, and re-testing time.
 3. Any defects in the corrosion protection system discovered at or during the functional, final, and/or warranty inspection(s) shall immediately be repaired and retested in a timely manner (repairs starting within 30 days and completed, tested, and approved within 60 days of notice) by the Contractor. All repairs shall be in accordance with the written product manufacturer's instructions as reviewed and approved by the Engineer. Provide the Engineer with a minimum of five (5) days advance notice before beginning repairs.
 4. All repairs or any damage to other work caused by such defects or repairing of the defects including additional Engineering, full-time observation during repairs, and retesting or re-warranty inspections shall be at sole cost to Contractor.

8B.2 MATERIALS

A. General:

1. All materials specified within this specification shall meet the requirements of this specification section as well as Section 8A. Materials referenced within Specification Section 8B do not necessarily imply that the stock material item is in compliance with Section 8A. The supplier and contractor are responsible for complying with Specifications 8A and 8B collectively and in their entirety unless modified by project specific requirements.
2. The use of a manufacturer's name and model or catalog number is solely for the purpose of establishing the standard of quality and general configuration desired. Products of other manufacturers of equal standard and quality will be considered in accordance with the General Conditions.

B. Material Suppliers: Suppliers listed below can usually supply the types of materials specified in this section. Alternate suppliers will be considered, subject to approval of the Engineer. Address given is that of offices in the Western United States; contact these offices for information regarding the location of their representative nearest the project site:

1. Farwest Corrosion Control, Denver, CO (888-532-7937) www.farwestcorrosion.com
2. Hoff Company, Denver CO (800-736-4546) www.pipelinesupplies.com
3. MESA Products, Inc., Tulsa, OK (888-800-6372) www.mesaproducts.com
4. Total Corrosion Solutions, Inc., TCS, Billings, MT (406-248-6985)

C. Wires:

1. All cathodic protection wires, joint bond wires, bonding cables, leads, and cables provided shall be insulated **STRANDED** copper wire. Wire size, type, and insulation type as specified in this section. Wire shall conform to applicable requirements of ANSI/NEMA WC 70-09 / ICEA S-95-658-09.

a) Tracer wire materials specification is included under TRACER WIRE.

b) All wire, including test leads, anode leads, joint pigtail bond wires, etc. associated with the cathodic protection system outlined in these specifications shall have a high molecular weight polyethylene (HWMPE) insulation rated for 600 volts. Minimum thickness shall be 45-mil for No. 10 American Wire Gauge (AWG) and smaller wires and 110-mil for No. 8 AWG and larger wires, as outlined in this specification.

2. Joint Bonds:

a) **General:** Type of joint bonds shall depend on pipe joint coating and shall be either:

- 1) Insulated copper joint bond wires for all pipe joint bond locations.

- 2) Metallic Fitting Pigtail Bond Wires shall be No. 12 AWG single conductor, stranded copper wire with 600-volt rated HMWPE insulation.
- I. Provide with a sleeve on each end of No. 12 AWG metallic fitting pigtail bonding wire used for bonding of metallic fittings including but not limited to fittings, valves, couplings, mega-lugs, metallic fitting glands or restraint rings, etc. for metallic and plastic pipe.
 - II. Two-piece or split fittings, restraints, couplings, etc. require a No. 12 AWG bonding wire between the individual pieces of the fitting for 10-inch diameter and smaller pipe. Two No. 12 AWG bonding wires are required for fittings 12-inch pipe and larger; the two wires may not utilize the same welds.

b) Insulated Joint Bond Wires: Provide joint bond wires consisting of single-conductor, stranded insulated copper wire. Supply all joint bonds complete with a formed copper sleeve on each end of the wire. Wire conductor for field-applied sleeves shall extend 1/4 inch beyond end of copper sleeve. End of factory formed copper sleeves shall be angled to allow end of wire to be exposed to thermite weld material.

c) Bond Lengths: Length of bond strap and joint bond wire may have to be increased for different pipe size and joint type per pipe manufacturer's recommendations to provide sufficient slack (one (1)-inch minimum on each end or two (2)-inches total) for pipe or joint movement between each thermite weld connection.

1) For Pipe Diameters larger than 16-inch:

- I. For Push-on, Mechanical, or Flanged Joints: No. 2 AWG wires, 18-inches long minimum.
- II. For Flexible Coupling Joints: No. 2 AWG wires, 24-inches long minimum, with two 12-inch long minimum insulated No. 12 AWG wire pigtails.
- III. Smaller couplings than 24-inch outer diameter (OD) pipe may allow shorter lengths. Contractor shall confirm that bond wire length supplied provides a minimum of one-inch of slack on each end for a total of two inches of slack.
 - i. Bond wires with pigtail wires can be utilized at flexible couplings, fitting or valve locations. The pigtail wires shall be bonded to the fitting or valve body.
 - ii. For multiple piece fittings, No. 12 AWG pigtail wires shall be utilized to bond different pieces to pipe. Pigtail wire length shall be as required.
- IV. For Insulated Flexible Coupling Joints: No. 2 AWG insulated copper wire, 18-inch long minimum, with one 12-inch long minimum No. 12 AWG wire pigtail.

2) For pipe smaller than 15-inch diameter, Contractor may utilize No. 4 AWG wire size instead of No. 2 AWG wire size.

3) Acceptable pre-made insulated copper joint bond wires are available from:

- I. Hoff Company, Inc., (800-736-4546), Denver, CO, www.pipelinesupplies.com;

II. nVent Erico, (800-753-9221), Cleveland, OH;

III. Continental Industries, Inc. (ThermOweld®), A Hubbell Company), 800-558-1373, Tulsa, OK;

IV. Or approved equal.

3. Pump Station, Vaults, Test Station, and Cross Bond Pipe Connecting Wires:

- a) Single-conductor, No. 2 AWG, No. 4 AWG, No. 6 AWG, and No. 8 AWG cathodic protection cables shall be single conductor, stranded copper wire with 600-volt high molecular weight polyethylene (HMWPE) insulation.

Insulation shall be 7/64-inch (110-mil) minimum thickness in accordance with ASTM D 1248, Class C, Grade 5.

- b) Bonding of buried and above grade appurtenances may be required to minimize stray current, safety hazards, and corrosion effects (e.g., bonding through a vault).

4. Test Wires:

- a) No. 12 AWG wire for prepackaged galvanic anode and No. 12 AWG test leads and No. 12 AWG and No. 14 AWG reference electrode lead wires shall be single conductor, stranded copper wire with 600-volt rated HMWPE insulation.

- b) No. 2, No. 4, No. 6, or No. 8 AWG leads shall be single-conductor, stranded copper wire with 600-volt rated HMWPE insulation.

5. Wire Identification:

- a) Wire insulation color shall indicate the function of each wire and shall be as follows:

1) Pipeline test wires:

I. Water Pipeline: Blue

- i. Test wires for water systems of different pressure zones shall be uniquely identified by the following color combinations on transmission mains and at zone separation valves only:

I) **High Level:** Blue with 1 strip of Blue tape.

II) **Low Level:** Blue with 1 strip of White tape.

II. Foreign Pipeline: White or as requested by Foreign pipeline company.

III. **Unprotected Pipe (not cathodically protected):** Black (e.g., pump station side of metallic pipe).

2) Casings: Orange

- 3) **Anode Lead Wires:** Black
- 4) **Reference Electrode Wires:** Yellow
- 5) **Coupon Wires:** Green
 - I. Pair of leads to protected coupon (one strip of white tape)
 - II. Pair of leads to unprotected coupon (one strip of black tape)
- 6) **Tracer Wires on Plastic, Concrete, or Non-metallic Pipe:**
 - I. Blue with two strips of black tape.
 - II. Color code tracer wire by project pressures and direction with tape strip(s) as noted below:
 - i. **Project Pressures (for transmission main projects and at zone separation valves only):**
 - I) **Higher Pressure:** One strip of BLUE tape
 - II) **Lower Pressure:** One strip of WHITE tape
 - III) Or as directed in the plans.
 - ii. **Direction:**
 - I) North (1 Strip) and West (2 Strips) PURPLE tape.
 - II) South (1 Strip) and East (2 Strips) GRAY tape.

D. THERMITE WELD MATERIALS:

1. Electrical connection of copper wire or copper strap to metallic (steel, ductile iron, and cast iron) fittings, pipe, and structures shall be by the thermite weld method. The thermite weld materials shall be UL listed to ANSI/UL 467.
2. The thermite weld metal shall consist of a mixture of copper oxide and aluminum material ignited by magnesium starting powder with a spark or by an electronic type ignition. Thermite weld materials shall be designed for connection of copper to steel or ductile iron and cast iron surfaces. The materials and exothermic process shall provide a completed permanent type connection that will not loosen or develop high resistant connection points and have a resistance equal to or lower than the strap or wire, be durable, be corrosion resistant, and have a high adhesion connection to both the surface and strap or wire.
3. Supply the proper size and type of wire sleeves, cartridges, and welder molds as required for each type of connection and pipe material in accordance with the thermite weld manufacturer's written recommendations.

- a) Material and equipment shall be from the same manufacturer and utilized throughout the entire project.
 - b) Weld materials from different manufacturers shall not be interchanged.
4. The individual thermite weld metal charges shall be sealed in a moisture-resistant plastic container (tube or cartridge) with tight fitting caps with the separate steel disks in a prepackaged sealed container. The starting (ignition) material shall be packed in the bottom of the tube with the weld material on top or for the electrical ignition type intermixed as required. The individual plastic containers shall be packed in sealed boxes to protect the individual containers and keep their contents dry. The size (weight in grams) and type of the charge shall be clearly marked on the plastic package and individual sealed containers.
5. Provide type of charges required for each pipe, fitting, or structure base material.
- a) Provide steel charges for steel materials. Charge (cartridge) size shall be minimum of 15-grams and maximum of 25-grams for steel materials.
 - 1) Cadweld F-33 (Green Top) or Thermoweld P Standard Powder;
 - 2) **Electronic Ignition Materials:**
 - I. Cadweld Plus CA15PLUSF33 with black top or CA25PLUSF33 with red top, or
 - II. ThermOweld EZ Lite Remote with suitably sized Thermoweld P Standard Powder Charges,
 - III. Or approved equal.
 - b) Provide cast iron charges for all ductile iron and cast iron materials. Charge (cartridge) size shall be a minimum of 15- or 25-grams and maximum of 32-grams for ductile and cast iron materials.
 - 1) Cadweld XF-19 or Thermoweld CI Cast Iron Powder;
 - 2) **Electronic ignition materials:**
 - I. Cadweld Plus CA15XF19, CA25PLUSXF19 or CA32PLUSXF19;
 - II. ThermOweld EZ Lite Remote with suitably sized Thermoweld CI Cast Iron Powder Charges;
 - III. Or approved equal.
 - c) Minimum cartridge size for strap bonds shall be 25 grams for 1/2-inch and 5/8-inch diameter hole sizes to steel and 32-grams for 5/8-inch diameter holes for ductile iron pipe per manufacturer's recommendations.
6. Welder molds shall be graphite molds sized for each type and size of charge and pipe size and type to be used as recommended by the thermite weld manufacturer. Each mold shall

have permanent identification showing manufacturer's name, mold part number, wire size, and weld metal type and size.

- a) Ceramic "One Shot" molds will not be acceptable.
 - b) Special welders and materials are required for copper strap, formed joint bond wires, and flexible coupling bonds.
 - c) Vertical type connections require special welders and materials as recommended by the weld manufacturer.
7. For horizontal type connections to smaller pipe and fitting sizes, different molds to match the different pipe curvature are required according to the manufacturer's recommendations. These molds for small pipe sizes shall be identified by each pipe diameter.
- a) For steel pipe and fittings, different molds are required for pipe up to 3-1/2-inch diameter. Different steel mold sizes are required for 4-inch and 6-inch to 8-inch pipe sizes. For steel pipe 10-inch or larger, flat steel molds can be used.
 - b) For ductile iron or cast iron pipe and fittings, different size of molds are required for different pipe diameters up to 24-inch. The molds must be obtained for each pipe size to be welded.

8. Electronic Ignition Connections:

- a) Cadweld Plus Exothermic or ThermOweld's EZ Lite Remote: Connections with prepackaged containers with electronic type ignition can be substituted for standard thermite weld spark type ignition connections provided that equal or better low resistance, durability, adhesion, and performance characteristics are proven.
 - b) Electronic type ignition materials shall be able to be used in standard graphite molds for wire and strap type connections for each structure type and size.
 - c) Manufacturer shall provide a reference table with corresponding molds and charge sizes and types.
 - d) Spark type and electronic ignition type materials from different manufacturers shall not be intermixed.
9. Weld mold sealer shall be heavy duty, clay-like, mold sealer putty material, specially designed for that use.

Acceptable sealer putty brands include:

- a) Electrical Duct Seal manufactured by Ideal Industries;
- b) Duct Seal Compound manufactured by Gardner Bender;
- c) CADWELD® Mold Sealer by Erico® Products, Inc.;

- d) Or approved equal.
10. Cleaning wheels shall be self-cleaning and leave no resin or residue on surface to be bonded to as recommended by the weld manufacturer.

The use of resin, rubber, or shellac-impregnated type grinding wheels are not recommended by the weld material manufacturers and shall not be used.

11. Mold cleaner shall be type and size recommended by weld manufacturer for each type of graphite weld mold being used.

12. Adapter Sleeves:

- a) Install adapter sleeves for all No. 10 AWG and No. 12 AWG wires. Provide sleeve type as recommended by thermite weld manufacturer and attach in the field.
- b) Install adapter sleeves for all No. 4 AWG and No. 2 AWG wires. Premade factory sleeved wires or wires with sleeves made in the field with the appropriate sized sleeves and hammer die are acceptable.
- 1) Factory formed sleeves shall be beveled to allow molten thermite weld material to directly contact wire.
 - 2) Field formed sleeves shall be attached with the appropriate sized and type of hammer die with method as recommended by the thermite weld manufacturer. Wire conductor for field installed adapter sleeves shall extend ¼-inch beyond end of the sleeve to allow molten thermite weld material to directly contact wire.

Table 8B.1. Sleeved Thermite Weld Materials – Horizontal Connections

STRANDED TEST LEAD OR BOND WIRE SIZE	CADWELD®		ThermOweld®	
	SLEEVE MODEL No.	HAMMER DIE MODEL No.	SLEEVE MODEL No.	HAMMER DIE MODEL No.
No. 12 AWG	CAB-133-1H	Crimped	38-0200-00	Crimped
No. 10 AWG	CAB-133-1K	Crimped	38-0201-00	Crimped
No. 4 AWG	CAS-20-F	CAD-11	38-0204-00	38-4859-00
No. 2 AWG	CAS-09-F	CAD-09	38-0203-00	38-0310-00

Table 8B.1 presents sleeve and hammer die information for Cadweld® and ThermOweld® products.

13. Thermite weld materials are available as specified from:

- a) Erico Products Inc. (CADWELD 800-248-9353), Cleveland, OH;
 - b) Continental Industries, Inc. (ThermOweld®), A Hubbell Company, 800-558-1373, Tulsa, OK;
 - c) Or approved equal.
14. Thermite Weld Mold, Charge and Size for pipes LARGER than 8-inches in diameter are provided in Table 8B.2.

CONDUCTOR SIZE	CADWELD®			ThermOweld®		
	SLEEVE #	MOLD #	MAXIMUM CHARGE TYPE AND SIZE	SLEEVE #	MOLD #	MAXIMUM CHARGE TYPE AND SIZE
No. 12 AWG	CAB-133-1H	CAHBA-1G-PS	CA15XF-19 CA25XF-19	38-0200-00	M-156	15CI or 25CI
No. 10 AWG	CAB-133-1H	CAHBA-1G-PS	CA25XF-19	38-0201-00	M-7351-PS	25CI
No. 8 AWG	N/A	CAHBA-1G-PS	CA25XF-19	38-0201-00	M-7351-PS	25CI
No. 6 AWG	N/A	CAHBA-1G-PS	CA25XF-19	38-0202-00	M-7352-PS	25CI
No. 4 AWG	CAS-20-F	CAFCA-1L-PS	CA32XF-19	38-0204-00	M-154-PS	32CI
No. 2 AWG	CAS-09-F	CAFCA-1V-PS	CA32XF-19	38-0203-00	M-175-PS	32CI

Table 8B.2.**Thermite Weld Mold, Maximum Charge Size and Type for Diameters Greater than 8 Inches****E. Thermite Weld Repair Coating:** One Hundred Percent (100%) Epoxy Repair Coating

- 1) Field repair material shall be fast cure, high build, low temperature (cure down to 0 degrees (°) Fahrenheit (F)), moisture tolerant (cure underwater), 100-percent epoxy material that can be distributed in a two component repair cartridge tubes with a dispensing gun.
- 2) Repair coating shall be compatible with original pipe or fitting coating and exhibit minimum 2,000 pounds per square inch (psi) adhesion values.
- 3) Acceptable field epoxy repair type coatings are:
 - a) Denso North America Protal 7125 Repair Cartridge;
 - b) CANUSA-CPS HBE-95 WG high build epoxy;
 - c) Or approved equal.

F. Easy Bond Pin Brazing:

1. Pin Brazing for joint bond and test wire connection to dielectric lined pipe offers lower temperature, less weather restrictions, and greater versatility in connection locations.

Only direct type pin brazing connections to pipe or fitting shall be utilized, no threaded bolt and nut type connections shall be allowed. Direct type pin brazing connection shall be sized as required to meet specified test wire or joint bond wire and strap size. Consult pin brazing manufacturer for recommended direct metal type connection sizes.

2. Wire ring tongue terminal pin brazing connectors to bond or test lead wires shall be crimped and silver-soldered for all pin brazing type wire connections.
3. Pin brazing connections can be made directly to suitable sized punched copper straps.

4. Pin brazing system for cathodic protection connections shall consist of direct type pin brazing pins connected with a BAC pin brazing system are available from:

- a) Farwest Corrosion Control Company;
- b) GMC Electrical, Inc.;
- c) Hoff Company, Inc.;
- d) Mesa Products;
- e) Or approved equal.

G. Ground Clamps: Heavy duty all bronze ground clamps for wire connections to copper service pipe shall be sized to fit the pipe and wire and UL 467 listed for direct burial in earth or concrete. All parts of the clamp shall be bronze including bolts and nuts, as manufactured by:

- 1. Burndy, LLC;
- 2. EMERSON Industrial Automation;
- 3. Thomas and Betts;
- 4. Or approved equal.

H. Galvanic Anodes:

1. **Magnesium Anode:**

- a) High-Potential Magnesium Composition for buried soil applications shall be cast of primary magnesium and meet or exceed ASTM B843 Grade with Alloy M1C chemical requirements as shown in Table 8B.3.

Table 8B.3 High-Potential Magnesium Anode Composition

ELEMENT	CONTENT
Aluminum (Al)	0.010% maximum
Manganese (Mn)	0.500% to 1.300%
Copper (Cu)	0.020% maximum
Silicon (Si)	0.050% maximum
Iron (Fe)	0.030% maximum
Nickel (Ni)	0.001% maximum
Total Others	0.050% each or 0.300% maximum total
Magnesium (Mg)	Remainder

- b) **Prepackaged Magnesium Anode Dimensions:** The anode size and weight may differ slightly because of variations in casting and mold shapes, but shall be the manufacturer's standard and should approximate the characteristics in Table 8B.4.

Table 8B.4 High-Potential Magnesium Anode Dimension Characteristics

BARE ANODE SIZE	17 POUND ANODE	32 POUND ANODE
Shape	17D3	32D5
Bare Anode Nominal Dimensions	3 inches by 25 inches long minimum	5 inches by 20 inches long minimum
Packaged Weight	42 pounds minimum	68 pounds minimum
Nominal Package Size	6 inch diameter by 29 inches long minimum	7 inches by 28 inches long minimum

- c) **Magnesium Anodes:** Shall be verified with a third party ASTM G97 tests for quality control and meet the following minimum requirements:

- 1) Minimum Open Circuit Potential shall be -1.7 volts or more negative to a copper/copper sulfate reference electrode.
- 2) Minimum current efficiency shall be 50-percent (50%) efficiency or higher or a minimum 500 amp hours or higher.
- 3) Anode suppliers (distributors) shall provide anode manufacturing certificates, manufacturing quality control testing results, and supplier's own third party ASTM G97 test results for each batch of anodes supplied for project.
- 4) If any anodes provided for the project do not pass the minimum criteria specified ASTM G97 requirements, then all anodes supplied in that batch or lot shall be rejected and replaced at no cost to the Owner.

- d) **Acceptable High Potential Magnesium Anodes are:**

- 1) MAXMAG by Interprovincial Corrosion Control Company (ICCC), Lewiston, NY, 800-699-8771, www.rustrol.com;
- 2) MESA High Potential Magnesium Anodes, MESA Products, 888-800-6372, www.mesaproducts.com;
- 3) UltraMag High Potential Magnesium Anode, Farwest Corrosion Control Company, 888-532-7937, www.farwestcorrosion.com;
- 4) Or approved equal.

2. Zinc Anode:

- a) Zinc anodes for buried soil conditions shall meet the requirements of ASTM B 418, Type II, as shown in Table 8B.5.

Table 8B.5 Zinc Anode Composition

ELEMENT	CONTENT
Aluminum (Al)	0.0050% maximum
Cadmium (Ca)	0.0030% maximum
Iron (Fe)	0.0014% maximum
Lead (Pb)	0.0030% maximum
Copper (Cu)	0.0020% maximum
Zinc (Zn)	Remainder

- b) **Prepackaged Zinc Anode Dimensions:** The anode size and weight may differ slightly because of variations in casting and mold shapes, but shall be the manufacturer's standard and should approximate the characteristics provided in Table 8B.6.

Table 8B.6 Zinc Anode Dimension Characteristics

BARE ANODE SIZE	18 POUND ANODE	30 POUND ANODE
Shape	ZUR-18	ZUR-30
Bare Anode Nominal Dimensions	1.4 inches by 36 inches long minimum	2 inches by 30 inches long minimum
Nominal Package Dimensions	5 inch diameter by 42 inches long minimum	5 inches by 38 inches long minimum
Packaged Weight	70 pounds minimum	70 pounds minimum

3. Prepackaged Galvanic Anode General Requirements:

- a) **Anode Wire:** Supply each anode with No. 12 AWG stranded copper wire with HMWPE insulation. Provide anode lead lengths as required for test stations to extend splice free from anode to test station location. Lead wire shall be coiled and bound.
- b) **Wire-to-Anode Connection:** The anode connection shall be stronger than the wire. The galvanic anode material shall be cast around a galvanized steel wire, strap, or pipe core. The anode lead wire connection to the steel core shall be silver-soldered (45% silver) by the manufacturer's standard process and be stronger than the wire. Connection of lead wire to anode shall be electrically insulated with manufacturer's standard waterproof epoxy or electrical potting compound type insulation.
- c) **Prepackaged Anode Backfill Material:** Shall have a grain size so that 100-percent is capable of passing through a 20-mesh screen and 50-percent will be retained by a 100-mesh screen. The mixture shall be thoroughly mixed and firmly packaged around the galvanic anode within the cloth bag or cardboard tube by means of adequate vibration. The complete packaged galvanic anode shall weigh a minimum of 2.0 times the bare anode weight. The quantity of backfill material shall be sufficient to cover all surfaces of the anode to a depth of 1-inch.
- d) **Packaging and Shipping:** Bare anodes shall be centered in cotton bag filled with specified backfill material. Provide anode packaged in and shipped and stored in waterproof plastic or heavy multi-walled paper bag of sufficient thickness to protect the anode, wire, backfill material, and cloth bag.

- e) **Compliance Statement:** Furnish an independent laboratory analysis certifying that all anode and backfill material supplied meets the requirements of this Specification and specified laboratory testing.
- f) **Field Verification:** At the Engineers option, if an anode is supplied by a manufacturer other than the manufacturers listed in the specifications, a galvanic anode may be selected at random for Contractor to provide an independent laboratory analysis on to demonstrate that both the anode and backfill material supplied meets the requirements of this Specification.
- g) Prepackaged Galvanic Anode Backfill material Composition is provided in Table 8B.7.

Table 8B.7 Prepackaged Galvanic Anode Backfill Material Composition

ELEMENT	CONTENT
Ground Hydrated Gypsum	75 Percent
Powdered Wyoming Bentonite	20 Percent
Anhydrous Sodium Sulfate	5 Percent

I. Cathodic Protection Test Stations:

1. Flush Mounted Test Stations:

- a) Flush mounted test stations shall be standard unless specifically indicated on the plans.
- b) **Test Station Box:** Traffic H-10 load rated concrete body cast with a cast iron ring, with a minimum weight of 55 pounds and minimum dimensions of 10-inch inside diameter and 12-inches long.
 - 1) Furnish with locking metallic ring extensions as required to penetrate concrete or pavement surfaces by 4-inches minimum.
 - 2) Furnish with a minimum 12 pound cast iron lid with the letters "TS" or words "CP Test", "Test Station" or similar words cast into the lid.

3) Test Boxes shall be:

- I. Model 3RT Traffic Valve Box by Brooks Products, www.brooksproducts.com;
 - II. Model G3 Traffic Valve Box by Christy Concrete Products, www.oldcastleprecast.com;
 - III. Or approved equal.
- c) **Terminal Block:** Plastic or glass-reinforced, ¼-inch thick laminate terminal board with minimum dimensions of 3-inches by 4-inches.
 - 1) Furnish terminal block with a minimum of seven (7) terminals. Terminal nuts and studs shall be ¼-inch with double nuts for securing the studs to the terminal board.

- 2) Terminal nuts, studs, flat and lock washers shall be nickel plated brass, bronze, or Series 300 stainless steel.
- 3) Terminal block shall not be connected to flush test station cap or be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.
- 4) **Manufactured seven terminal test boards shall be:**
 - I. CP Test NM-7 by Bingham & Taylor;
 - II. Flush Fink 7 by COTT Manufacturing;
 - III. Or approved equal.

2. Shunts:

a) Shunts for test stations shall be:

- 1) Holloway Type RS 0.01 ohm manganin wire shunt with 6-amp capacity by Holloway Shunts;
- 2) Yellow CP Shunt (0.01-ohm shunt with 8-amp capacity) by M.C. Miller Company;
- 3) Yellow CP Shunt (0.01-ohm shunt with 8-amp capacity) by COTT Manufacturing;
- 4) Or approved equal.

J. Miscellaneous Reference Monitoring Equipment and Materials:

1. **Reference electrodes:** Shall only be used at locations specifically indicated in the plans or as directed by the Engineer.
2. **Prepackaged Copper/Copper Sulfate (CU/CUSO4) Reference Electrodes:**
 - a) Permanent reference electrode for buried piping locations shall be a copper/copper sulfate reference electrode. Reference electrode dimensions shall be approximately 1.5-inches in diameter by 6-inches long. Reference electrode shall be suitable for permanent installation and designed for a 15-year minimum life expectancy with an accuracy of plus or minus 5-millivolts.
 - b) Electrodes shall be supplied prepackaged in a permeable cloth bag containing manufacturer's special low-resistivity backfill mixture formulated to retain moisture and maintain electrode stability. Outside dimensions of electrode package shall be approximately 6-inches in diameter by 14-inches long.
 - c) Supply electrode with a lead wire attached and electrically insulated with the manufacturer's standard connection. The connection shall be stronger than the wire. Lead wire shall be single conductor No. 14 AWG or larger stranded copper wire insulated as specified under WIRE, this section. Lead wire shall be of sufficient length

(minimum 50 feet) or longer as required to reach splice free from reference electrode to test station. Lead wire shall be coiled and bound.

- d) Package cloth bag with reference electrode in and shipped and stored in waterproof plastic or heavy paper bag of sufficient mil thickness to protect the electrode, wire, backfill, and cloth bag.

e) **Acceptable CU/CUSO₄ reference electrodes can be obtained from:**

- 1) STAPERM Model CU-1-UGPC by GMC Electrical, Inc.;
- 2) Model UL CUG LongLife Reference Electrode by Electrochemical Devices, Inc.;
- 3) Or approved equal.

3. **Plastic Reference Monitoring Pipe:** Shall be a 3-inch minimum diameter Schedule 40 PVC plastic pipe with a threaded pipe cap provided at test stations as shown on the Drawings or called out in the test station schedule. Plastic reference monitoring pipe at flush test stations shall not require a threaded cap.

K. Conduit, Lockouts, And Straps:

1. The minimum conduit size shall be 1-inch diameter unless otherwise indicated on drawings or specified.
2. Use intermediate metal conduit, including couplings, elbows, nipples, and other fittings, hot-dipped galvanized and meeting the requirements of UL and the NEC.

Do not use setscrew type couplings, elbows, and nipples unless approved by the Engineer.

3. Heavy wall rigid PVC conduit shall be Schedule 40, UL listed for concrete encasement, underground direct burial, concealed and direct sunlight exposed use.

Use conduits, couplings, elbows, nipples, and other fittings meeting the requirements of NEMA TC and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use.

4. Flexible metal conduit shall be UL listed, liquid tight flexible metal conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.
5. Locknuts, two hole straps, and other miscellaneous hardware shall be galvanized steel.
 - a) Galvanized items shall be hot dipped galvanized in accordance with ASTM A153.
 - b) Galvanized hardware shall not be used underground or in immersion service.
6. Conduit bushings shall be threaded plastic or plastic-throated galvanized steel fittings.

L. Wire Connections And Splice Materials:

1. Compression Connectors:

- a) Compression connectors for in-line, multi-splices, and tap splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced.
 - b) Compression connectors shall be applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size.
 - c) **Acceptable Type "YC" wire compression connectors as manufactured by:**
 - 1) Burndy, LLC;
 - 2) Thomas and Betts;
 - 3) Or approved equal.
 - d) Inline "butt" type wire splice connectors or wire nuts are **NOT** acceptable.
 - e) Split bolts are acceptable only if silver soldered after a physical connection is made and both the wires are equal to or smaller than No. 10 AWG size.
 - f) **Silver Brazing Alloy:**
 - 1) Brazing Alloy with minimum 15-percent silver content, 1185° to 1300° F melting range.
 - 2) Provide suitable silver brazing alloy and flux recommended by manufacturer for materials being connected (i.e. copper to stainless steel, copper to steel, and/or copper to copper, etc.).
2. Splices shall be made with suitably sized copper compression connectors and insulated with either a hand tape system, with a specially formulated splicing kit, or with an epoxy splice kit depending on wire size.
- a) Smaller wires (equal to or smaller than No. 8 AWG) can be repaired with tape, or insulated with a specially fabricated splicing kit, or made with an approved epoxy insulated splice kits.
 - b) Insulation damage or splices to large cathodic protection cables (No. 4 AWG or larger) shall only be made with an approved epoxy type splice kit.
 - c) **Electrical Splicing Tapes and Sealers:** Tape for wire splice insulation shall be UL and CSA approved, cold and weather resistant, highly elastic, with a high dielectric strength and highly resistant to sun, water, oil, acids, alkalis, and corrosive chemicals.
 - d) Tapes and electrical sealers shall be suitable for moist or wet environments and may include the following:

- 1) Rubber High Voltage Electrical Tape: Linerless 30-mil rubber high voltage splicing tape suitable for splicing cables through 69k;
 - 2) VScotch Professional Grade Linerless Rubber Splicing Tape 130C by 3M Products;
 - 3) Plymouth L969 Plyvolt Linerless EPR High Voltage Tape by Plymouth Bishop;
 - 4) Or approved equal.
- e) **High Voltage Vinyl Electrical Tape:** All weather, minimum 7-mil thick, vinyl electrical tape suitable for cable splices up to 600 volts.
- 1) Scotch Super 33+ Vinyl Electrical Tape as 3M Products;
 - 2) Plymouth Premium 111 Black Vinyl Plastic Electrical Tape by Plymouth Bishop;
 - 3) Or approved equal.
- f) **Filler Tapes:** Low voltage rubber filler tapes or putties that can be wrapped, stretched or molded around irregular shapes for quick, smooth insulation build-up to insulate connections up to 600 volts for topcoating with vinyl electrical tapes.
- 1) Scotchfill by 3M Products;
 - 2) Plymouth 125 Electrical Filler Tape by Plymouth Bishop;
 - 3) Or approved equal.
- g) **Electrical Coating Sealer:** Electrical coating for sealing tape insulation on splices in severe conditions, suitable for direct burial, direct water immersion, and above grade applications.
- 1) Scotchkote Electrical Coating by 3M Company;
 - 2) Or approved equal.
- h) Specially formulated splicing kit shall consist of an elastomeric insulating compound that seals and waterproofs connection area with a resin-impregnated, moisture-cured fabric bandage shell such as Royston SpliceRight Splicing Kit available from Chase Industries.
- i) **Epoxy Splice Kits:** Epoxy splice kit shall be type suitable for above grade and buried applications and rated for non-shielded cables up to 5 kV and multi-conductor cables through 1,000 volts.
- 1) Splice kit shall consist of snap together plastic mold sized to fit around splice, funnels, tape for sealing ends of mold, and two-part epoxy resin in a single pouch for mixing.

- 2) Epoxy resin shall be electrical insulating low viscosity type that will harden (cure) quickly with time.
- 3) In-Line type splice insulating kit for insulation repair shall be epoxy resin, 3M Company Scotchcast Series 82; Plymouth Bishop Plycast Splicing Kit 2638; or approved equal.
- 4) Wye type splice insulating kit for insulation repair shall be epoxy resin, 3M Company Scotchcast Series 90B1; Plymouth Bishop Plycast Splicing Kit 2636; or approved equal.

3. Terminal and Connection Coating and Electrical Sealers:

- a) **Electrical Insulating Spray:** Electrical insulating spray for sealing tape insulation on splices, or on terminals to minimize external corrosion.
 - 1) Scotch 1601 Insulating Spray by 3M Company;
 - 2) Royston Protective Coating Product Data No. 614 Royston Laboratories;
 - 3) Or approved equal.
 - b) **Oxidation Inhibiting Compound:** Oxidation inhibiting compound shall be non-water soluble, non-petroleum based and suitable for aluminum, copper, steel and rubber and polyethylene type insulating materials.
 - 1) Penetrox A-13 by Burndy Products;
 - 2) Contax Inhibiting Compound Type CTB by Thomas and Betts (T&B);
 - 3) Or approved equal.
4. **Wire Connector Terminals:** A ring tongue terminal or single hole solderless lug type connector shall be installed on the end of all stranded wire before connecting it to test station, terminal box, or junction box terminal studs.
- a) Wire connector terminals shall be sized to fit wire and stud size and be suitable for use with copper conductors.
 - b) One-piece heavy duty, tin plated copper crimp on ring tongue terminal. **Acceptable ring tongue wire connectors are manufactured by:**
 - 1) Burndy LLC;
 - 2) 3M;
 - 3) Thomas and Betts;
 - 4) Or approved equal.

- c) Single hole seamless copper Lug-it type connector rated shall be UL listed for 600-volt service with off-set tongue suitable for wire size being terminated.

Acceptable No. 4 and No. 2 AWG wire single hole solderless lugs are:

- 1) L125 by Burndy;
 - 2) BTCO208-B2 by Thomas and Betts;
 - 3) Or approved equal.
- d) Wire forked end type terminals are **NOT** acceptable.
 - e) Acceptable one-hole, non-insulated copper crimp wire lug terminals sizes for ¼-inch stud sizes are listed in Table 8B.8.

Table 8B.8 Stranded Copper Wire Ring Tongue Terminal Connectors

Stranded Cable Size (AWG)	Bolt or Stud Size	MANUFACTURER AND MODEL			
		Anderson	Blackburn	Burndy	T and B
No. 14 to 20	1/4"	----	----	YAV14 Box	Series 54100 Model C10-14
No. 10 to 12	1/4"	----	----	YAV10 Box	Series 54100 Model C10-14
No. 8	1/4"	----	CTL8-14	YA8C-L Box	54130
No. 6	1/4"	VHCS-6-14	CTL6-14	YA6C-L Box	54105
No. 4	1/4"	VHCS-4-14	CTL4-14	YA4C-L Box	54106
No. 2	1/4"	VHCS-2-14	CTL2-14	YA2C-L2 Box	54107

- 5. **Electrical Connectors:** Hardware used in electrical connections including bolts, studs, nuts, washers, and lock-washers shall be tin or nickel plated copper, brass, bronze, or 300 series stainless steel for electrical conductivity and atmospheric corrosion resistance.

M. Plastic Conduit Sheathing: Plastic conduit for cathodic protection cable sheathing for cathodic protection cables or wires shall be one-inch minimum diameter Schedule 40 polyethylene (PE) or polyvinyl chloride (PVC) plastic pipe.

N. Location Marking Tags:

- 1. Test station locations shall be identified with stamped brass or aluminum marking tags.
 - a) Minimum tag size shall be 2-inch diameter.
 - b) **Marking tags are available from:**
 - 1) Western Electromarker, Edmonton, Alberta, Canada (866-486-4250);
 - 2) Or approved equal.

2. Contractor shall supply the type and number of location marking tags sufficient for the number of test stations listed in the Test Station Schedule for the project.
 - a) One UNSTAMPED tag shall be left in each test station.
 - b) Engineer will stamp the tags with appropriate identification at the time of final acceptance testing.

O. Warning Tape:

1. Warning tape shall be used on all projects where specifically called out in the Plan General Notes.
2. Warning tape shall be heavy-gauge, 4-mil minimum thickness, plastic tape for use in trenches.
 - a) Warning tape shall be non-traceable type. Warning tape shall be resistant to corrosive soil and intended for extended direct burial service.
 - b) Tape shall meet A.P.W.A. national color code and shall be imprinted with an appropriate legend to define the type of utility. Tape shall be labeled with bold black letters for full length of tape.
 - c) Warning tape for water mains shall be blue and labeled "CAUTION: WATER LINE BURIED BELOW".
 - 1) For pipe lines of 10-inch diameter and less, the warning tape shall be 6-inches in width.
 - 2) For pipe lines of 12-inches and greater, the warning tape shall be 12-inches in width.
 - d) Warning tape for buried cathodic protection cables and conduits shall be yellow and labeled "CAUTION: CABLES BURIED BELOW" and a minimum of 3-inch width.
 - e) **Acceptable products are available from:**
 - 1) ITT Blackburn;
 - 2) Allen Systems, Inc.;
 - 3) Reef Industries;
 - 4) Or approved equal.

P. Tracer Wire:

1. **Tracer Wire:**
 - a) **Copper Tracer Wire:** No. 10 AWG wire for tracer wire shall be UL listed single conductor, **stranded** copper wire with 600-volt HMWPE insulation. **Acceptable**

single-conductor copper wire for open cut pipe trench and in-conduit type installations are:

- 1) Agave Copper PE Tracer Wire 45-mil (APUT-1019) from Agave Wire, LTD;
 - 2) 45-mil HMWPE Copper Tracer Wire from Kris-Tech (K-T) Wire
 - 3) Pro-Trace Type CU HDPE Copper Tracer Wire 45-mil (Copper PE45-Stranded) from Pro-Line Safety Products;
 - 4) Or approved equal.
- b) Bi-metallic Tracer Wire:** No. 10 AWG wire for tracer wire may be a hard-drawn, copper-clad steel conductor wire with a 45-mil high density HWMPE insulation. **Acceptable bi-metallic tracer wire is:**
- 1) Agave APCU 1001 from Agave Wire, LTD;
 - 2) Pro-Trace (HDD-CCS PE45) as manufactured by Pro-Line Safety Products;
 - 3) Copperhead High Strength Tracer Wire (1030B-HS-xx) as manufactured by Copperhead Industries, LLC;
 - 4) Copper-Clad Steel (CCS) Tracer Wire from Kris-Tech (K-T) Wire;
 - 5) Or approved equal.
- c)** Tracer wire will only be required for non-metallic pipe sections and for copper water services as detailed in 13945PS.
- d)** Tracer wire insulation shall be resistant to corrosive soil and intended for extended direct burial service.
- e)** Tracer wire color and tape markings shall be in accordance with other sections of this Specification.
- f)** Tape for attachment of tracer wire to pipe shall have an aggressive adhesive intended for direct burial service. **Standard-duty Duct Tape is not an acceptable product. Minimum tape requirements are:**
- 1) Adhesive PVC/butyl rubber (polyethylene) tape materials minimum 1- ½ to 2-inch wide 6- to 10-mil nominal thickness shall be provided to securely hold tracer wire in place on top of pipe.
 - 2) Adhesive PVC/butyl rubber (polyethylene) tape materials and adhesion to bare metal surface and to backing shall be a minimum of 22 grams per ounce/inch and meet AWWA C105 requirements.
- 3) Acceptable products are:**
- I. Gorilla Tape available from Gorilla Glue Company,

- II. No. 140 Black Pipe Wrap Tape available from Sigma Corporation,
- III. UPC Pipe Tape available from Northtown Company,
- IV. Or approved equal.

g) Tracer Wire Splices:

- 1) Compression connectors for in-line splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced in accordance with "Wire Connections and Splice Materials" this section. Wire compression connectors shall be supplied with tape or epoxy resin type splice insulation kits.
- 2) **Acceptable Type "YC" wire compression connectors as manufactured by:**
 - I. Burndy LLC;
 - II. Thomas and Betts (T and B);
 - III. Or approved equal.
- 3) Electrical Spring Connector (Wire Nut) Pigtail Wire Type Connectors with silicone gel insulation filled resin tube.
 - I. The electrical spring connector shall consist of a steel spring, metal shell, with a flame-retardant PVC insulator outer covering.
 - II. The plastic tube assembly shall consist of a polypropylene tube with locking fingers to hold the electrical spring connector in the bottom portion of the tube and a plastic cap.
 - III. The tube shall be prefilled with non-hardening silicone electrical insulating gel sealant.
 - IV. The electrical spring connector and plastic tube assembly shall be UL listed and CS Certified for 600 volts direct bury and submersible applications.
 - V. The electrical spring connector is suitable for copper wires only and shall be sized to fit three No. 10 AWG tracer wires.
- VI. Suitable tracer wire splice kits are:**
 - i. 3M Direct Bury Splice Kit (DBR/Y-6);
 - ii. Dryconn Waterproof Connectors Direct Bury Twist-On with Strain Relief (DBSR Aqua) from King Innovation;
 - iii. Or approved equal.

- 4) Compression Connectors or split bolts with silver solder and specially formulated splicing kit shall consist of an elastomeric insulating compound that seals and waterproofs connection area with a resin-impregnated, moisture-cured fabric bandage shell.

- I. Royston SpliceRight Splicing Kit available from Chase Industries;
- II. Or approved equal.

2. Tracer Wire Access Boxes:

a) Flush Mounted Tracer Wire Access Box:

- 1) Two different sizes of tracer wire access boxes may be used on a project. The difference in sizes is described within this specification section.
- 2) For two wire, 45-mil insulation, tracer wire access, 4-inch flush mounted tracer wire access boxes may be used unless specifically indicated on the Plans.
 - I. Plastic flush terminal box body (18" long shaft, 4" diameter minimum size) with cast iron collar and lockable cast iron lid, suitable for traffic conditions.
 - II. Lids, if colored, shall meet APWA standard color for utility.
 - III. Tracer wire access boxes shall be furnished with a lock-down lid and marked "Test", "TW", "Tracer", "TWAB" or other label approved by the Engineer. Markings shall allow easy differentiation between tracer wire access boxes and cathodic protection test stations.
 - IV. Minimum four (4) wire non-conductive terminal board with ¼-inch diameter stainless steel, nickel plated brass, or bronze hardware for wire terminations.
 - V. Terminal board shall not be connected to flush tracer wire access box cap or be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.
 - VI. **Acceptable 2-wire, 45-mil insulation, flush mounted tracer wire access boxes are:**
 - i. Model No. P445 DT Test 4-inch Shaft Cathodic Protection Test Boxes by Bingham and Taylor;
 - ii. Model NM-7, 5-inch inner diameter (ID) 18-inch Shaft Cathodic Protection Test Station by C.P. Test Services – Valvco, Inc;
 - iii. Model T4, 4-inch ID 18-inch Shaft Cathodic Test Stations by Handley Industries;
 - iv. Model TWAB4PT, 4-inch Tracer Wire Access Box by Drainage and Water Solutions, Inc.

- 3) For more than two tracer wires of 45-mil insulation thickness **or** two or more tracer wires, each being 100-mil or more insulation thickness, concrete tracer wire access boxes with separate terminal board shall be utilized and shall have H-10 rated concrete body with a cast iron ring and lid.
- I. The concrete tracer wire access boxes shall have a minimum weight of 55-pounds and minimum dimension of 10-inch inside diameter and shall be a minimum of 12-inches long.
 - II. Tracer wire access boxes shall be furnished with locking metallic ring extensions as required to extend to surface of pavement greater than four inches in thickness.
 - III. Tracer wire access boxes shall be furnished with a 12-pound minimum cast iron, bolt down lid marked "Test", "TW", "Tracer", "TWAB" or other label approved by the Engineer. Markings shall allow easy differentiation between tracer wire access boxes and cathodic protection test stations.

IV. Acceptable Concrete Tracer Wire Access Box Manufacturers are:

- i. Brooks Products Model 3RT Traffic Valve Box;
- ii. Christy Concrete Products Model G3 Valve Box;
- iii. Or approved equal.

V. Tracer Wire Terminal Board:

- i. Plastic or glass-reinforced, non-conductive, ¼-inch thick laminate terminal board with 3-inch by 4-inch minimum dimensions.
- ii. Terminal board shall be furnished with a minimum of four (4) terminals.
- iii. Terminal nuts and studs shall be ¼-inch with double nuts for securing the studs to the terminal board. Terminal nuts, studs, flat and lock washers shall be nickel-plated brass, bronze or Series 300 stainless steel.
- iv. Terminal board shall not be constructed in a manner that will accidentally allow wires to be shorted together through terminal board.

v. Acceptable Manufactured Terminal Boards are:

- I) CP Test NM-4 Terminal Test Board;
- II) Bingham & Taylor 4 Terminal Test Board;
- III) Flush Fink 4 Terminal Test Board;
- IV) Handley Industries 4 Terminal Test Board;
- V) Or approved equal.

Q. Insulating Joints:**1. General:**

- a) Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.
- b) No size restrictions for monolithic type insulators in buried, submerged or above grade locations.
- c) No size restrictions for insulated flange or insulated couplings in above grade or vault type locations.

2. Flange Insulating Kits for Flanges and Restrained Rod Harness Sets:**a) Gaskets:**

- 1) Low Pressure (Less than 150 psi) or Small Pipe Diameter (Less than 22-inch) - Provide full-face Type E with O-ring seal, style as recommended by manufacturer for flange face type. The 1/8-inch minimum thick flanged gasket shall be supplemented with a neoprene facing on each side to accomplish a seal. Sealing element shall be designed to seal either flat, raised face, or ring type joint (RTJ) flanges.
- 2) High Pressure (150 psi or greater) or Large Pipe Diameter (22-inch or larger) - Provide full-face Type E with O ring seal, style as recommended by manufacturer for flange face type. The 1/8-inch minimum thick flanged gasket shall be supplemented with a Nitrile (240° F maximum operating temperature) O-ring seal and a phenolic or G-10 (Pyrox) retainer facing on each side to accomplish a seal. Sealing element shall be designed to seal either flat, raised face, or RTJ flanges.

b) Insulating Sleeves: Individual full-length fiberglass reinforced epoxy, NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) or NEMA G-11 Grade material (Glass Reinforced Epoxy). Tube shall be 1/32-inch thick and extend one-half way into both of the inner steel washers next to the flange. Sleeve shall be a length sufficient to provide a small air gap between sleeve and nut when flange is tightened down in accordance with the manufacturer's recommendations.

c) Insulating Washers: Individual high-strength fiberglass reinforced epoxy NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) or NEMA G-11 Grade material (Glass Reinforced Epoxy). Size shall be 1/8-inch thick, standard SAE washer dimension.

d) Steel or Stainless Steel Washers: Plated, hot-rolled steel, Minimum 1/8-inch thick. If in area where stainless steel bolts and nuts required, provide Series 300 stainless steel materials or coated washers.

Provide two washers per bolt for flange diameters less than 36-inch diameter.

e) Flange Holes and Fasteners (Bolting):

- 1) For steel pipe flange, oversize bolt holes as recommended by insulated sleeve manufacturer. For ductile iron, provide standard bolt hole size as recommended by sleeve manufacturer.
- 2) Fasteners in accordance with AWWA C207 for steel and AWWA C110 for ductile iron and the following:
 - I. Minimum bolt length shall be a minimum 1/8-inch to 1/4-inch longer (before torquing or tightening down) than the sum of all of the materials being jointed together. This would include but not be limited to the maximum thicknesses of the mating flanges surfaces, the sealing gasket, the insulating and metal washer thicknesses, and the depth of the nut.
 - II. Provide bolts with full thread cut lengths or threaded rod as required to meet inside diameter dimension requirements of insulating sleeves. Insulated sleeves may not fit over unthreaded portions of the bolt body.
 - III. Coordinate bolt length and diameter with flange, bolt, and insulating sleeve manufacturers.
- f) Provide Single Insulating Washer Set Kits for Buried Applications.
- g) Provide Double Insulating Washer Set Kits for Above Grade Applications.

h) Acceptable Flange Insulating Kits Are Available From:

- 1) Trojan Sealing Insulating Gaskets by Advance Products and Systems, Inc., Lafayette, LA (800-335-6009), www.apsonline.com;
- 2) Type E Jock by Central Plastics Co., Shawnee, OK (800-654-3872), www.centralplastics.com;
- 3) Low Pressure Linebacker Type E Sealing Gasket and High Pressure GasketSeal Type E Sealing Gasket by GPT Industries (formerly Pacific Seal and Insulator, Inc. (PSI) and Pikotek) Houston, TX (800-423-2410), www.gptindustries.com;
- 4) Or approved equal.

3. Flexible Insulated Couplings:

- a) Insulating Couplings shall meet AWWA C219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe. The coupling type, size, and clearance shall be style intended by coupling manufacturer to be utilized with two insulating boots (sleeves, bands, etc.) with a small lip that fits over pipe end to keep pipe separated.

Insulated couplings shall be factory provided by coupling manufacturer and not be made with field conversion kits.

- b) Coupling Coating and Linings: Insulated fittings shall be steel and externally coated and lined with factory epoxy coating internally and externally in accordance with AWWA C210, AWWA C213, or AWWA C550.
- 1) Minimum surface preparation shall be white metal blast (SSPC SP-5) for internal surfaces and near white blast (SSPC SP-10) or better for external surfaces.
 - 2) Liquid epoxy coating shall be a minimum of two coats for 14 MDFT.
 - 3) Fusion-bonded epoxy coating shall be a minimum of 10 MDFT.
 - 4) Provide repair kits for epoxy-coated materials.
 - 5) Provide a manufacturing affidavit or certification that all coating furnished complies with AWWA standards and that all AWWA standard's inspection and tests have been completed.
- c) Buried, submerged, or immersed insulating couplings bolts, nuts, and washers shall either be Series 300 stainless steel or fusion-bonded steel coupling bolts, nuts, and washers per requirements of this specification. CorTen® bolts are not acceptable for buried, submerged, or immersed fitting or piping locations.
- d) Insulating boots shall be type and thickness as recommended by coupling manufacturer for intended service including products carried and pipe temperature. The insulating boots shall be factory fabricated and provided by coupling manufacturer. Insulating boots shall be size and type that do not interfere with correct installation and operation of the coupling.
- 1) Two insulating boots shall be provided for each coupling. Insulating boot shall be one-piece type and have an insulating shape with a lip or edge that fits over the end of the pipe. Boot shall be long enough to extend past end of coupling assembly body and be visible when coupling is assembled.
 - 2) Insulating boot material shall be neoprene, nitrile, or EPDM or approved equal per coupling manufacturer's recommendation depending on pipe size and type of service.
 - 3) **Minimum Insulating Boot Thickness Shall Be:**

1/8-inch for pipe up to 60-inch size.
- e) Insulated couplings at restrained joints shall be provided with the necessary supplemental insulated restrained joint harness assemblies as described below.
- 1) The use of field conversion kits will not be allowed except to insulate the restrained joint harness assembly.
 - 2) Insulated Flexible Coupling Restrained Harness Assembly: Where shown on the Drawings and/or as required and specified provide insulated restraint/harness assembly at insulated couplings on metallic pipelines. Harness bolts shall be of

sufficient length, with harness lugs placed so that coupling can be slipped at least in one direction to clear joint.

- 3) Provide an insulating flange conversion kit consisting of individual one-piece flange insulating sleeves and insulating washers to electrically isolate restraint harnessing assembly on both ends of harness rod.
 - I. Insulating sleeves shall be individual full-length 1/32-inch thick fiberglass reinforced epoxy, NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) sleeves of sufficient length to extend completely through harness lug assembly.
 - II. Insulating washers shall be 1/8-inch thick individual high-strength fiberglass reinforced epoxy NEMA G-10 Grade material (Glass Reinforced Epoxy, Pyrox) with a metallic washer at standard SAE washer dimension.
 - III. **Acceptable Products:**
 - i. G-10 One-Piece Sleeve and Washer from PSI;
 - ii. Or approved equal.
- 4) Harness lugs and harness bolts shall be sized as required to allow easy installation of insulating sleeves.
 - I. Harness assembly rods and bolts shall be stainless steel (Series 300) for buried or submerged locations, fusion-bonded epoxy coated for dry above grade conditions.
 - II. Individual rods or entire assemble shall be heat shrink coated, coated with a 100-percent moisture cure epoxy repair coating at 20-mil thickness.
 - III. Petrolatum tape coated after assembly and insulator testing.
 - IV. Bitumastic type coatings are not an acceptable option for coating of restraining rods.
- f) Insulating Flexible Couplings shall be F x E Type 1 insulated style that is electrically insulating type with two insulated boots (or bands) to be installed on the pipe under the coupling. **Acceptable insulating flexible couplings are:**
 - 1) Dresser Style 39 by Dresser Industries, Inc., Bradford, PA (814-368-3131);
 - 2) Style 416 by Smith-Blair, Inc., Texarkana, AR (501-773-5127);
 - 3) Depend-O-Lok by Victaulic, Inc., Atlanta, GA (800-841-6624);
 - 4) Series 200 couplings by Baker Coupling Company, Los Angeles, CA (323-583-3444);
 - 5) Or approved equal.

- g) All buried or submerged flexible coupling fasteners shall be Series 300 stainless steel.

4. Copper Service Line Insulators:

- a) Insulated service fittings shall consist of brass union body that encapsulates a nylon insulator specially designed to provide electrical isolation for this type of intended use:

Insulated corporation ball valves, insulated curb ball valves, and service line insulators shall be provided to insulate copper or metallic service lines.

- b) Acceptable service line insulators are available from:

- 1) Mueller Co., Decatur, IL (800-423-1323);

- 2) Or approved equal.

- c) Consult manufacturer for model number and installation procedures for each application.

R. Insulating Floor And Wall Sleeves And Modular Seals:

- 1. **Wall Sleeves:** Pipe wall sleeves or cored openings shall be provided at all wall and floor locations in accordance with pipe and sleeve manufacturer's recommendations.

- a) The pipe wall sleeves shall be of sufficient thickness to resist any deformation. The pipe wall sleeves shall be round with a maximum plus or minus (+/-) 1/8-inch variation in diameter allowed. The wall sleeve shall be a minimum wall thickness of 0.375-inch or standard wall thickness. The minimum width of the wall sleeve shall be per the modular seal manufacturer's recommendations to meet minimum width requirements based on seal type and pipe diameter and weight.

- b) Pipe wall sleeves shall be provided with a minimum 3-inch water stop collar that evenly contacts the wall or floor opening all the way around for a minimum length of 1-inch or more if recommended by the sleeve manufacturer. The water stop (collar) shall be of the same type of material as the wall sleeve. The wall sleeve shall have a smooth continuous weld with no welding slag or rough or high welds. The water stop collar shall be continuously welded on both sides of the collar for the entire circumference of the wall sleeve.

- c) The wall sleeve and the water stop collar shall be positioned such that it is located in the center of the structure wall or floor, when the wall sleeve is positioned in place. Steel wall sleeves and water stop collars shall be coated. The wall or floor penetration diameter and width shall be sized sufficiently to allow correct installation of the wall sleeve and water stop.

- d) Wall penetrations and wall sleeves types and sizes shall be coordinated with sleeve manufacturer, modular seal manufacturer, and pipe manufacturer to provide proper type of opening to provide a liquid tight connection.

- e) Wall pipe sleeves placed around pipe and grouted in place in accordance with sleeve and pipe manufacturer's recommendations are an acceptable method of wall openings.
 - f) Coordinate wall sleeve type, model, size, and location with modular seal and pipe manufacturers.
 - g) Prefabricated Coated Steel Pipe Wall Sleeves shall be pre-primed or coated minimum Schedule 40 wall thickness with standard 12-inch length, centered type with a minimum 3-inch water stop sized to fit pipe size.
 - 1) Depending on location, wall size, and pipe size prefabricated steel pipe wall sleeves are available from:
 - I. Model WS Steel Wall Sleeves (coated steel with a welded water stop) by GPT Industries (formerly PSI), Houston, TX (800-423-2410);
 - II. Model SWS (primed steel with a welded water stop), or Model GWS (steel with a welded water stop and Galvo-Plast coating) by Advance Products and Systems, Inc., Lafayette, LA (800-335-6009);
 - III. Or approved equal.
 - 2) Consult manufacturer for specific model required.
- 2. Insulating Wall or Floor Modular Seals:** Insulating wall and floor seals shall be adjustable modular mechanical type seals able to provide a positive seal (liquid tight) and long lasting electrical insulation for wall or floor penetrations for pressures up to 40 feet of static head. Coordinate with and provide pipe and modular seal manufacturer's recommended modular seal type and size for pipe type, pipe diameter, casing or hole opening size, environmental exposure, operating temperature, and intended installation conditions.
- a) The modular seals shall consist of synthetic rubber-bolted links, heavy duty reinforced high density nylon polymer plastic pressure plates, and Type 316 stainless steel hardware (bolts, nuts, washers, etc.) for adjustment. The modular seals shall be manufactured at a plant with a current International Organization for Standardization (ISO) ISO-9001 registration which shall be included as part of the submittal.
 - b) The rubber links shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the opening. The individual links shall be colored and permanently identified with the manufacturer's name and model number. The link shall be sized per the manufacturer's recommendations. The links shall have the following properties per ASTM standards for standard type applications (minus 40 degrees Fahrenheit to positive 250 degrees Fahrenheit), (-40° F to 250° F) Model C EPDM = ASTM D2000 M3 BA510 Black.
 - c) The pressure plates shall be molded glass reinforced nylon polymer with an integrally molded compression assist boss on pressure plated top side (bolt entry side). The pressure plate shall incorporate an integral recess ("Hex Nut Interlock") to accommodate commercially available fasteners. The individual pressure plates shall

be colored and permanently identified with the manufacturer's name. The pressure plate shall be sized per the manufacturer's recommendations. The links shall have the following properties per ASTM standards for standard type applications:

- 1) ASTM D-256 Izod Impact = Minimum 2.05 foot-pound/inch
 - 2) ASTM D-790 Flexure Strength at Yield = Minimum 30,750 PSI
 - 3) ASTM D-790 Flexure Modulus = Minimum 1,124,000 PSI
 - 4) ASTM D-638 Elongation Break = Minimum 11.07%
 - 5) ASTM D-792 Specific Gravity = Minimum 1.38
- d) The modular seal hardware shall be sized according to the seal manufacturer's recommendations depending on the size and type of modular seal. The 316 Stainless Steel hardware shall have the following properties per ASTM standards for standard type applications including ASTM F593 with an average tensile strength of a minimum 85,000 PSI.
- e) **Modular Wall Seals:** Acceptable modular wall seal insulators for pipe diameters equal to or smaller than 24-inch diameter are:
- 1) Thunderline Link-Seal Model LS-300 or LS-400 by GPT Industries Houston, TX (713-747-6948);
 - 2) Pipe Linx by Calpico, Inc. South San Francisco, CA (650-588-2241);
 - 3) Innerlynx by Advance Products and Systems, Inc., Lafayette, LA (800-315-6009);
 - 4) Or approved equal.
- f) Wall sleeves passing through walls of structures containing liquids shall be provided with double sets of modular wall seals to provide pipe support at the penetration and protection against leakage.

S. Coating And Lining For Fittings, Incidental Piping And Valves:

1. Supply incidental pipe, valves, fire hydrants and fittings with linings and coatings of the same type as adjacent pipe, except where shown on the Drawings. Coat incidental pipe and fittings installed as specified in this specification section.
2. Coat and line all buried metallic (steel, ductile iron, and cast iron) valves, fittings, miscellaneous piping, and hydrants internally and externally. Supply factory coated valves and fittings with linings and coatings of the same type as adjacent above grade pipe, except where shown on the Drawings or where coating or lining specified for buried main pipeline is not feasible for fabricated items or special pipe pieces (such as incidental metallic piping, valves, fittings, tees, flexible couplings, glands, hydrants, etc.).
 - a) Internal linings and coatings exposed to water shall be NSF approved for potable water service.

- b) Minimum surface preparation shall be white metal blast (SSPC SP-5) for internal surfaces and near white blast (SSPC SP-10) or better for external surfaces.
- c) Provide tight bonded coating and lining of pipe and fitting joints at maximum thicknesses shall be as recommended by the pipe or fitting manufacturer and shall not impair engagement of pipe or fitting joint or function of fitting.
- d) All ferrous interior mounting faces/surfaces shall be prepared and shop primed with a suitable rust-inhibitive holding primer applied in accordance with this specification and the coating manufacturer's recommendations. Holding rust-inhibitive primer shall be compatible with specified top coats. Apply per coating manufacturer's recommendations to a thickness that will not impair the clearances required for proper installation of the joint or fitting (valve, coupling, flange, etc.) operation.
- e) Valve bolts, nuts, and washers, (including in valve bonnet and stuffing) box) shall be Series 300 stainless steel.

3. Ductile Iron and Cast Iron Factory Coating Surface Preparation:

- a) Use Society for Protective Coatings (SSPC) SP grades as surface preparation guide only as it applies to cast iron or ductile iron in percentage cleanliness required and surface contaminants removed, not the color of the metal.
 - b) The abrasive blast cleaning operation shall remove the same percentage of all surface contaminants (including tightly adhered annealing scale) as the SSPC SP grade referenced.
 - c) The entire surface area shall be abrasive blasted. No tight rust stains shall be allowed.
 - d) Avoid overblasting, high nozzle velocities, and excessive blast times.
 - e) Cast iron and ductile iron attain a gray color when abrasive blasted due to the higher carbon content compared to steel.
 - f) SSPC SP-10 Near White Grade is specified for cast iron or ductile iron, the degree of surface cleanliness is comparable to a near white blast for steel and requires 95 percent removal of all surface contaminants including tightly adhered annealing scale. Ductile or cast iron will not be required to be near-white but will only be required to be a near-gray color.
4. At Contractor's option, factory coat or line the incidental piping, valves, or fittings with liquid epoxy or with fusion-bonded epoxy coating in accordance with these specifications and AWWA C210, AWWA C213, AWWA C116, or AWWA C550. Coating shall meet all AWWA standard requirements and tests and this specification section.

5. Liquid Epoxy:

- a) Provide factory applied liquid epoxy lining and coating in accordance with AWWA C210 and AWWA C550 and these specifications. Epoxy material shall meet the performance requirements of the referenced AWWA standards. Epoxy material shall

be the product of a coating manufacturer normally engaged in production of such material and shall be for intended service conditions.

- b) Coating in contact with potable water shall conform to NSF Standard 61.
- c) The liquid epoxy coating shall be a two part chemically cured coating or 100-percent material. Coating shall be mixed and applied per coating manufacturer's directions. Liquid-epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
- d) Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
- e) Coating shall be a minimum of two or more coat system with a minimum thickness of 14 MDFT.
- f) Minimum adhesion to prepared steel shall be 400 psi per ASTM D1002 or per coating manufacturer's printed literature, whichever is higher.
- g) Acceptable liquid epoxy materials for linings in contact with potable water or buried-service metallic fittings, valves, etc. are:
 - 1) Carboguard as manufactured by Carboline®;
 - 2) DeVoe Bar-Rust 233H as manufactured by AkzoNobel;
 - 3) SherPlate PW Epoxy B62 as manufactured by Sherwin-Williams;
 - 4) PotaPox Plus Series N140 or L140 manufactured by Tnemec;
 - 5) Or approved equal.
- h) Acceptable liquid epoxy materials for above grade structures are:
 - 1) Carbothane 133 LH as manufactured by Carboline®;
 - 2) Devthane 379 UVA Polyurethane Enamel as manufactured by AkzoNobel;
 - 3) Endura-Shield II series 1074U Aliphatic Acrylic Polyurethane as manufactured by Tnemec;
 - 4) Or approved equal.
- i) Finish for above grade structures shall be high gloss with color selected by the Owner for the intended service.

6. Fusion-Bonded Epoxy:

- a) Provide factory applied fusion-bonded epoxy lining and coating in accordance with AWWA C213, AWWA C116, and AWWA C550, and these specifications.
 - b) Fusion-bonded epoxy material shall meet the performance requirements of the referenced AWWA standards.
 - c) Coating in contact with potable water shall conform to NSF Standard 61.
 - d) Fusion-bonded epoxy material shall be the product of a coating manufacturer normally engaged in production of such resin and shall be for intended service conditions.
 - e) The fusion-bonded epoxy coating shall be a 100-percent powder epoxy based thermosetting coating. Coating shall be applied by flocking, fluidized bed, or electrostatic method per coating manufacturer's directions.
 - f) Fusion-bonded epoxy lining of metallic pipe and fittings shall be potable grade epoxy coating approved for potable water contact and this type of intended service.
 - g) Abrasive blast with material and in manner as recommended by coating manufacturer to produce surface profile depth and angular shape needed. Surface preparation shall be a minimum of SSPC SP-5 (White) for immersion service and SSPC SP10 (Near White) or better for external service.
 - h) Fusion-bonded epoxy coating shall be one or two-coat system with a minimum thickness of 8 MDFT.
 - i) Minimum adhesion to prepared steel shall be 3,000 psi per ASTM D1002 or per coating manufacturer's printed literature, whichever is higher.
 - j) Acceptable fusion-bonded epoxy materials are listed below:
 - 1) Scotchkote 206N, 323 or 162 as manufactured by 3M™;
 - 2) Nap-Gard® 7-2500 pipe coating as manufactured by Axalta Coating Systems;
 - 3) Nap-Gard 7-4500 (CV Red FBE) for valves and fittings as manufactured by Axalta Coating Systems;
 - 4) Or approved equal.
7. Conduct dry film thickness measurements and 100-percent holiday inspection of all factory epoxy-coated items prior to shipment.
- a) Conduct dry film thickness measurements in accordance with SSPC PA-2 with exception that the specified thickness is the absolute minimum.
 - b) A minimum of two dry film thickness measurements shall be completed for each fitting or appurtenance.

- c) Repair all defects with approved repair material according to original coating manufacturer's directions prior to shipment.
8. Provide field repair kits for all types of coated materials.
9. Provide exterior coating for all above-grade piping, fittings, and vent pipes with two coats of polyamide epoxy coats at a minimum 2.5 MDFT per coat (MDFTPC) and with one top coat of polyurethane enamel at a minimum 3 MDFT or with a minimum 10 MDFT fusion-bonded epoxy coating system. Minimum surface preparation shall be near-white metal blast (SSPC SP-10) for external surfaces. Color specified by Engineer.
Hot dipped galvanized or plastic (PVC) type vent pipes do not require epoxy/polyurethane coating system.
10. Coating for valves, adapters, fittings and fire hydrant legs shall consist of one of the following:
- a) Liquid epoxy coating shall be a minimum of two coats or more for a minimum 14 MDFT coating thickness.
 - b) Fusion-bonded epoxy coating shall be one or more coats for a minimum coating thickness of 8 MDFT.
 - c) Nylon coating shall be one or more coats for a minimum coating thickness of 10 MDFT applied in a fluidized bed.
 - d) Polyurethane coating shall be a minimum 40 MDFT for ductile iron valves and fire hydrant legs and stub pieces (American AVK fusion-bonded epoxy interior with polyurethane coated exterior or approved equal).
 - e) Maximum coating thickness shall be as recommended by fitting manufacturer to not impair engagement of joint or function of fitting.
11. Provide a manufacturing affidavit for all factory epoxy coated or stainless steel items that list:
- a) Applicator of coating including name, address, phone number and date of Application.
 - b) Coating Material Manufacturer and Product Designation with a product data sheet.
 - c) Certification that all coating furnished complies with AWWA standards and these specification requirements and that all AWWA standard's inspection and tests have been completed and were met.
 - d) Certification that stainless steel items are provided as specified including name of stainless steel manufacturer and Series 300 grade provided.
- 12. Restraint Fitting Coating System:**
- a) Restrained fittings (casting bodies, wedge assemblies, and related parts, etc.) shall be abrasive blasted followed by a phosphate wash, rinse, and drying pretreatment process just prior to coating.

- b)** Restrained fittings (casting bodies, etc.) shall be coated immediately following the pretreatment process. The coatings shall be electrostatically applied and heat cured. Acceptable casting body coating systems shall consist of:
- 1)** A sealer prior to pretreatment drying and two coats of a thermosetting powder coating at minimum 3 to 6 MDFT.
 - 2)** Acceptable TGIC polyester powder coatings for restrained fittings (casting bodies) are:
 - I.** EBAA Iron Mega-Bond Restraint Coating System;
 - II.** Star-Bond Coating System;
 - III.** Or approved equal.
 - 3)** A fusion-bonded epoxy coating at a minimum 8 MDFT, Romac Industries Romacote Corvel Black;
 - 4)** A nylon coating system at minimum 10 MDFT Romac Industries Romac Nylon Coating;
 - 5)** Or approved equal.
- c)** Wedge assemblies and related parts shall be coated immediately following the pretreatment process with an approved coating system consisting of either:
- 1)** A thermoplastic flouropolymer type fastener coating specifically designed for that type of application at a minimum 1 to 2 MDFT.
 - 2)** The thermoplastic flouropolymer coating system shall consist of two or more coats of liquid thermoset epoxy coating with heat cure following each coat.
 - 3)** Acceptable flouropolymer coatings for the wedges and wedge actuators are:
 - I.** EBAA Iron Mega-Bond Restraint Coating System;
 - II.** Star-Bond Coating System;
 - III.** Or approved equal.
- 13.** A fusion-bonded coating system consisting of one or more coats of fusion-bonded epoxy electrostatically applied and heat cured following each coat with a total fusion-bonded epoxy coating system minimum thickness of 6 MDFT.
- 14.** Provide stainless steel materials or coat all other miscellaneous buried metallic items, (tie rods, thrust restraints, tapping saddles, harnesses, etc.). Coat tie rods and rebar when directly exposed to soil. Provide with factory applied epoxy coating, fusion-bonded epoxy coating, heat shrink sleeves, or with coating recommended by coating manufacturer for buried application and approved by the Engineer for intended exposure.

15. Bolts, nuts, and washers, for valves (including in valve bonnet and stuffing box) shall be Series 300 stainless steel.
16. Galvanized or black steel materials (piping, nipples, unions, fittings etc.) shall not be used in wet, immersed, or buried locations or vaults unless tight-bonded coated as specified.

T. Fasteners (Bolts, Nuts, Washers, Etc.):

1. All fasteners (bolts, nuts, tee bolts, and washers) type, size, and strength shall conform to this specification unless other design information is provided in the plans or detailed specifications. All nuts shall be fully seated. Nuts shall be compatible with the bolts and have a proof stress equal or greater than the tensile strength of the bolts. Minimum bolt size, lengths, and tensile shall be as designed for the application.
2. Coated fasteners (bolts, nuts, tee bolts, and washers) are allowed. Coated fasteners shall meet the following requirements:
 - a) Coated bolts shall be undersized or the nuts oversized as required to minimize damage to coatings, however, size shall still satisfy design and manufacturer's requirements for bolt strength and size in the particular application. Provide with applicator name, coating manufacturer and product number, and certification that coating was applied as specified.
 - b) Coated bolts, nuts, and washers for ductile iron pipe and fittings shall be low carbon weathering steel meeting the strength, physical, marking, traceability, and chemical requirements of AWWA C111 and coated with an approved fastener coating system.
 - c) Bolts, washers, nuts, and T-bolts shall be pretreated and coated with a thermosetting powder coating or fusion-bonded epoxy type fastener coating system.
 - 1) Thermosetting powder coatings shall be at a minimum 1 MDFT with Xylan, Type E, Flour Kote #1, or thermoplastic fluoropolymer type fastener coatings specifically designed for that type of application.
 - 2) Fusion-bonded coated steel bolts, nuts, and washers, fittings, and bodies shall be coated with a minimum 6 MDFT epoxy coating per AWWA C213. Surface preparation shall be SSPC SP-10 (near white).
3. **Stainless Steel Fasteners (bolts, nuts, T-bolts, washers, etc.):**
 - a) Stainless steel bolts, tee bolts, nuts, and washers shall be Series 304 or Series 316 for the specific environment of use.
 - b) Stainless steel bolts and nuts shall be provided with an anti-galling lubricating compound or coated with a 1-mil fluoropolymer or equal fastener coating system to aid in preventing galling.
4. CorTen® bolts are not acceptable for buried, submerged, or immersed fitting or piping locations.

5. Bolts and nuts shall be adequately labeled to provide traceability of the material and producer.
 - a) The identification mark shall be cast, forged or stamped on the bolt and nut. Painted markings are not acceptable.
 - b) The bolt and nut manufacturer shall provide information on the type of material provided and corresponding identification mark, and country of origin.
 - c) Markings and traceability requirements shall be in accordance with the Industrial Fasteners Institute and AWWA C111.
6. All bolts and nuts shall be installed according to manufacturer's requirements including the use of anti-galling lubricant compound or use of a thermosetting fluoropolymer type coating for stainless steel materials.

If galling or seizing of the nut and bolt occurs they shall be cut off and replaced with a new nut and bolt.

U. Stainless Steel Fabrication And Passivation:

1. Utilize Type L grade stainless steel for all items to be welded.
2. During fabrication, handling, and installation take necessary precautions to prevent mild carbon steel impregnation of stainless steel members.
3. Utilize brushes (stainless steel, non-metallic), grinding wheels (aluminum oxide discs), and tools intended for stainless steel and not used previously for carbon steel work.
4. Degrease and clean prior to welding with non-chlorinated solvents.
5. Weld stainless steel with approved materials and techniques.
6. Clean and remove contamination, remove weld heat tint, and repassivate welds per ASTM A380 and ASTM A967.
7. After treatment, visually inspect surfaces for compliance.
8. Pack stainless steel parts and pad mild steel fork lift forks and use straps instead of metal chains to handle stainless steel parts to avoid iron contamination of stainless steel.
9. After installation, visually inspect stainless steel surfaces for evidence of iron cross contamination, rust, oil, paint, and other forms of contamination. Repair as required and re-inspect.

V. Pipe And Fitting Field Coating Repair Materials:

1. Field repair incidental pipe and fitting coatings and linings in accordance with this specification section.

2. Field repair coating shall be compatible with factory coating and linings and be approved by factory coating manufacturer for repair on their products.
3. **Field Coating Repair Materials:**
 - a) **Heat Shrink Sleeve and Sleeve Repair Materials:** Heat shrink sleeve repair materials shall consist of either heat shrink sleeve in tube form or heat shrink patch kit depending on size and shape of repair. Acceptable heat shrink products are:
 - 1) Covalence WaterWrap sleeve or PERP Repair Patch Kit available from Protection Engineering, Pittsburg, CA;
 - 2) CANUSA Aqua-Shield Aqua-Sleeve or CANUSA CRPK Repair Patch Kit available from CANUSA, Inc., Houston, TX;
 - 3) Or approved equal.
 - b) **Tape:** Cold-applied field repair polyethylene repair type coatings shall consist of suitable primer and minimum 35-mil thick patch/repair/joint tape with aggressive adhesive and release liner, 4-inch or 6-inch width. Suitable primer shall be provided with the repair coatings as recommended by the repair-coating manufacturer. Acceptable products are:
 - 1) Tapecoat H35 Gray by The TAPECOAT Company, Evanston, IL;
 - 2) Polyken 1027 primer and Polyken 934-35 tape by Tyco Adhesive (Polyken Kendall) Mansfield, MA;
 - 3) Tek-Rap 200-23 Series primer and Tek-Rap 280 tape by Tek-Rap, Inc., Houston, TX;
 - 4) Or approved equal.
 - c) **Epoxy Repair Coatings:** Provide 100-percent epoxy coatings that can cure under wet or dry conditions. Acceptable products are:
 - 1) A 788 Splash Zone Compound by Koppers, Pittsburgh, PA;
 - 2) Aquata Poxy A-6 by Raven (King Adhesive Corporation), St. Louis, MO;
 - 3) Protal 7125 Repair Coating by Denso North America;
 - 4) Tnemec FC 22 Epoxoline by Tnemec Company Incorporated, Kansas City, MO;
 - 5) HBE-95 WG High Build Epoxy, CANUSA-CPS, Inc., Houston, TX;
 - 6) Or approved equal.
 - d) Four-layer petrolatum wax-tape system (AWWA C-217) intended for burial conditions.

- 1) Completed buried system shall consist of a minimum four-layer system consisting of a primer, mastic filler, petrolatum wax tape and an outerwrap.
- 2) Acceptable petrolatum coating systems are:
 - I. Denso Pipe and Fittings Petrolatum System by Denso Products, Houston, TX;
 - II. No. 1 Wax-tape Coating Systems for buried locations by The Trenton Corporation, Ann Arbor, MI;
 - III. No. 2 Wax-tape Coating Systems for above grade and vault applications by The Trenton Corporation, Ann Arbor, MI;
 - IV. Or approved equal.

W. Corrosion Test Equipment: Obtain and furnish the following equipment and materials for corrosion and tracer wire functional testing. Arrange and have test equipment at project site before construction begins:

1. One Heavy Duty, Digital Multimeter, with case and test leads. Instrument shall be suitable for field conditions, be sealed to meet IP 67 waterproof and dust conditions, meet CAT IV minimum 600-volt rating, and comply with IEC and ANSI electrical safety standards. Acceptable digital multimeters are:
 - a) Model No. 27 II or Fluke 28 II by John Fluke Mfg. Co., Inc. Everett, WA;
 - b) Amprobe Model HD-160C by Amprobe Test Tools (formerly Wavetek Instruments, Beckman) Everett, WA;
 - c) Or approved equal.
2. Two copper-copper sulfate reference electrodes with cone shaped tip:
 - a) Model 6B by Tinker and Rasor, San Gabriel, CA;
 - b) Model RE-5C by M C MILLER Co., Vero Beach, FL;
 - c) Or approved equal.
3. One 32-oz. bottle of Copper-Copper Sulfate Anti-Freeze Solution as manufactured by Tinker and Rasor, San Gabriel, CA; M C MILLER Co., Vero Beach, FL; or approved equal.
4. One $\frac{3}{4}$ -pound bottle of Copper-Copper Sulfate Crystals as manufactured by Tinker and Rasor, San Gabriel, CA; M C MILLER Co., Vero Beach, FL; or approved equal.

The test equipment shall be stored at the project site and shall be maintained in accurate, working condition. The test equipment shall be available to Engineer and Owner for testing purposes.

- X. Manufacturer's Certifications:** Manufacturer's certifications of materials and installation are provided at the end of this specification section. Attachments A, B and C shall be completed and submitted as outlined in the attachments.

8B.3 EXECUTION

A. General:

1. All materials and equipment associated with pipe connecting wires, joint bonding, test stations, reference electrodes, galvanic anodes, insulating joints, and casing insulators as shown and specified herein shall be furnished and installed by the Contractor.
2. Coordinate installation of the specified work as necessary such that installation of the items herein specified can be completed concurrently with pipeline installation. Test leads shall be installed only during pipe installation. Items not installed before backfilling of the pipe shall be installed at the Contractor's sole expense. Additional excavation of pipe after backfilling shall be minimized to protect pipe and coating from possible damage. Galvanic anodes shall be only installed at the same time as metallic fitting installations are being constructed.
3. Nothing included or omitted in this specification shall relieve the Contractor of the obligation of providing a complete and satisfactory pipeline that is electrically continuous, electrically isolated, and provided with a functioning cathodic protection system with test stations as specified.
4. **Weather Conditions:**
 - a) Installation of the corrosion protection system components, such as splices, bonds, and wire installation shall only be allowed when ambient temperature are above ten degrees (10°) F (-12° C.) and rising to minimize wire and insulation damage.
 - b) Materials shall be stored in covered and heated storage units to maintain minimum temperatures above restricted minimum temperatures stipulated by material manufacturer.
5. Do not thermite (exothermic) weld, pin braze, weld, or utilize open flame or torches in areas of flammable vapors or air borne particles, where a fire or explosion could result.
6. Install and work around above grade and buried AC powerlines and gas pipelines with extreme care, follow minimum separation distances per foreign company requirements and regulations. Do not work next to powerlines during times of high lightning activity.
7. Installations shall be completed per the National Electrical Code (NEC), and as specified in this section.

B. Material Storage and Handling:

1. Store materials in secure, protected location in accordance with material manufacturer's recommendations. Store thermite weld materials, reference electrodes and prepackaged galvanic anodes off the ground and keep them dry at all times.

2. Equipment or materials damaged in shipment or in the course of installation shall be replaced. Immediately remove from site all mechanically damaged materials.
3. Prepackaged corrosion control items shall be handled with care to prevent loss of backfill material. Do not lift, lower, or hold anodes and reference electrodes by the lead wire.
4. Do not allow reference electrodes to freeze. Store in protected area, off the ground. Utilize before expiration of shelf life.

C. Pipe Joint and Fitting Bonding:

1. To form an electrically continuous pipeline and associated appurtenances, the joints of all buried metallic pipe, vault, and manhole piping and all appurtenances, adapters, tees, elbows, restrained joints, valves, and fittings including hydrant and blow-off piping shall be electrically joint bonded. All joints including all bolted and restrained joints shall be joint bonded, except those joints specified to be threaded, welded, or insulated. Blow off and hydrant pipe and fittings shall also be bonded. **DO NOT bond across insulating joints.**
2. Various components of metallic fittings (thrust restraint devices, follower rings or glands, etc.) on plastic or ductile iron pipelines shall be bonded together to provide an electrically continuous fitting or appurtenance.
3. Place metallic fitting bond wires on top quadrant of pipe or fitting to bolt pattern area or where flange edges are to minimize damage to internal coating or joint materials. Bonding can be completed above grade prior to fitting assembly.
4. Wire connections to pipes or fittings shall be as specified under WIRE CONNECTIONS.
5. Install one insulated joint bond wire or bond strap per joint on all pipe or fittings 10-inches in diameter or smaller. Install a minimum of two or more insulated joint bond wires per joint on all pipe or fittings 12-inches in diameter or larger for redundancy.
6. Bond wire size may be No. 4 AWG on pipe sizes equal to or smaller than 15-inch diameter. Place bond wires on top quadrant of pipe.
7. Factory Coated or Tape Coated Pipe Joints: Use insulated stranded copper joint bond wires or insulated copper strap bonds for bell and spigot locations where heat shrink sleeves are not used.

Use insulated stranded copper joint bond wires or insulated strap bonds for all other locations where joints or fittings are already coated such as for factory coated bolted fittings, where a heat shrink sleeve is not specified.

8. Bond bolted restrained type joints, multiple segmented fitting sections, and metallic gland connection pieces on fittings on plastic pipe, and metallic pipe into cathodic protected metallic fittings or pipe with single No. 12 AWG stranded insulated copper wires with sleeves. Length of pigtail bond wire as required. Bond across the joint with the specified number and larger sized bonds listed above based on pipe size and material.

9. Joint bonding of cast iron soil pipe is not required unless specifically shown on Drawings. Joint bonds for cast iron soil pipe and fittings and high silicon cast iron pipe and fittings shall be in accordance with the manufacturer's recommendations.
10. Bronze wedges, restrained joints, bolted or compression sleeved wires or copper straps, thrust restraints, or welded "Z" bars are **NOT** acceptable methods of achieving electrical continuity.

D. Wire Connections:

1. The electrical connection of copper wire or copper strap to metallic (steel, cast iron, and ductile iron) surfaces shall be by the thermite weld method. Prepare surface and make connections in accordance with the thermite weld manufacturer's recommended procedures and these specifications, which ever one is more stringent.
2. Provide adequate ventilation and safety equipment (gloves, safety glasses, etc.) and follow safety and training requirements as recommended by the thermite weld material manufacturer. Avoid contact with hot materials. Remove or protect fire hazards in the area during the thermite welding operations.
3. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way. Do not use on Cast Iron Soil Pipe (ASTM 74-93).
4. Complete thermite or pin brazing weld connections at locations and in a manner that does not damage sealing materials, gaskets, plastic pipe, and/or coatings, and/or polyethylene encasement. Maintain minimum 2-inch separation from pipe O-ring gasket in accordance with the pipe or fitting manufacturer recommendations.
5. Complete thermite weld wire connections on horizontal surfaces, if at all possible. Thermite weld connections to vertical surfaces should be minimized and only completed if approved by the Engineer. Conduct horizontal type thermite weld wire connections to fire hydrant risers and pipe stubs in horizontal positions above grade prior to installation in excavations. Pin brazing type connections can be completed in horizontal or vertical positions.
6. All connections to stainless steel materials, copper, and light wall steel tubing (0.035-inch or less), shall be either with a silver soldered connection (silver brazing) or a physical type connection.
7. Connections to stainless steel fittings and appurtenances can be made with a ring tongue terminal placed under a bolt or a soldered connection as approved by the Engineer. Thermite weld connections to stainless steel are NOT allowed.
8. **Exothermic Thermite Weld Method:**
 - a) The Contractor is responsible for repair of any damage to pipe, fitting, lining, or coating that is a result of the thermite weld process.
 - b) Make thermite weld connections at locations that will not damage pipe gasket or internal linings exposed to liquid.

- c) The electrical quality and resistance of the connection is dependent on proper adhesion of the welded connection to the pipe or fitting surface. Observe proper thermite weld material selection, safety precautions, surface preparation, and welding procedures as recommended by the material manufacturer.
- d) Use cast iron type charges for all cast iron and ductile iron pipe and fitting thermite weld connections. Use steel type charges for all steel pipe and fitting thermite weld connections. Utilize correct sized mold (as shown on metal tag on graphite mold) based on wire and pipe or fitting size and type. Utilize correct type and size of charges for each connection based on wire and pipe or fitting size and type. Cartridge charge type and size in grams is shown on box and charge tube.
- e) The wire and cable to be exothermically welded shall be clean, bright, and dry. Clean all wire that is contaminated with oil and grease in accordance with the thermite weld manufacturer's recommendations. Remove all corroded cable including the individual strands.
- f) Before the connection is made, clean the surface to bare metal by making a two-inch (2-inch) by two-inch (2-inch) window in the coating, and then filing or grinding the surface with a grinding wheel to produce a bright (white) metal finish.
- g) All power grinding shall be with a vitrified type-grinding wheel. The use of resin, rubber, or shellac-impregnated type grinding wheels is not recommended by the thermite weld manufacturer and will not be acceptable.
- h) Contractor shall take appropriate actions for existing coatings with asbestos to minimize worker exposure and to contain, handle, and dispose of asbestos per regulations.
- i) After the surface is cleaned to a smooth, white metal finish, lightly tap the pipe surface with a sharp tool (back of claw hammer or metal chisel edge, etc.) to produce dimples to improve surface profile and adhesion for the weld material.
- j) In certain high humidity conditions, cold weather, or on cold or wet surfaces, preheating of the metal surface and/or molds may be required to improve successful connections and minimize porous welds.
- k) Exothermic welding should be completed immediately following preparation of the metal surface before surface flash rusting or oxidation can occur.
- l) Where specified, wire sleeves shall be firmly attached to the end of the wire before thermite welding to the metal surface. Wire and sleeve shall be clean and dry. Wire shall extend 1/4-inch out of field formed sleeves. Factory formed sleeves shall be provided with end of sleeve beveled or angled so that wire is exposed to thermite weld material.
- m) Utilize exothermic weld packing compound around mold as required on irregular or small weld surface areas to seal bottom of welder mold to prevent molten metal leakage.

- n) Replace worn molds at intervals as recommended by the thermite weld manufacturer to minimize the possibility of molten metal leakage during the thermite welding process.
 - o) The mold and base metal should always be clean and dry. Avoid moisture and contaminants in mold and materials being welded as this may result in spewing of hot molten material.
 - p) Place a metal disk in the bottom of the graphite mold and then pour in the weld material or place the prepackaged weld material cartridge in mold. Squeeze the plastic cylinder to get all of the starting powder out. Close the mold body lid.
 - q) Place the graphite mold on the prepared pipe surface and install the wire in the slot at the bottom of the mold. Confirm that the mold and wire provide a proper fit and that the mold is in intimate contact on all sides with the surface being welded to. Hold the wire and mold steady and firm on the pipeline or fitting surface.
 - r) Ignite the weld material with the spark gun or electrical starter depending on type of charge. Lightly tap the mold body during the ignition fusion process. Carefully remove the graphite mold after the exothermic fusion process is completed approximately 15 to 20 seconds later.
 - s) Care should be taken during the thermite welding process, as the exothermic process produces a molten liquid metal that is extremely hot, 2,500° F (1,400° C) and will result in a local release of smoke. Do not watch the bright light (flash) or breathe the fumes from the thermite welding process.
 - t) Do NOT sharply hit or move the graphite mold body during the thermite weld process to minimize expelling the molten metal out of the graphite mold.
 - u) The graphite mold should not be touched or allowed to come in contact with the pipe coating or other flammable or meltable materials, as it is extremely hot. Carefully clean the slag out of the graphite mold body with the mold cleaner intended for that mold size and type.
 - v) After the weld connection has cooled, remove slag, visually and physically test quality of connection by tapping with a hammer and lightly pulling on the wire. The completed weld should visually present a good appearance of a well-formed connection with a minimum loss of weld material or splatter. All portions of the wire and sleeve shall be covered with the weld material. Remove and replace all visually defective, porous, or poor welds.
- Completed thermite welds shall visually not demonstrate a porous or honeycombed appearance or have lava tubes or holes. They shall not be easy to physically remove from the pipe or fitting surface. If any of these conditions occur, Contractor shall use charges from a different batch of materials and contact the exothermic materials manufacturer immediately.
9. Narrow or Small Fitting Attachment Locations: Thermite weld connections on metallic fittings, restraint devices, sleeve type coupling rings, mechanical joint follower gland rings, or bolted restraint joint ring type joints, and couplings where only a small or narrow metallic

surface is available shall be carefully done to not damage the internal lining, O-ring, or damage the fitting.

- a) Two or more wires can be attached under the same thermite weld connection as long as the bond or pigtail wires are not being connected to the same structure under the same thermite weld.
- b) Apply approved mastic packing material around mold to keep molten thermite material in place. Do not hold mastic packing material in-place with bare or gloved hands.
- c) Completing connections prior to complete fitting assembly and installation of the fitting into the trench in a manner to allow the thermite weld connection to be made to a level surface on top of the fitting is the preferred method.
- d) Vertical connections after the fitting is assembled and in the trench are a more difficult type connection to make.
- e) Coat with epoxy repair coating as provided in these specifications.

10. Pin Brazing Method: Authorized BAC pin brazing manufacturer technical representative, or approved equal shall demonstrate and observe proper connection procedures for a minimum of ten (10) connections for each type of joint bond and test wire size and type utilized on project.

- a) Weld connection shall be cleaned to bare white metal similar to that for thermite weld type connections.
- b) Load pin brazing gun with proper sized and type of pin and ferrule. Only direct to metal type connections are allowed. No threaded bolts or nuts are allowed.
- c) Activate pin brazing unit to braze the cable and lug to the pipe or fitting surface.
- d) Visually inspect, physically test with hammer, and conduct digital low resistance ohmmeter (DLRO) electrical test of completed connection.
- e) Repair coat similar to thermite weld type connections.

11. Silver Solder:

- a) Use for electrical connection of copper wire to thin-wall steel tubing (0.035-inch wall or less), copper, or stainless steel pipe and pin brazing connectors.
- b) Silver solder connections shall be made at locations on the edge of the fitting lip at a location that will not damage the rubber gaskets.
- c) Before the connection is made, clean and flux the area around the connection with a suitable flux as recommended by the pipe manufacturer for the materials being soldered.

- d) Weld the copper sleeved wire to the fluxed area with the suitable silver brazing alloy in such a manner that the completed connection is free of cracks or crevices in accordance with the solder manufacturer's recommendations.
 - e) After the connection is completed, allow to cool, and remove the remaining flux by wire brush and solvent clean (SSPC-SP-1).
 - f) Clean and coat silver soldered connections on copper and steel appurtenances with epoxy repair coating. Stainless steel connections do not require coating.
- 12. Ground Clamps:** Wire connections to copper service pipe shall be made with a bronze clamp. Clean service pipe and wire and attach to service pipe in accordance with ground clamp manufacturer's recommendations.
- 13.** Pipe coating shall be protected during thermite welding or soldering procedures. Coating damaged by welding or weld splatter shall be repaired per this specification section. Welded area shall be allowed to cool to "warm to touch" condition prior to application of primer and field coating.
- 14.** Each bond wire shall be visually and physically tested before coating according to the "Electrical Continuity Testing" section of this specification. Remove, replace or install additional joint bonds at all locations not passing electrical or physical tests.
- 15.** All damage to pipe or fitting coatings or linings, gaskets or O-rings, and/or plastic pipe or fittings, etc., shall be repaired by the Contractor at his sole expense.

E. Wire Connection Coating:

- 1. Clean weld area and coat with epoxy repair coating per manufacturer's directions over each completed connection after testing.
- 2. In cold weather, store coating repair materials in a heated location and keep warm until use.
- 3. The pipe and factory-coating surface shall be clean and dry before application of epoxy repair coating.
- 4. **Liquid Repair Epoxy Coating Application:** Wire connection shall be completed with a liquid one hundred percent (100%) repair type coatings. All bare surfaces, including exposed wire shall be coated.
 - a) Complete surface preparation and apply one hundred percent (100%) solids, low temperature epoxy repair coating in accordance with coating manufacturer's directions.
 - b) Total minimum dry film thickness shall be 20-mil, apply in multiple coats if required by manufacturer of specific coating utilized.
 - c) Allow coating to cure to sufficient degree to prevent damage to coating, prior to handling and backfilling.

- d) Strictly follow minimum cure time recommended by coating manufacturer based on surface and ambient temperatures.
5. All exposed metallic surfaces not covered by the epoxy repair coating, shall be repaired per PIPE AND FITTING COATING REPAIR.

F. Prepackaged Galvanic Anode Installation:

1. General:

- a) Remove plastic or paper shipping wrap from prepackaged anode prior to placement. Galvanic anodes packaged in cardboard type chip-tube shall be thoroughly perforated just prior to installation.
- b) Install galvanic anodes a minimum of 1-foot below the fitting invert and 3- to 5-feet from buried metallic piping or 3-feet from metallic fittings to be protected.
 - 1) Space galvanic anodes equally around the fitting, pipe section, or appurtenance. Locate at bottom edge of pipe trench as shown on the Drawings or as specified.
 - 2) If two or more anodes installed at the same location, place on opposite sides of the pipe or fitting.
 - 3) Provide a minimum anode spacing of 5-feet from other unprotected pipelines.
 - 4) In general, the standard location for galvanic anodes shall be on the north or east side of the fitting, valve or other metallic appurtenance being protected. However, it may be necessary to adjust the location dependent upon underground obstructions. **The installed location of the anodes shall be marked on the Contractor's red line drawings.**
- c) Handle prepackaged anode with care. Damage to the anode, anode to wire connection, backfill material or prepackaged anode bag will require replacement of the entire assembly.
- d) Place anode in native earth backfill. Do not use pipe zone bedding material.
- e) Earth backfill around each anode shall be thoroughly compacted to a point 1-foot above the anode. Backfill material around each anode shall be native soil free of roots, organic matter, trash, and rocks. Stop backfill at specified grade to allow for placing of topsoil, pavement, or concrete, when required.
- f) All anode wires shall be buried a minimum of 36-inches below finish grade. Wires shall be handled with care. Splices or damage to the insulation on any wire shall be repaired in accordance with WIRE INSULATION REPAIR and be approved by the Engineer.
- g) Electrical connection of the anode wire to steel, cast or ductile iron metallic pipe or fittings shall either be directly to the pipe or fitting by the thermite weld or pin brazing type method or through a test station with shunt as shown on the Standard Details.

- h) Electrical connection of the anode wire to stainless steel fittings shall either be directly to the stainless steel fitting with a silver solder or ring tongue terminal physical type connection or through a test station with a shunt as shown on the Standard Details.
- i) Electrical connection of the anode wire to copper services shall either be directly to the copper service by a ground clamp or through a test station with a shunt as shown on the Standard Details.

2. Installation:

- a) Each buried or submerged metallic (steel, ductile, or cast iron) pipeline section, appurtenance, intermediate pipe restraint, valve, or fitting shall receive a minimum of one galvanic anode of size necessary to comply with these specifications.
- b) All metallic valves, blow-offs, air valves, or fittings located in vaults on plastic pipeline, which will be either continuously or intermittently under the water table shall be cathodic protected as if buried. Place galvanic anode inside vault and attach directly to metallic fitting.
- c) Each buried or submerged stainless steel appurtenance (tapping sleeve, coupling, service saddle, repair clamp, etc.) shall receive a minimum of one galvanic anode of size necessary to comply with these specifications.
- d) Install a minimum of one each or more 17-pound or 18-pound galvanic anode for each copper service line on each side of the curb stop or insulated coupling at the tie-in to the existing service line.
- e) Install a minimum of one each or more 17-pound or 18-pound galvanic anode for each connection to existing ductile, cast iron, steel, or prestressed concrete cylinder pipe (PCCP) piping. Type of prepackaged anodes is project specific and is specified in the general notes of the plans.
 - 1) Prepackaged zinc galvanic anodes for protection of metallic pipe and fittings in lower resistivity soils (1,500 ohm-cm or below).
 - 2) Prepackaged magnesium galvanic anodes for protection of metallic pipe and fittings in soils with higher resistivity soils (1,501 ohm-cm or above).
- f) Where two or more metallic fittings are adjacent to each other, install joint bonds as specified in WIRE CONNECTIONS, and install the specified quantity of galvanic anodes for each metallic pipe section, appurtenance, valve, or fitting used in conjunction with nonmetallic pipe.
- g) At the Contractor's option with the Engineer's approval, larger anodes may be used in place of multiple smaller anodes for a group of bonded metallic components on non-metallic piping provided the same total bare weight of galvanic anode is used. Maximum separation distance shall be 5-feet on fittings to be protected with one anode, if multiple fittings are bonded together.
- h) For metallic (steel, ductile iron and cast iron) fittings (including but not limited to include service saddles and Foster adaptors), where specified coating thickness is not

provided or specified holiday testing and/or 100-percent holiday free coatings are not completed by the fitting manufacturer, or bare fitting is coated with petrolatum tape type coating system, Contractor with Engineer's approval shall install one specified size larger anode or double the number of anodes for each fitting as listed in Table 8B.9.

If one 17-pound or 18-pound anode is required per Table 8B.9 and coating thickness is not as specified nor has the fitting been certified 100% holiday free, then at Contractor's option, install either a 30-pound or 32-pound anode or two 17-pound or 18-pound anodes.

- 1) Existing fittings that are exposed and coated with a four-layer petrolatum tape type coating system shall receive double the number of anodes specified or the next larger anode size shown in these specifications.
 - 2) For example, if a bare fitting (16-inch or less) is exposed and petrolatum tape coated, it shall receive two 17-pound or 18-pound size or one 30-pound or 32-pound anode.
- i) The minimum number of anodes to be installed on buried or submerged factory coated metallic fittings (including but not limited to include service saddles and Foster adaptors), pipeline sections, or appurtenances with non-metallic pipelines shall be in accordance with Table 8B.9.

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Table 8B.9 Minimum Quantity and Size of Galvanic Anodes

DESCRIPTION	0" TO 30" DIAMETER
Single Coated Metallic Fitting	1-17 pound(#) Magnesium (Mg) or 1-18# Zinc (Zn) Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
Two (2) Metallic Fittings (5-foot separation MAXIMUM)	1-17# Mg or 1-18# Zn Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
COATED Fire Hydrant or Blowoff Assembly (coated tee, valve and hydrant) with PVC main and 6-inch PVC lead less than 10 feet long	1-17# Mg or 1-18# Zn Anode (Certified) 2-17# Mg or 2-18# Zn Anode (Noncertified)
COATED Fire Hydrant or Blowoff Assembly (coated tee, valve and hydrant) with PVC main and 6-inch METALLIC lead less than 10 feet long	2-17# Mg or 2-18# Zn Anode
1-inch up to and including 2-inch copper service line	1-17# Mg or 1-18# Zn Anode
Existing metallic pipe tie-in, concrete encased stub piece or on existing metallic main at new service tap	1-17# Mg or 1-18# Zn Anode
Existing metallic pipe LEAK location	2-17# Mg or 2-18# Zn Anode

Notes: 1) **Certified** – Coating meets specified minimum thickness, has been 100% holiday tested and certified by manufacturer; 2) **Noncertified** – Coating meets specified minimum thickness, but has not been 100% holiday tested and has not been certified by manufacturer; 3) 1-30 pound (#) Magnesium (Mg) or 32# Zinc (Zn) anode may be utilized in lieu of 2-17# Mg or 2-18# Zn anodes.

G. Test Station and/or Tracer Wire Access Box Installation:

1. Cathodic protection test stations and tracer wire access boxes of the types indicated shall be installed and located as specified herein and as shown on the Drawings. Current span wires, reference electrode, coupon, plastic reference pipe, or resistance probe shall be installed only at test station locations indicated on test station schedule.
2. Install test wires to pipe and tracer wires only at time of pipe installation along with the necessary reference electrode, coupons (minimum of two each), plastic reference monitoring pipe, drain/ground anode, or resistance probes if required before the pipe is backfilled and compacted around. Install sufficient wire to reach test station final location. Test station boxes can be completed at a later date. Contractor shall protect wires from damage if not terminated in test station or junction box at the time of pipe installation.
 - a) **Test station or tracer wire access box types shall be installed on metallic pipelines or fittings as shown on test station schedule or drawings per the test station types as follows:**

Install flush-mounted test stations at specified galvanic anode installation locations on metallic fittings on plastic pipeline sections.

b) Tracer Wire Access Boxes:

- 1) Install flush-mounted tracer wire access boxes at each end of all plastic pipe runs and at specified locations on plastic pipeline sections.
 - I. Install tracer wire access boxes at each end of all plastic pipe runs whether shown on the test station and tracer wire access box schedule or drawings or not.
 - i. This includes plastic water services between the curb stop and the building being served.
 - ii. In the instance of private plastic water services, the tracer wire access box shall be placed within the street right-of-way adjacent to the curb stop or within a utility easement.
 - II. Install tracer wire access boxes at locations shown on test station and tracer wire access box schedule found in drawings at maximum of five hundred feet (500') for in-town transmission or distribution type pipelines or shorter spans.
- 2) **Cased Crossings:**
 - I. Install flush-mounted tracer wire access boxes on each side of cased crossings, if specified in the plans.
 - II. Install flush-mounted tracer wire access boxes on each side of cased crossings where anodes connected directly to casings, if specified in the plans.
3. If test stations or tracer wire access boxes are installed in locations other than those called out in the plans or if locations change, the Contractor shall record the location in the as-constructed plans using station-offset or coordinates relative to the project horizontal datum. Recorded location shall be within 0.5 feet of true location of test station or tracer wire access box.
4. Color-code wires per specifications before installation of wires in conduit or backfilling of the test station wires.
5. Wherever possible test stations or access boxes shall be located directly over the centerline of the pipeline. In locations, where pipe is in field and parallels a fence, install test station or access box next to and on parallel fence line. Desired maximum offset distance from pipe centerline shall be 15 feet or at edge of right-of-way which may be up to 50 feet as directed by Engineer for future physical protection of test station.
6. Locate next to other above-grade facilities and structures for protection, where possible. Install in protected locations that does not restrict intended use of the land, outside roadways, cultivated fields, and irrigation facilities.
7. Install at protected locations such as next to pipeline structures, fences and road crossings. The Engineer shall determine the final location. Changes in the location of any test station shall be reviewed and approved by Engineer prior to installation.

8. At test stations, where multiple metallic fittings are bonded together by No. 12 AWG bond wires on plastic pipelines, install one test lead to first fitting from the test station and second test lead to farthest fitting from the test station. This will allow the continuity between the metallic fittings to be confirmed.
9. Flush mounted test stations or tracer wire access boxes shall be located directly over pipeline, except in areas of heavy traffic conditions. Where heavy traffic conditions exist, locate to the side of the street.
 - a) Compact under, and install flat support blocking or brick under flush mounted test stations or tracer wire access boxes for support. Install supports and concrete collar around test station to prevent settlement.
 - b) Install a minimum 6-inch thick concrete collar either in a minimum 2-foot square pad or 3-foot diameter circular pad around flush mounted test stations or tracer wire access boxes as shown on Drawings. Shape selected by Engineer.

See Detail 13942FH for co-located test stations and tracer wire access boxes.

- c) When installed in roadway, rotate flush mounted test station or tracer wire access box square concrete slabs so that slab points toward traffic flow.
 - d) Concrete collar and test station lid shall be set level and flush with the top of curb, sidewalk or roadway. Concrete collar and test station or tracer wire lid shall be set level and ½-inch to 1-inch higher than finished grade in open dirt and lawn areas. Test stations and collars that settle or are set too low or high shall be replaced at Contractor's sole cost.
 - e) Provide sufficient slack in test wires to allow terminal block to extend a minimum 18-inches out of test station box or tracer wire access box.
 - f) Do not connect test or tracer wire terminal board to flush mounted test stations or tracer wire access box lids that may short wires together.
10. Test wires shall be attached to the pipe as specified under WIRE CONNECTIONS.
11. Test wires shall be provided with sufficient slack and looped or coiled at the test station and pipeline to prevent the wire from being unduly stressed or broken during backfilling operations. Install test wires to top test station terminals. Wires shall be installed in a continuous length.
12. All cathodic protection and test wires shall be buried a minimum of 36-inches below finished grade.
13. Test stations shall be located and identified by test station location tags. Contractor shall supply the type and number of location tags sufficient for the number of test stations listed in the Test Station Schedule for the project. One UNSTAMPED tag shall be left in each test station. City personnel or the Engineer will stamp the tags with appropriate identification at the time of final acceptance testing.

14. Wire connections to test station terminals shall be with crimp-on ring tongue terminals, or Lug-it connectors, except where terminal strips with tubular clamps are used.
15. Connect wires to test station terminals as shown on Drawings. Wire type, color code, and marker tag designations as shown on Drawings and specified under PRODUCTS in this section, shall be maintained throughout project.
16. Seal completed wire connection test lead terminals with electrical sealer for all buried flush mounted test stations and at above grade test station locations where high atmospheric corrosion may occur. Clean surface of all dirt, wax, grease and other surface contaminants. Protect or mask other areas from spray application, vigorously shake aerosol can before and during spray application. Apply 2-mil to 3-mil layer from a 12-inch to 15-inch distance in light even coats. Allow to dry then close test station.

H. Wire Insulation Repair:

1. Wire splices shall be made with suitably sized Type C compression connectors as specified or mechanically secured and silver soldered. Inline type butt connectors or wire nuts are **NOT** allowed. Split bolts are **NOT** allowed unless silver soldered and both wires are No. 10 AWG wire or smaller.
 2. Minor insulation damage to small cathodic protection wires (equal to or smaller than No. 8 AWG) shall be repaired by spirally wrapping (minimum of 50 percent overlap) with two layers of high voltage rubber splicing tape and two layers of vinyl electrical tape coated with an approved electrical seal coat in accordance with the tape manufacturer's installation instructions, or with a specially fabricated splicing kit, or made with an approved epoxy insulated splice kit.
 3. Insulation damage or splices to large cathodic protection cables (No. 4 AWG or larger) shall only be made with an approved epoxy insulated splice kits.
 4. Install splice kits in accordance with the product manufacturer's written directions. Allow splice kits to cool and set before moving.
 5. All wire splices and wire insulation repair locations shall be observed by the Engineer. Contractor shall record the location in the as-constructed plans using station-offset or coordinates relative to the project horizontal datum. Recorded location shall be within 0.5 feet of true location of splice or insulation repair.
- I. **Warning Tape:** Bury warning tape, if specified, above all underground cathodic protection cable and conduit. Warning tape shall be placed approximately 12-inches above pipe and structures being identified or at specified depths as required in other sections of this contract document or shown on the details. Align parallel to and within two (2) inches of the centerline of conduit or cable run.

J. Plastic Pipe Tracing Wire:

1. Insulated stranded copper or copper clad steel tracer wire shall be installed on all non-metallic pipe sections.

2. Tracer wire shall be electrically continuous between tracer wire access boxes with no accidental electrical contacts (shorts) to metallic fittings, anodes or other structures.
3. Tracer wire shall be centered on top of plastic or non-metallic pipeline and securely held in place with tape meeting requirements provided under TRACER WIRE. Tracer wire shall be taped with two full circumferential wraps, or as approved by the Engineer, at a maximum distance of every five feet (5') along the pipe and within one foot either side of each fitting. Standard-duty Duct Tape is not an acceptable product.
 - a) The first wrap of tape shall be started under the tracer wire, adhesive side down, inverted after six inches so adhesive side is up and wrap continued around pipe circumference. With tracer wire on top of first wrap, flip tape over so adhesive side is down and wrap around pipe circumference ending past the start of the initial tape wrap.
 - b) The intent is to have the tape adhere to itself with the tracer wire in between the two adhesive sides to minimize tracer wire falling from top of pipe.
4. For short sections of plastic pipe (less than 50 feet) where two No. 12 AWG wires are already used to bond the metallic fittings to the metallic main line, the No. 12 AWG bond wires can be utilized in place of the tracer wire. These No. 12 AWG bond wires are not the same as test station wires. If listed on the test station schedule, install separate wires for the test leads.
5. For plastic pipe installed by directional drilling in bores, install tracer wire in heavy duty plastic conduit bored in at the same time as the waterline. Terminate tracer wires at each bore pit in flush type tracer wire access boxes.
6. Do not attach tracer wire directly to metallic fittings or appurtenances.
7. Install tracer wire access boxes and terminate tracer wires at all fire hydrant assemblies, each end of all casings, bores, building or tank walls, and each end of a pipe run.
8. Install tracer wire access boxes at the end of all plastic pipe runs whether shown or not on the test station and tracer wire access boxes schedule and/or drawings.
9. Maximum tracer wire span distance shall be: The maximum span distance shall be five hundred feet (500') or less.
10. On private plastic water service lines, tracer wire shall extend from the curb stop to the residence. The tracer wire from the plastic service line shall be clamped to the copper service line using a brass ground clamp. A single tracer wire shall be extended up the curb stop box and terminate above ground in order to trace both to the main and to the residence.
11. Field terminate tracer wires in accordance with the drawings by:
 - a) Bring end of tracing wire leg from each pipe direction to above grade surface elevation by installing a flush tracer wire access box. One tracer wire end shall come from each pipe direction.

- b)** Terminate tracing wire above grade at tracer wire access boxes located next to pipe appurtenances (vaults, vent pipes, blow-offs, or at fire hydrant bases).
 - c)** Tracer wire shall be electrically continuous between tracer wire access boxes locations. Tracer wires shall not be terminated in valve boxes or below grade.
 - d)** Color code and connect the tracer wire for each tracer wire span to the same terminal location on the terminal board depending on wire direction (i.e., top terminal board location for north or west tracer wire directions and bottom terminal location for south or east tracer wire directions).
 - e)** Make inline splices and insulation repair as specified under section WIRE INSULATION REPAIR only when observed the Engineer.
 - f)** Terminate tracer wire in a flush tracer wire access box per test station schedule in accordance with the Engineer's direction.
 - g)** If tracer wires terminate in vault, drill vault wall or roof above maximum waterline and terminate outside vault in an access box next to the vault or vent pipe (if present). Seal penetrations to minimize entry of liquid in the conduit or vault structure. Terminate tracer were in vaults next to ladder to allow easy access for attachment only if approved by Engineer.
 - h)** Install tracer wire access boxes and terminate each tracer wire span in box with ring tongue terminals connected to the tracer wire access box terminal board.
 - i)** Provide jumper bond wires with ring tongue terminal connected across the two tracer wire span terminals on the test station terminal board for transmission-type projects. The jumper bond wire shall be installed under another nut on the front side of the terminal board to bond consecutive spans together while allowing easy temporary removal for testing.
- 12.** Test tracer wire for continuity with an approved method in accordance with the specified functional testing per this specification section, prior to final acceptance of the pipeline installation. Functional testing to be completed by Contractor, as a minimum, shall consist of the following:
- a)** Test tracer wire prior to placement of curb and gutter.
 - b)** In roads and streets, test tracer wire after placement of road base but prior to placement of pavement.
 - c)** At end of project after all excavations have been completed.
 - d)** Use of pipeline locator equipment for functional testing is not recommended.
 - e)** For transmission-type projects, bond all of the tracer wire spans together with jumper bond wires or shorting straps and conduct final round of Contractor tracer wire functional testing for the entire length of transmission main project.

K. Insulated Joints:

1. Insulated joints shall be installed to electrically isolate the pipeline from other structures.
 - a) Insulated joints shall be located at connections to existing metallic pipe, where loose bonded coated (polyethylene encased) pipe is connected to tight bonded coated pipe, where concrete encased pipe is connected to dielectric coated pipe, where cathodically protected pipe connects to pipe not intended to have cathodic protection, and where shown. Install a flush test station at each buried insulated joint.
 - b) Insulated joints shall be utilized to isolate electric motors and magnetic water meters from cathodically protected pipeline sections.
 - c) Provide electrical shields at locations where other metallic structures (pipe supports, conduit, bare ground wires, etc.) either may be in contact with piping or are in close proximity to the pipe. Install on both sides of the insulated joint to maintain electrical isolation.
 - d) Install electrical shield between pipelines at crossings or close parallels as shown on drawings or specified.
 - e) Install copper insulating joints where copper services are connected to metallic water mains and at service meters or curb stops where ownership of copper service lines changes.
2. Install insulated joints at locations listed on test station schedule or as shown on the Drawings. Coordinate and carefully follow both insulating joint and manufacturer's recommendations for large diameter insulating joint installations.
3. Allowable insulating joint type for maximum pipe diameter size for buried locations shall be 36-inches for insulating flanges.
4. Install insulated joints above grade in buildings, vaults, and manways whenever possible. Insulated joints shall be installed a minimum of 12-inches clearance above floor or from wall to allow access for testing and maintenance. Maintain clearance from other structures or provide electrical shields as required to maintain electrical isolation.
5. Insulated joints shall be provided over-voltage protection with ground cells, flange protectors, or polarization cell replacement (PCR) devices at locations as shown on the Drawings and/or listed on the test station schedule.
6. **General:**
 - a) Carefully align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.
 - b) Support, backfill, and compact pipe and fitting in accordance with the insulator and pipe manufacturer's recommendations that will not cause leaks or damage to the insulating joint.

- c) Test each insulating joint as specified under FUNCTIONAL AND PERFORMANCE TESTING this specification section. Test buried insulating joints before and after backfilling.
- 7. Insulated Flanges:** Install insulated flanges, sleeves, and washers according to manufacturer's recommendations.
- a) Bolts for insulated flanges and restrained couplings should be undersized or holes slightly oversized to allow installation of insulating sleeves. Bolts shall be threaded for full length. Coordinate with fitting manufacturer and insulating flange manufacturer.
 - b) Clean flange surface and holes of all dirt, grease, oil, and contamination. Examine flange and bolt holes for burrs, sharp edges, or spurs. Remove any irregularities.
 - c) Confirm that both flange faces are free of all pits, dents, gouges, grooves, corrosion, burrs, or other type of irregularities. Both flange faces surfaces shall be smooth with a finish no rougher than 250 RMS. Refinish flange faces if surface too rough in accordance with flange insulator manufacturer's recommendations.
 - d) Align flanges so that they are concentric and parallel and carefully install flange gasket to not damage sealing element. Do not use grease, lubricant or adhesives on either the flange faces or the flange gasket.
 - e) Check bolts and nuts and clean as required. Apply non-conductive lubricant to all threads and flange side of nuts.
 - f) Carefully align bolt holes to minimize damage to insulating sleeves during assembly. Line up bolt holes with non-tapering drift pins at a minimum three locations with 120° between locations.
 - g) Carefully measure and adjust sleeve length as required to provide an air gap (space) between end of sleeve and nut after flange is tightened down, length as recommended by the insulator manufacturer.
 - h) Carefully insert sleeves over bolts and place insulating washer and metal washer over end, line up holes in fitting, install bolt with sleeve into place. Do not force bolt insulating sleeves into the flange hole. If force is required to insert the insulating sleeve, check alignment and readjust as required. Replace any damaged insulating bolt sleeves as required. Place insulating washer and metal washer on opposite end with nut.
 - i) Two insulated washers, one on either side of insulator are required for all above grade applications. Insulating washers are only required on the unprotected pipe side for buried or immersed insulated flange locations.
 - j) Tighten bolts a few turns at a time in sequence and procedure as recommended by insulator manufacturer until all bolts are uniformly tightened. Repeat torque sequence; repeat tightening in sequence to final torque. Do not exceed manufacturer's recommended pounds per square inch of pressure during initial torque-up. Go completely around flange rechecking all bolts for correct torque. All bolt tightening shall be done in accordance with insulating flange manufacturer's recommended sequence

with torque wrenches (mechanical or hydraulic) or with a stud tension measuring device.

For all above grade flange locations recheck bolt tightness after system has been pressurized.

- k) Visually inspect for physical damage to insulating sleeves or washers, replace if cracked or damage observed. Check flanges (visually with a flashlight, calipers, or feeler gauge, etc.) for a section that may not be aligned correctly and which may show a gap or separation. Correct in accordance with the insulating flange manufacturer.
 - l) Test for electrical isolation before top-coating.
 - 1) In above grade locations where high humidity or high contamination present, seal with rubber caulk type sealer or provide and install above grade flange protectors at insulating flange locations in corrosive or wet environments in accordance with specific product manufacturer's instructions.
 - 2) In buried locations, coat after assembly and testing as specified.
- 8. Insulated Couplings:** Install insulating boots and insulated flexible couplings in accordance with the manufacturer's recommendations and AWWA Standard C219.
- a) Clean and install insulated boot (sleeve, band, etc.) over end of each pipe, two boots required for each location. Push insulating boot into place over pipe until small insulating boot lip contacts pipe end. Clean, lubricate, and install other sealing gaskets, middle ring and follower rings according to manufacturer's recommendations.
 - b) Line up and install bolts as required. Tighten bolts a few turns at a time in sequence and procedure as recommended by insulator manufacturer until all bolts are uniformly tightened. Do not exceed manufacturer's recommended pounds per square inch of pressure during initial torque-up. For all above grade locations recheck bolt tightness after system has operated.
 - c) Insulating boot should be visible on either side of coupling when completed.
 - d) Bond buried coupling body into protected pipe side with pigtail wires.
 - e) Test for electrical isolation both before top-coating insulated couplings and after burial.
- 9. Restrained Insulated Joints:**
- a) If insulated flexible coupling is utilized electrically isolate restraining rod assembly with insulating G-10 sleeves and washers on both ends of restraining rods. Oversize restraining device bolt holes or undersize restraining rod as required to not damage insulating materials and still meet specified restraining strength and pressure requirements. For buried or submerged insulator locations, only install insulating sleeve and insulating washer on unprotected end of restraining rod assembly.
 - b) Test restrained rod installation for electrical isolation prior to top-coating or backfill. Coat per specification if not stainless steel or fusion-bonded coated rod, with heat

shrink, liquid 100-percent moisture cured epoxy repair coating, or petrolatum tape coated.

c) Test buried insulator both prior to and after backfill.

10. Buried Flange Insulator Coating: At buried insulated flange locations, Contractor shall coat exterior portion of insulating joint after assembly and testing. At Contractor's option, coating shall consist of either:

a) Four-layer petrolatum wax-tape system intended for burial conditions per AWWA C217.

b) A 100-percent solids epoxy mastic coating, filler tape top-coated with two layers of specified pipeline joint/repair tape coating, or heat shrink sleeve.

11. Copper Service Line Insulators: Install insulated corporation ball valves, insulated curb ball valves, and insulated service fittings at locations as shown on the Drawings in accordance with the service liner manufacturer's instructions.

L. Insulating Wall And Floor Sleeves:

1. Coordinate and install pipe and wall sleeve to provide a smooth uniformly round shaped opening per pipe and modular seal manufacturer's recommendations.
2. Coordinate pipe fabrications, wall sleeves and modular seal types and sizes for wall or floor penetrations to allow for the watertight sealing system used at wall or penetrations. Install pipe and wall sleeve or core wall to provide uniformly round shape, grind as required to control weld seam height per pipe and modular seal manufacturer's recommendations. Factory grind all welds at wall sleeve location and a minimum of 12-inches on either side of wall or floor opening, do not remove parent material during grinding operations. Repair coating as required.
3. Insulating wall or floor sleeves or seals shall be installed according to manufacturer's recommendations. Wall sleeves shall be positioned so that the water stop (collar) is centered in the width of the opening and the water stop (collar) contacts the opening evenly for the minimum 1-inch distance or more as recommended by the modular seal manufacturer. Center the pipe in the opening and adequately support on both sides. Make sure that the pipe, opening, and wall sleeve are clean, smooth, and round. Install the exact number of links per the manufacturer's recommendations for the size and type of opening and pipe diameter.
4. Install the links in the same direction so that the bolts can be tightened from the inside of the building or vault location. Assemble, insert, align, and evenly tighten insulating modular seal in accordance with the manufacturer's installation instructions in a manner that will not damage pipe coating or insulating modular seal. Position centering blocks for casing end seal type installations on bottom one-half of the pipeline as recommended by the modular seal manufacturer. Position the modular seal so that it is centered in the wall sleeve and that when tightened down it provides an even, uniform spacing in the wall sleeve. Take up free slack in bolts and then tighten each bolt clockwise in opposing succession at torque and sequence as recommended by seal manufacturer. Evenly tighten the individual bolts the maximum number of turns as recommended by the

manufacturer until the sealing elements bulges around all of the pressure plates. Do not use power tools to tighten stainless steel bolts. Completed installation shall provide long term insulated and sealed (liquid tight) connection between pipe and floor or wall opening, sleeve, or casing.

5. Insulating wall or floor sleeve shall be positioned to allow adjustment from interior side of building and vault locations and exterior side of water bearing structure locations.
6. For water bearing structures or for locations if shown on the drawings, install a second modular wall seal.

M. Electrical Shields: Install electrical shields between sections of cathodically-protected pipe and pipe supports connected to or sitting on unprotected supports or structures in order to maintain electrical isolation as shown on the drawings.

N. Factory And Field Repair Coatings For Piping, Fittings And Accessories:

1. Miscellaneous Incidental Metallic Pipe, Fitting, and Appurtenance Coating Field Quality Control Testing.
 - a) Conduct quality control testing in the field on miscellaneous factory coated fittings and appurtenance in accordance with this specification section. Conduct dry film thickness measurements and holiday test to confirm conformance with specifications and referenced standards.
 - b) Conduct dry film thickness measurements in accordance with SSPC PA-2 with exception that the specified thickness is the absolute minimum.
 - 1) A minimum of ten (10) dry film thickness measurements shall be completed on each 40-foot length of pipe.
 - 2) A minimum of two dry film thickness measurements shall be completed for each fitting or appurtenance.
 - c) Conduct 100-percent holiday inspection of all factory-applied coatings.
 - d) Repair with provided repair kits or repair materials recommended and approved by the original coated material manufacturer.
2. Field testing, surface preparation and coating for field coating or repair of damaged coating on new or existing pipe, piping, appurtenances, and fittings shall be in accordance with this specification section.
 - a) Inspect and repair any coating or lining damage with original manufacturer's approved repair kit.
 - b) Follow coating manufacturer's written directions for surface preparation and repair coating application.
 - c) Utilize potable water approved materials for coatings and linings in contact with potable water.

- d) Complete surface preparation and field repairs of coatings and linings in accordance with coating manufacturer's written directions.
 - e) Observe environmental (weather and surface temperature) requirements.
 - f) Allow to cure in strict accordance with coating manufacturer's recommendations based on surface and weather conditions prior to handling, burial, or exposure to liquids.
3. External incidental pipe and fitting field or repair coatings shall consist of external coating materials and repair procedures as recommended by the original pipe or fitting coating manufacturer.
- a) Fusion-bonded epoxy coated items shall be repaired with epoxy repair coating outlined in these specifications.
 - b) Epoxy coated items shall be repaired with repair coating from the original coating manufacturer.
 - c) Spot coating damage at thermite weld connections shall be repaired with a 100 percent solids epoxy repair coating that can cure in either wet or dry conditions.
 - d) Field epoxy coat, tape coat or heat shrink sleeve, short sections of buried metallic piping such as vent pipes, blow-off assemblies, and pipe stubs to be concrete encased under or next to buildings or tanks if not already coated with an approved specified factory applied coating system.
 - e) Provide epoxy coatings for pipe and fittings in vaults if not already coated with an approved specified factory applied coating system. Provide epoxy/polyurethane enamel type coating system for above grade appurtenances if not already factory coated with an approved specified factory applied coating system.
4. Repair or field coatings shall overlap intact factory coating a minimum of ½-inch in all directions from the damaged area.
5. Install coated valves, fittings, and miscellaneous metallic pieces in a manner that will not damage coating or lining.
6. Coat rebar or tie-rods where utilized as tie-downs or thrust restraints and exposed to soil or liquid with fusion-bonded epoxy, heat shrink tube, or four-layer petrolatum tape system.
7. Fitting and Appurtenance Fasteners (Bolts, Nuts, and Similar Items): Series 300 stainless steel or fusion-bonded epoxy coated depending on specified location.
- a) All bolts and nuts shall be installed according to manufacturer's requirements including the use of anti-galling lubricant compound for stainless steel materials.
 - 1) If galling or seizing of the nut and bolt occurs the bolt shall be cut off, nut and bolt discarded and replaced with a new nut and bolt.

- 2) Exercise care to assure tightening of the nut is against the flange or gland and not due to galling or seizing.
 - b) Conduct testing of Series 300 stainless steel materials with magnet to confirm Series 300 stainless steel provided prior to installation.
8. If approved by the Engineer, coat miscellaneous hard to coat items with four-layer petrolatum tape system or heat shrink repair coating.

O. Field Coating For Incidental Steel And Ductile Iron Pipe Stub Pieces And Fittings:

- 1. Field tape coat or heat shrink sleeve, short sections of buried metallic piping such as vent pipes, blow-off assemblies, and pipe stubs to be concrete encased under or next to buildings or tanks if not already coated with an approved specified factory applied coating system.

Bituminous asphaltic coating does not qualify as an approved factory tight bonded coating.

- 2. Follow the coating manufacturer's recommendations and the referenced AWWA Standards.
 - a) Acceptable products are specified under PIPE AND FITTING FIELD COATING REPAIR MATERIALS.
 - b) Solvent wipe per SSPC SP-1 if required to remove contamination.
 - c) Hand tool clean small surfaces only. Abrasive blast location areas larger than 12-square inches. Abrasive blast to SSPC SP-10 (Near White) for external surfaces and SSPC SP-5 (White) for internal surfaces.
 - d) Repair coating should overlap intact factory coating a minimum of 4-inches in all directions from the damaged area.

e) Field Tape Coating:

- 1) For hand taping, provide suitable field primer (if required) and 35-mil field applied repair tape with aggressive adhesive and release liner, 4-inches or 6-inches width. Apply with 50-percent overlap for a minimum 70-mil hand tape coating system.
- 2) Pipe shall be clean and dry prior to and during application of both primer and tape coating. Tape shall be applied in a spiral wrap with a 50-percent overlap in accordance with AWWA C209.

f) Heat Shrink Field Coating:

- 1) For heat shrink sleeve installation, provide suitable filler material and heat shrink sleeve material for pipe size required or heat shrink repair patch as required for field repair.

- 2) Pipe shall be clean and dry prior to and during installation of heat shrink sleeve. Install sleeve in accordance with AWWA C216, the coating manufacturer's recommendations and these specifications.

g) Moisture Cure 100-Percent Epoxy Repair Coating:

- 1) Spot coating damage locations and hard-to-coat fittings and appurtenance (edges, flanges, tie-rods, bolts, nuts, etc.) locations shall be coated with a moisture cure 100-percent epoxy repair coating.
- 2) Clean and prepare surface in accordance with repair coating manufacturer's directions. Wire brush and sand as required. Clean per SSPC SP-1 if required.
- 3) Mix epoxy repair coatings at ratio and for time per repair coating manufacturer's directions. Apply to repair area by hand application method (brush, trowel, spatula, etc.) and smooth out onto intact coating in accordance with repair coating manufacturer's recommendations.
- 4) Provide manufacturer recommended 25-MDFT to 30-MDFT coating thickness.

h) Petrolatum Tape Coating System:

- 1) Field apply petrolatum tape system for all restraining fittings and rods if not already coated with an approved specified factory applied coating system or stainless steel.
- 2) Provide petrolatum system coating at insulated location to existing pipe or appurtenances exposed as part of connection installation if not already coated.
- 3) Provide petrolatum system coating for brass or bronze service saddles if not protected by a galvanic anode system.
- 4) Provide petrolatum system coating for isolated copper fittings if not already protected by a galvanic anode system.
- 5) For petrolatum system tape installation per AWWA C217, provide suitable primer, filler material (mastic), petrolatum tape and outer wrap material for burial application.
 - I. Pipe or fitting shall be clean and dry prior to and during installation of four-layer petrolatum wax tape system.
 - II. Install petrolatum tape system in accordance with coating manufacturer's instructions and these specifications.
 - III. Apply primer in an even uniform manner to entire tie rod, pipe, or fitting surface area to be coated to achieve minimum primer thickness of 3-mil wet film thickness. Increase amount of primer at and work primer into threads, cavities, pits, angles, edges, and other irregular areas. Apply primer with brush or glove.

- IV. Apply mastic immediately after application of primer, drying of primer is not required. Work and mold mastic into irregular shapes to fill voids and achieve a uniform contour to provide a smooth even support for the tape coating system to avoid bridging.
 - V. Apply one or more petrolatum tape layer(s) in a spiral wrap fashion around the tie rod or fitting circumference with a 50-percent minimum overlap onto the proceeding layer.
- 6) Apply the 10-mil PVC outer wrap tape layer in a spiral fashion around the pipe or fitting with a 50-percent minimum overlap.
 - 7) The completed petrolatum coating system shall be a minimum of 40 MDFT and adhere tightly to the coated structure and present a smooth unwrinkled appearance.

P. Functional And Performance Testing:

- 1. **Functional Testing:** Provide the Engineer with a minimum of seven (7) calendar days advanced notice before beginning functional testing unless the Engineer is already scheduled to or already onsite doing construction observations (services during construction). At such a time as the Engineer may indicate, the Contractor, in the presence of the Engineer, shall conduct the following functional testing.

2. Test Stations:

- a) Test each test station wire for continuity, correct termination, and proper connection and color code to the designated structure.
- b) Test each wire for continuity with potential measurements to a copper/copper sulfate reference electrode and with an ohm-meter between wires prior to connecting together on the terminal board.
- c) Test the buried permanent reference electrode, if present, test leads and potentials to confirm correct operation. If the reference electrode does not provide equal or near equal potential measurements to a portable copper/copper sulfate reference electrode (convert if required depending on buried reference electrode type), then saturate the buried reference electrode by pouring water down the plastic monitoring pipe. Retest the buried reference electrode again several days later after the buried reference electrode is moist.

Testing results shall be recorded on Form 8B.1 and transmitted to the Engineer following completion of functional testing.

- d) Do not connect reference electrodes to pipe test lead terminals.

3. Electrical Insulating Joints:

- a) Test each insulated joint after assembly for electrical isolation in accordance with the insulation checker manufacturer's written instructions and by potential measurements.

- b) Test insulator with radio frequency type insulator checker prior to backfill. Utilize a radio frequency type meter that is self-zeroing such as the Model RF-IT manufactured by Tinker and Razor or approved equal.
- c) Test and provide electrical isolation as specified in accordance with NACE SP0286.
- d) Buried electrical insulating joints shall be tested both before and after burial.
- e) Test for electrical isolation at electrical shields between pipe and pipe supports and at wall or floor penetrations.
- f) All defective electrical shields, pipe supports, wall penetrations, insulating joints, and/or damaged or defective insulation parts shall be corrected or replaced by the Contractor at his sole expense.

4. Tracer Wires:

- a) Demonstrate correct installation of tracer wire access boxes and tracer wire termination and continuity by field functional tests.
- b) **Acceptable tracer wire continuity testing methods shall consist of:**
 - 1) Electrical continuity (four wire) type testing that demonstrates voltage (potential) changes at end of line from temporary connection to a DC current source at far end of the tracer wire;
 - 2) Verification of a voltage measurement to a test battery with the tracer wire as one side of the two-wire circuit; and/or
 - 3) Use of commercially-available cable continuity verification testing equipment utilized in accordance with the test equipment manufacturer's written instructions.
 - 4) Use of typical pipe locating type equipment IS NOT an acceptable continuity verification test method. This type of equipment may walk through tracer wire breaks.
- c) Contractor shall utilize Form 8B.2 for recording continuity testing results and transmit results to the Engineer following functional testing. Test data will be reviewed by the Engineer prior to acceptance of tracer wires and access boxes.
- d) **Potential Functional Testing Outcomes:**
 - 1) Similar or equal potential change observed at the far end and start of tracer wire span is an indication of an electrically continuous tracer wire with no accidental shorts.
 - 2) No change at the far end of the span being tested indicates a possible break in the tracer wire.
 - 3) A difference between the potential measurement value at the start of the test span and the measured value at the far end of the test span may be an indication of an

accidental electrical contact or short to one or more metallic fittings. The greater the potential difference, the more likelihood of a short or the larger the surface area shorted to.

- 4) Typically measured potential values at the start and end of a tracer wire span should be approximately 10-volts to 12-volts or higher at each end, if the source is a full-charged 12-volt battery. Measured potentials lower than 10-volts at either end indicate a possible accidental short to one or more metallic fittings or structures.
- 5) If potentials below 10-volts are measured, conduct additional testing with a cable-type locator and A-frame to locate and correct possible tracer wire insulation damage or accidental shorts to other metallic structures.
 - I. Operate cable locating equipment in accordance with equipment manufacturer's instructions at the lowest output settings possible in order to be more sensitive to problem locations and to minimize walk-through (jumping the discontinuity or break) or missing accidental contacts.
 - II. Carefully observe changes in signal strength and depth measurement values as likely indicators of either possible breaks or accidental contact locations.
 - III. Once discontinuity is located, test the span from the opposite direction to confirm discontinuity location prior to commencing with repair(s).
- 6) Repair all insulation damage found. Retest tracer wire span with 12-volt potential test to confirm all possible shorts have been found and corrected.

5. Galvanic Anode Energizing and Testing:

- a) Some of the galvanic anodes will be connected to the pipe or the fittings in the anode test stations with calibrated shunts after the installation of the galvanic anode cathodic protection system is completed.
- b) Test continuity of each anode lead wires and to confirm correct type of anode with potential measurements prior to connecting to test station terminal board.
 - 1) Zinc anodes shall read a minimum of -1.0 volt to a copper/copper sulfate reference electrode, and
 - 2) High potential magnesium anodes shall read a minimum of -1.6 volt to a copper/copper sulfate reference electrode.
- c) Do not connect anode and pipe or fitting leads together with a shunt in test stations until the Engineer is present.

Q. Final Testing:**1. General:**

- a) After construction is complete and all of the individual functional tests have been completed by the Contractor, the Engineer shall conduct final testing on the pipeline to ensure proper installation of the specified corrosion protection items.
 - b) At Contractor's option, he may be present during this final testing if desired.
2. **Galvanic Anodes Cathodic Protection System:** The Engineer shall make sufficient tests throughout the network of galvanic anode cathodic protected metallic pipe and fittings to determine proper installation of the galvanic anode cathodic protection system.
 3. **Tracer Wire and Access Boxes:** The Engineer shall make sufficient tests to determine proper installation of the tracer wire and access box system. The acceptance method for the final tracer wire continuity testing shall be by the potential shift method.
 4. Any construction defects or incomplete work identified by the Engineer during functional or final testing or during warranty inspections shall be located and corrected by the Contractor at his sole expense including additional Engineering, retesting, and inspection time.
 5. Any defects in the corrosion protection system, (including but not limited to fitting, valve or other metallic appurtenance coating or lining, tracer wire continuity, pipeline electrical isolation, cathodic protection system, test stations, etc.) when discovered, shall immediately be repaired and retested in a timely manner (warranty work shall be completed within 60 days of notice) by the Contractor in accordance with this specification and the written product manufacturer's instructions as reviewed and approved by the Engineer.

Contractor shall provide the Engineer with a minimum of 7 day advanced notice before beginning warranty repairs.

8B.4 METHOD OF MEASUREMENT

- A. **Galvanic Anodes:** Anodes and the attachment of lead wires to fittings, valves or other metallic components shall be incidental to each of the new metallic water system components installed. No separate measurement will be made.
- B. **Cathodic Test Stations:** Shall be counted on a per each basis for "Test Station". The cathodic test station bid item shall include all items specified and necessary to install and to make operational a complete test station.
- C. **Tracer Wire and Tracer Wire Access boxes:**
 1. Tracer wire and all accessory items necessary for the installation of an electrically-continuous tracing system shall be incidental to the pipe installed. No separate measurement will be made.

2. Tracer wire access boxes for 2-wire, 45-mil insulation shall be counted on a per each basis for "Tracer Wire Access Box – 2-wire".
 3. Tracer wire access boxes for more than two tracer wires with 45-mil insulation or wires greater than 100-mil insulation shall be counted on a per each basis for "Tracer Wire Access Box – Large".
- D. Service Line Insulators:** Shall be incidental to the service line installed. No separate measurement will be made.
- E. Coating Repairs:** Coating repairs to fittings, existing coated pipe or project specified coated pipe are considered incidental to the pipe or fittings installed. No separate measurement will be made.
- F. Functional Testing:** Functional testing of the cathodic protection and tracer wire systems shall be incidental to the water system components installed. No separate measurement will be made.
- G. Final Acceptance Testing:** Will be performed by the Engineer.

8B.5 BASIS OF PAYMENT

- A. Galvanic Anodes:** No separate payment will be made.
- B. Cathodic Test Stations:** Payment shall be made for "Test Station" and shall include all items specified and necessary to install and to make operational a complete test station.
- C. Tracer Wire and Tracer Wire Access boxes:**
1. No separate payment will be made for tracer wire and all accessory items necessary for the installation of an electrically-continuous tracing system.
 2. Payment for tracer wire access boxes for 2-wire, 45-mil insulation bid item shall be made for "Tracer Wire Access Box – 2-wire" and shall only include furnishing and installing a complete tracer wire access box.
 3. Payment for tracer wire access boxes for more than two 45-mil insulation tracer wires or tracer wire with 100-mil+ insulation bid item shall be made for "Tracer Wire Access Box – Large" and shall only include furnishing and installing a complete tracer wire access box.
- D. Service Line Insulators:** No separate payment will be made.
- E. Coating Repairs:** No separate payment will be made.
- F. Functional Testing:** No separate payment will be made.
- G. Final Acceptance Testing:**
1. No separate payment will be made.

2. If final acceptance testing shows inconsistencies in the cathodic protection or tracer wire systems, the Contractor shall be responsible for all labor, equipment and materials necessary to determine the cause and the location of the inconsistencies and the repair of the problem.

The Contractor is also responsible for the costs of subsequent acceptance testing associated with the cost of repairs incurred by the Engineer.

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**FORM 8B.1
STRUCTURE-TO-REFERENCE ELECTRODE POTENTIAL AND GALVANIC ANODE
MEASUREMENTS**

Project Name						Tested By	
Contractor						Date	
Station	Test Location Structure and Wire Size, Type & Color Code	Test Station Type	Anode Shunt (mV)	Milli- Amps	Potential (Volts) OFF	Potential (Volts) ON	Notes (1 mV = 100 mA)

Submitted By: _____ **Date:** _____

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FORM 8B.2

CITY OF RAPID CITY CORROSION PROTECTION - PLASTIC PIPE SYSTEMS	SHEET _____ OF _____ DATE: _____
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TEST TAKEN BY: _____

TRACER WIRE POTENTIAL AND ELECTRICAL CONTINUITY TEST WORKSHEET

CLIENT: _____	PROJECT#: _____
PROJECT: _____	LOCATION: _____

PURPLE COLOR: _____ NORTH (1) OR _____ WEST (2) TAPE STRIPS / TOP 2 TERMINAL LOCATIONS
 GRAY COLOR: _____ SOUTH (1) OR _____ EAST (2) TAPE STRIPS / BOTTOM 2 TERMINAL LOCATIONS
 FROM STATION _____ + _____ TO STATION _____ + _____ TOTAL DISTANCE (FT) = _____

PROVIDE A SKETCH BELOW (INCLUDE TEST CONNECTIONS, DISTANCES, STATIONING, ETC.):

START TEST POINT STATION (STA)						
END TEST POINT STA						
TEST LOCATIONS AND WIRE CONNECTIONS (+ TO GROUND / - TO TRACER WIRE) AT BATTERY	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT	COLOR, NUMBER & CURRENT (ON Test)	ON/OFF POTENTIAL SHIFT
AT START, TOP TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT START, TOP TERMINAL COLOR _____ POTENTIAL AT TEST (RECORD mVolt and mAmp)		V		V		V
AT START, BOTTOM TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT START, BOTTOM TERMINAL COLOR _____ POTENTIAL AT TEST (RECORD mVolt and mAmp)		V		V		V
AT END, TOP TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT END, TOP TERMINAL COLOR _____ POTENTIAL AT TEST		V		V		V
AT END, BOTTOM TERMINAL COLOR _____ POTENTIAL BEFORE TEST		V		V		V
AT END, BOTTOM TERMINAL COLOR _____ POTENTIAL AT TEST		V		V		V
RESULTS/NOTES:						

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FORM 8B.3

INDIVIDUAL WIRE JOINT BOND RESISTANCE TEST SUMMARY

PIPE NAME/SIZE _____ CONTRACTOR _____
DATE _____ SHEET _____ OF _____

<i>Conduct test at DLRO min. 10 A. current output 6,000 micro-ohm setting</i>							
MAXIMUM ALLOWABLE JOINT WIRE RESISTANCE							Calibration Time/By
No. 2 AWG Joint Bond Wires Structure or Bond Type and Length	Micro-Ohms						
Two (2) Joint Bond Wires (18" Long)							
Three (3) Joint Bond Wires (18" Long)							
Test No.	Pipe Joint No.	Approx. Pipe Stationing at Joint Measured	Measured Bond Resistance (Micro-Ohms)	Type of Joint & Pass Yes or No. If No Add Another	Additional Bond Micro-Ohms	Time Measured	Tested By

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**ATTACHMENT A and B
PVC PIPE AND DUCTILE IRON FITTINGS CERTIFICATION**

CONTRACT: _____ DATE: _____

CONTRACTOR: _____

PIPE MANUFACTURER: _____

DUCTILE IRON FITTINGS MANUFACTURER: _____

This certification applies to PVC pipe and Ductile Iron Fittings, as may be provided by Manufacturers as identified above. Omission of any required project certification herein does not relieve the Pipe or Ductile Iron Fittings Manufacturers or the CONTRACTOR from responsibilities of performance as may be required by the Contract Documents.

For pipe and pipe materials, joints and fittings to be supplied on the above referenced contract, the listed Pipe Manufacturer certifies as follows:

1. The PVC pipe shall be manufactured as specified in Section 8A – Water– of the Standard Specifications.
2. Ductile Iron Fitting Manufacturer shall provide required coatings and linings in accordance with Section 8B – Corrosion Protection - Plastic Pipe Systems – of the Standard Specifications.

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**ATTACHMENT A
PVC PIPE CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____ E-mail: _____

This certification shall be sent by the Pipe Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Pipe Manufacturer.

NOTARY:

The above certification was signed by _____ of _____

in my presence on _____, 20_____

Notary Public: _____

My Commission Expires On: _____ 20_____

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**ATTACHMENT B
DUCTILE IRON FITTINGS CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____ E-mail: _____

This certification shall be sent by the Ductile Iron Fittings Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Ductile Iron Fittings Manufacturer.

NOTARY:

The above certification was signed by _____ of _____

in my presence on _____, 20 _____

Notary Public: _____

My Commission Expires On: _____ 20 _____

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ATTACHMENT C (Part 1)
MATERIAL HANDLING AND INSTALLATION CERTIFICATION

CONTRACT: _____ DATE: _____

CONTRACTOR: _____

PIPE MANUFACTURER: _____

This certification applies to all plastic pipe, fittings, and materials as may be provided by Pipe Manufacturer as identified above. Omission of any required project certification herein does not relieve the Pipe Manufacturer or the CONTRACTOR from responsibilities of performance as may be required by the Contract Documents.

For pipe and pipe materials, joints and fittings to be supplied on the above referenced contract, the listed Pipe Manufacturer certifies as follows:

1. The Pipe Manufacturer has been present and observed the CONTRACTOR's work for the placement of the first feet of pipe from Station _____ to Station _____ for the dates of _____ to _____. During their observation of the CONTRACTOR, the CONTRACTOR was following the Pipe Manufacturer's recommendation for handling, storing, assembling and installing pipe, pipe joints, fittings, and repair procedures for coating and linings.
2. During the site visit, Pipe Manufacturer observed construction from Station _____ to Station _____ between the dates of _____ to _____. The Pipe Manufacturer has observed the CONTRACTOR's storage and handling of the pipe, assembly of pipe joints, fittings, and proper repair procedure for coatings and linings, where applicable, and all are in conformance with the Pipe Manufacturer's recommendations.

A trip report with summary of observations shall be attached to this certification and shall include any additional items that may be need to be addressed by the Contractor or problems resolved during site visits.

The Pipe Manufacturer has reviewed the Contract Documents and has taken into consideration the contract requirements governing pipe manufacture and installation as specified therein.

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**ATTACHMENT C (Part 2)
MATERIAL HANDLING AND INSTALLATION CERTIFICATION**

IN CERTIFICATION THEREOF:

Name: _____

Title: _____

Signature: _____

Company: _____

Address: _____

Phone: _____

E-mail: _____

This certification shall be sent by the Pipe Manufacturer to the CONTRACTOR, and then forwarded by CONTRACTOR to the ENGINEER. This certification shall be signed by an authorized representative (with power of attorney) of the Pipe Manufacturer.

NOTE: Attachment C is required to be completed by the Manufacturer for projects of any size diameter pipe when the total length of pipe is greater than 2,600 feet OR when project pipe diameters are larger than 12-inches and the total length of large diameter pipe is greater than 600 feet. Refer to Infrastructure Design Criteria Manual for further information.

SECTION 9

SANITARY SEWER

9.1 DESCRIPTION

A. General: This work consists of furnishing and installing sanitary sewer mains, manholes, service lines, and appurtenances. This includes all equipment, tools, materials, labor, and other incidentals to provide sewer mains and service lines complete and ready for use. The work also includes, but is not limited to, all necessary excavation, backfilling, compaction, testing, clean up, and restoration. All connections to the City sanitary sewer system, directly or indirectly, need to be designed and constructed in accordance with City Criteria.

B. Related Work:

Section 7	General Conditions
Section 8A	Water
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 11	Utility Excavation and Backfill
Section 18	Erosion, Sediment, and Water Pollution Control
Section 19	Incidental Work
Section 41	Utility Trench Resurfacing
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 92	Temporary Traffic Control
Section 112	Select Granular Backfill
Section 200	Controlled Low Strength Material
Section 203	Submittals
Section 205	Televising

C. Submittals: Shall be required unless otherwise specified in the detailed specifications or special provisions. The term "Submittals" includes, but is not necessarily limited to, manufacturer's product data sheets of pipe, manholes, appurtenances, and fittings. Submittals shall be submitted for the materials used on the project in accordance with the specifications and plans. All items included in Section 9.2 of this specification that are to be incorporated into the work shall be submitted to the Engineer for review.

All Submittals shall be made in accordance with Section 203.

Resubmittals shall be made in the same manner as Submittals, with changes clearly shown.

9.2 MATERIALS

A. Pipe: Sanitary sewer pipe up to and including 24 inches in diameter shall be Polyvinyl Chloride (PVC). Sanitary sewer pipe larger than 24 inches in diameter shall be

Reinforced Concrete Pipe (RCP) or Fiberglass Pipe (FRP). The use of materials other than those indicated requires the prior written approval of the Engineer.

1. **PVC Pipe and Fittings:** 4 inches through 15 inches diameter, shall conform to the requirements of ASTM D-3034, Type PSM, SDR-35 minimum. PVC pipe 18 inches through 24 inches diameter shall conform to the requirements of ASTM F679, minimum wall thickness T-1. PVC pipe shall be manufactured in a continuous extrusion process employing a prime grade of un-plasticized PVC plastic material that meets the requirements for this product as specified in ASTM D1784. The pipe shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, 12364-C, or 13364-B. SDR-35 is a minimum and the design engineer shall determine if depths and soil conditions require additional wall thickness.

PVC Sewer Pipe shall have a flexible elastomeric seal (O-ring or rubber sealing elastomeric gasket joint), and conform to the latest revisions of ASTM D3212. Solvent cement joints are not allowed for sewer pipe and fittings.

Nominal laying lengths shall not be less than 12.5 feet, except shorter lengths may be used adjacent to manholes and for the installation of inline wyes and tees. Each length of pipe shall be marked, as a minimum, with size, SDR, "Sewer Pipe" and ASTM number.

2. **Reinforced Concrete Pipe (RCP) and Fittings:** In sizes 27 inches through 108 inches in diameter, shall conform to the requirements of ASTM C-76 and shall be manufactured using TYPE II cement. The pipe and fittings shall be manufactured at a precast facility that is certified by the American Concrete Pipe Association, is approved for supplying products to the South Dakota Department of Transportation, or as approved by the Engineer. Class of pipe shall be as shown on the plans or specified in the detailed specifications. Joints for RCP pipe shall meet the requirements of ASTM C-361 for concrete joints and confined rubber profile gaskets.
3. **Fiberglass Pipe (FRP):** The use of FRP pipe requires the design engineer to prepare a detailed specification for the material and requires the prior written approval of the Engineer to use the material specification.
4. **Sanitary Sewer Force Main:**
 - a) **Polyvinyl Chloride (PVC) Pipe and Fittings 4 Inch and larger** - Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and Section 8B – Corrosion Protection – Plastic Pipe Systems. PVC force main shall utilize a green dye resin for color in order to represent wastewater or a green locator ribbon with the word "sewer" stenciled shall be used.
 - b) **Ductile Iron Fittings 4 Inch and larger** - Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and Section 8B – Corrosion Protection – Plastic Pipe Systems and requires the prior written approval of the Engineer to use. A green locator ribbon with the word "sewer" stenciled shall be used.

- c) **High-density Polyethylene (HDPE)** - The use of HDPE pipe is allowed however the design engineer shall prepare and submit detailed specifications for the material and installation procedures. The detailed specifications shall be reviewed and approved by the Engineer prior to plan approval. The HDPE pipe shall incorporate a green stripe to indicate "sewer".

5. Sewer Service Pipe and Fittings:

- a) All gravity pipe and fittings shall conform to the requirements of ASTM D-3034, SDR-35.
- b) Service line cleanout caps shall be flush type cap. Cleanouts installed in travel surfacing shall have a frame and cover per the Standard Details.
- c) Force mains less than 4 inch diameter shall utilize HDPE. The use of HDPE requires the Contractor to submit detailed specifications for the material to the Engineer for approval of use.

B. Miscellaneous Pipe Materials:

- 1. **Pipe Couplings:** When coupling PVC pipe to PVC pipe a gasketed PVC repair coupling shall be used. A clamp style coupling shall generally be used when coupling dissimilar pipe materials or for coupling non-PVC pipes.

Clamp style couplings shall be Fernco-Strong back RC series repair couplings, or approved equal.

Nonshear reinforced banded style couplings shall be adjustable repair coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., PVC repair couplings, or approved equal shall be used on all pipe 6 inches in diameter or less. All couplings shall bear the manufacturer's identifying mark and size.

Increasing/reducing couplings will not be allowed.

- 2. **Caps/Plugs:** PVC caps and plugs shall be the gasketed or solvent welded sewer fitting type.

Concrete caps and plugs for non-PVC pipe shall be non-shrink grout placed continuously for a one foot or one pipe diameter, whichever is greater, into the pipe.

- 3. **Sewer Main Insulation:** Refer to Section 11 Utility Excavation and Backfill.

- 4. **Sanitary Sewer Force Main Fittings, Valves, and Ancillary Items:** Shall conform to Section 8A Water Piping Systems, subsection 8A.2 Materials and

Section 8B – Corrosion Protection – Plastic Pipe Systems. Tracer wire color shall be green.

C. Concrete Manholes:

1. **General:** Manholes shall be pre-cast reinforced concrete, manufactured using Type II cement, and shall have diameters as shown on the plans. The manholes shall be manufactured at a precast facility that is certified by the American Concrete Pipe Association, is approved for supplying manholes to the South Dakota Department of Transportation, or has been approved by the Engineer. Manholes 48 inches in diameter shall meet the current requirements of ASTM-C-478. Manholes with diameters larger than 48 inches shall have steel reinforcing that meets the requirements of ASTM C-76, Class 2. Upon request from the Engineer, the Contractor and/or supplier shall supply a test report from an independent testing laboratory showing compliance with this Specification.
2. **Manhole Bases:** Shall be precast integral (monolithic) with the barrel section and shall be cast to a minimum thickness of 6 inches.

Cast-in-place bases shall not be allowed unless pre-approved by the Engineer. When specified in the detailed specifications or shown on the plans, cast-in-place bases shall have a minimum thickness of 8 inches with concrete conforming to the requirements of Class M6, Section 56, and manufactured using Type II cement. Cast-in-place bases shall incorporate a water stop between the base slab and manhole barrel. The water stop material shall be American Colloid “Water stop – RX”, 1 inch x $\frac{3}{4}$ inch size or approved equal. The detailed specifications and use of this type of base shall be reviewed and approved by the Engineer.

3. **Cone Sections:** Shall be eccentric type with 27-inch opening.
4. **Flat Cover Slabs:** When shown on the plans or specified in the detailed specifications, shall be designed for H-20 loading and shall have an offset 27-inch diameter opening.
5. **Gasketed Joints:** Joints between manhole sections, and between manhole sections and flat cover slabs shall be rubber gasketed joints conforming to the requirements of ASTM C443. Gasket types shall be either the O-ring style, the profile style, or approved equal.
6. **Manhole External Joint Seals:** Shall meet the requirements of ASTM C877 Type III, and are required on all manhole joints. The wrap must provide a minimum seal width of 9 inches. Manhole external joint seal shall be Infi-Shield External Gator Wrap or approved equal. Manhole external joint seals shall be installed on all manholes where ground water is present and shall be installed in accordance with the manufacturer’s recommendations. Engineer will identify on the plans where external joint seals are required.
7. **Manhole Steps:** Shall not be provided.

- 8. Lifting Holes:** Penetrating through the manhole sidewalls are not permitted.
- 9. If an interior lift system is used:** Inserts shall be grouted flush with the interior of the manhole after placement, grouted with a non-shrink grout.

- 10. Non-Shrink Grout:** Shall conform to the following requirements:

Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7000 psi in 28 days. Approved manufacturers are:

“Crystex” - by L & M Construction Chemicals

“588 Non-Metallic, Non Shrink Grout” - by W.R. Meadows

“Master Flow 713” – by Master Builders

“SonogROUT 10K” – by Sonneborn

“Five Star Grout” – by US Grout Corp.

Or approved equal.

- 11. Manhole Inverts:** Shall be Class M-6 concrete per Section 56.

- 12. Pipe Connections to New Manholes:** Shall be constructed with a compression-type flexible connector cast into the manhole wall, as manufactured by A-Lok Products, Inc., or approved equal.

Alternatively, shall be constructed with a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring, and double metal take-up clamps, as manufactured by Press Seal Gasket Corporation, or approved equal. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Gasket Corporation or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923.

- 13. Pipe Connections to Existing Manholes:** Are not allowed unless prior approval of the Engineer has been obtained. If approved the connection shall be made by coring the existing manhole and installing a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring and double metal take-up clamps, as manufactured by Press Seal Gasket Corporation, or approved equal. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Gasket Corporation or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923. The existing manhole inverts shall be reconstructed to meet specifications. Refer to Section 9.3 regarding Construction Requirements and the Standard Detail for further guidance with this installation.

- 14. Coating for Concrete Manholes and Lift Station Wet Wells:** When indicated on the plans or specified in the detailed specifications a corrosion resistant interior grout liner shall be provided on manholes or lift station wet wells. This includes coating of the manhole walls and bench, unless noted on the plans otherwise. The

liner shall be Sauereisen Sewergard™ No. 210, Induron Ceramasafe 90 Ceramic Epoxy, or approved equal. These products are specifically formulated for coating the interior of concrete manholes or wet wells for corrosion protection.

Coating color shall be the Earthcoat gray for manholes and Earthcoat white for wet wells unless otherwise indicated on the plans or specified in the detailed specifications.

D. Manhole Frames and Covers:

1. **All Frame and Covers:** Shall be constructed with gray iron having a tensile strength of not less than 35,000 pounds per square inch. The frame and covers shall conform to ASTM A48, Class 35B. The castings shall be heavy-duty type, designed for H2O loading conditions. The castings shall be free from cracks, blowholes, porosity, shrinkage distortion or other imperfections. They shall be true to pattern and free from warpage. The frame and covers shall fit together in a satisfactory manner. Machined bearing surfaces shall be provided to prevent rocking and rattling. Manhole frames and covers shall be as follows:
 - a) Standard frames and covers shall have a minimum casting height of 7 inches.
 - b) Standard frames and covers shall be Neenah 1733, Deeter 1260, Municipal Castings (MC) 301, or approved equal unless otherwise indicated on the plans or specified in the detailed specifications.
 - c) Extra deep frames and covers shall be installed where manholes are located in pavements thicker than 7 inches. A casting height corresponding to or exceeding the pavement thickness (up to 10 inches) shall be selected. Extra deep frames and covers shall be Neenah 1733-A; 1733-B; or 1733-C, Deeter 1261, or approved equal.
 - d) Bolt down frames and covers shall be installed as specified but will mainly be used in areas, which are without hard surfacing and are subject to flooding. Bolt down frames and covers shall be Neenah R1916-F, Deeter 1247-B, or approved equal.
2. **All Covers:** Shall be supplied with concealed pick holes as specified in the standard plates. All covers shall be marked with the letter "S" or word "Sewer" formed in the center of the cover. The cover style shall be a Neenah Type "B" Lid, indented top design, or approved equal. All covers shall be supplied with self-sealing type "T" or O-Ring gaskets as manufactured by Neenah Foundry Company, machined groove continuous O-Ring gasket as manufactured by Deeter Foundry Inc., or approved equal. The covers shall be delivered from the manufacturer with pre-installed glued-in gaskets. The gasket shall be installed in a machined groove and be continuous around the perimeter. The gasket material shall be oil resistant Nitrile (60 DURO) glued in the groove, and have a maximum swell of 90 percent when tested in accordance with ASTM D471 using ASTM No.

3 oil. The glue shall be Lock-rite Black Max as manufactured by 3M Products or approved equal.

E. Manhole Adjusting Rings:

1. Concrete Adjusting Ring Materials:

- a) **Masonry Bricks, Masonry Blocks, or Masonry Shimming Devices:** will be allowed for use in adjusting manhole castings. Wood blocking or wood shimming devices greater than one inch in thickness will not be allowed. Any blocking or shimming device, when used, will not extend to the interior of the manhole.
- b) **Adjusting Rings:** Concrete adjusting rings shall be in accordance with ASTM C478. The adjusting rings shall be sized to conform to the standard manhole 27-inch cone opening, frame, and cover.
- c) **Mortar:** Shall be "Non-Shrink Grout" as previously specified in this section.

2. Plastic Adjusting Ring Materials:

- a) **Sealant:** Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK #3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
- b) **Plastic Adjusting Rings:** The adjusting rings shall be injection molded HDPE as manufactured by Ladtech, Inc. or approved equal. The adjusting rings shall be manufactured from polyethylene plastic as identified in ASTM D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Material properties shall be tested and qualified for usage in accordance with the ASTM Test Methods referenced in ASTM D-1248. The plastic adjusting rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers).

The adjusting rings shall be tested to assure compliance with impact and loading requirements in accordance with the AASHTO Standard Specification for Highway Bridges. The adjusting rings shall meet and exceed the static load requirements of AASHTO Highway Bridge Specification HS-25 (21,280 lbs). The rings must withstand 1,000,000 plus full load cycles of 10 seconds or less duration. The rings must perform without failure to a minimum of 150 percent of these load values. The adjusting rings shall be sized to conform to the standard manhole 27-inch cone opening, frame, and cover.

3. Rubber Adjusting Ring Material:

- a) **Sealant:** Sealant shall be polyurethane, formulated specifically for use with rubber adjusting rings and shall be manufactured by GNR Technologies, or approved equal.
 - b) **Rubber Adjusting Rings:** Rubber adjusting rings shall be Infra-Riser multi-purpose rubber adjustment riser as manufactured by GNR Technologies, or approved equal.
- F. Manhole Internal Frame Seal:** Manhole internal frame seals shall be installed with all manholes, unless pre-approved by the Engineer to be installed without a chimney seal. Manhole internal frame seals shall be CRETEX Internal Manhole Chimney Seals as manufactured by CRETEX Specialty Products, NPC Flexrib Seal, or approved equal. Internal frame seals shall consist of a flexible internal rubber sleeve and extension that completely covers all rings from cone to casting and stainless-steel compression bands.
- G. Tracer Wire System:** Tracer Wire shall be a direct bury wire per Section 8B except shall be modified as having the insulation color be green.

9.3 CONSTRUCTION REQUIREMENTS

A. Wastewater Flow Modifications:

1. **Interruption of Service:** The Contractor shall provide continuous, uninterrupted sanitary sewer service to all users in and upstream of the project area.
2. **Flow Handling Plan:** Prior to beginning work on any manhole or sewer main requiring flow modifications the Contractor shall present a plan for handling wastewater flows to the Engineer for approval. The plan shall describe the methods to be used and shall identify all materials and equipment that will be required for flow handling. The Contractor's plan shall also identify a contingency plan and procedures to be implemented in the event of an equipment failure or other emergency.
3. **Methods:** Bypass pumping is required during construction hours and temporary connections between existing and new sewer mains are required during non-working hours. Wastewater flows shall not be conveyed in open ditches nor in the trench excavation, and at no time shall wastewater be allowed on the ground surface, trench, streets, gutters, storm sewers, or other places, which may constitute a health hazard. Whenever, in the opinion of the Engineer, a health hazard exists because of actions or inactions of the Contractor, the Contractor shall immediately correct the situation to the satisfaction of the Engineer. If not corrected in a timely manner, the City may cause to take any actions necessary to remove the health hazard and charge the Contractor one and a half (1 ½) times the cost incurred.

If bypass pumping is required by site conditions or as per plan note, the following shall apply.

- a) The Contractor shall furnish all labor, supervision, tools, equipment, appliances, and materials to perform all operations in connection with bypass pumping of sewage flow for the purpose of preventing interference with the televising of the sanitary sewer manholes and mainlines as well as providing reliable sewer service to the occupants of the buildings being served.
- b) The Contractor will be required to provide adequate pumping equipment and force mains in order to maintain reliable sanitary sewer service in all mains involved in the scope of the work.
- c) Under no circumstances shall the flow be interrupted or stopped, such that damage is done to either private or public property, or sewage flows/overflows into a storm sewer or natural waterway.
- d) The Contractor shall provide bypass pumping of sewage around each segment(s) of main that is to be televised and shall be responsible for all required bulkheads, pumps, equipment, piping, and other related appurtenances to accomplish the sequence of pumping. Also refer to Section 205 for bypass pumping requirements when televising.
- e) The Contractor shall be required to have all materials, equipment, and labor necessary to complete the repair or replacement on the jobsite prior to isolating the sewer manhole or line segment and beginning bypass pumping operations.
- f) The Contractor shall locate bypass pumping suction and discharge lines so as to not cause undue interference with the use of streets, private driveways, and alleys to include the possible temporary trenching of force mains at critical intersections.
- g) The Contractor shall not initiate any effort to accommodate bypass pumping piping operations until specific written approval is given by the Engineer.
- h) The Contractor shall coordinate with all property owners to ensure that no damage will be caused to their property during any and all sewer rehabilitation work.
- i) The Contractor shall complete the televising as quickly as possible and shall satisfactorily meet all requirements prior to discontinuing bypass pumping operations and returning flow to the sewer manhole or main segment.
- j) The Contractor shall ensure that no damage will be caused to private property as a result of bypass pumping operations. Ingress and egress to adjacent properties shall be maintained at all times.
- k) Ramps, steel plates, or other methods shall be employed by the Contractor to facilitate traffic over surface piping.

4. **Damages to Property:** Any damages to private or public property due to backups, overflows, or surcharging resulting from work under this section shall be the responsibility of the Contractor and shall be corrected as soon as practical and at no cost to the City. If not corrected in a timely manner, the City will take the necessary action and charge the Contractor one and a half (1½) times the cost incurred.

B. Materials Handling and Storage:

The Contractor shall be responsible for the safe handling and storage of all materials furnished, and shall replace, at their expense, all such materials found defective in manufacture or damaged in transportation, handling, or storage.

Pipe, manholes, castings, and accessories shall be loaded and unloaded by lifting with hoists or skidding to avoid shock or damage. Under no circumstances shall such materials be dropped. All material shall be stored in a neat and orderly manner. Pipe shall be stored, to the greatest extent possible, in unit packages or bundles and shall be handled to prevent stress to bell joints and prevent damage to bevel ends. In addition, materials shall be handled and stored in accordance with manufactures' recommendations.

The Contractor shall cover all PVC pipe and fittings in accordance with manufacturer recommendations. In the absence of manufacturer recommendations, PVC pipe and fittings shall be stored to minimize direct rays of sun and UV exposure. This may be accomplished with a minimum of a light opaque material covering the pipe. The covering shall be positioned to allow adequate ventilation to prevent heat buildup. The submittal for this material shall identify the proposed method of storage. Pipe material that shows signs of UV impact including impacts such as chalking, faded colors will be removed from use on the project.

- C. **Underground Obstructions:** The Contractor shall expose existing underground obstructions shown on the plans or located in the field and shall determine their elevations far enough in advance of pipe laying that the proposed sewer main can be adjusted. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere with the proposed horizontal or vertical alignment of the sewer, the Contractor shall notify the Engineer so that the Engineer may modify the plans and order a deviation in the line and/or grade, or may arrange for the removal or relocation of the obstruction(s). The Contractor shall not deviate from plan line or grade without the Engineer's approval.
- D. **Sewer Main and Water Main Crossings:** Refer to Section 11 Utility Excavation and Backfill.
- E. **Protection of Existing Sewers:** The Contractor shall take necessary precautions to ensure that dirt, debris, and foreign materials do not enter existing sewers. Where new sewer mains are to be extended from and connected to existing sewers, the Contractor shall give, the City Utility Maintenance Division 24-hour notice in order that City personnel may install a temporary plug at the terminal manhole on the existing sewer.

Contractor is responsible to ensure that the plug remains functional. Said plug shall remain in place and functional until all work on the new sewer has been completed and the Engineer is satisfied that the new sewer is free of dirt, debris, and foreign materials. Plugs shall be salvaged to City Utility Maintenance upon removal. Any costs incurred by the City due to the Contractor allowing dirt, debris, foreign materials, trench water, or storm water to enter an existing sewer shall be charged to the Contractor at one and a half (1 ½) times the cost incurred.

F. Installation of Pipe:

1. **Trenching, Bedding, and Backfill:** Shall comply with the requirements of Section 11 Utility Excavation and Backfill. Trench dewatering discharges shall not be allowed to enter the sanitary sewer collection system at any time.
2. **Alignment and Grade:** Pipe shall be laid true to the line and grade established on the plans. Pipe shall be installed within 1/2 inch (0.04 feet) of the specified alignment and within 1/4 inch (0.02 feet) of the specified grade. These tolerances apply to any point along the entire pipe length.

The Contractor shall carry line and grade into the trench by means of an approved laser beam system and by surveying level instrument. At no time shall the Contractor change the grade without approval from the Engineer. If an underground obstruction is encountered at the assigned grade, the Contractor shall notify the Engineer and wait until the revised grade for the sewer has been determined, if necessary.

As a secondary check to the laser beam device, the Contractor shall check the grade from a surveyed grade stake to the pipe invert a minimum of every 100 feet using a surveying level instrument. The Contractor shall record all grade checks and produce the grade stake record if requested by the Engineer.

3. **Cleaning:** Shall be done as necessary so that the interior of all sewer pipe is free from all dirt, cement, or other foreign material before installation. Contact surfaces shall be wire brushed immediately prior to jointing.
4. **Pipe Cutting:** Shall be done without damage to the pipe with saw or abrasive wheel and shall be smooth, straight, and at right angles to the pipe axis. Ends of pipe shall be dressed and beveled to remove roughness and sharp corners.
5. **Laying and Joining of Pipes:** Shall be in accordance with the pipe manufacturer's instructions, unless specifically required otherwise by these specifications.
 - a) Each pipe length shall be inspected for defects prior to being lowered into the trench. All pipes shall be carefully lowered into the trench to prevent damage to the pipe and/or coating.
 - b) Sewer pipe shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe.

- c) Pipe shall be carefully installed to line and grade in accordance with line and grade stakes so that the finished sewer will present a uniform grade. Any noticeable variations from true alignment or grade will be cause for rejection of the work.
- d) All pipe shall be installed upgrade with spigot ends pointing in the direction of flow. The bottom of the trench shall be free of all rocks and stones and shall be hand shaped and bedded and the pipe shall be in firm contact with the bedding material for its entire length.
- e) At every bell and spigot pipe joint, a hole shall be dug of sufficient size so that the weight of the pipe will rest on the barrel of the pipe and not on the bells, and the bell hole shall not be compacted. All pipe must be properly fitted together.
- f) During the course of construction, a suitable stopper shall be kept in the end of the pipe to prevent any dirt and or water from entering during the progress of the work at all times. Any dirt, loose material or cement mortar, which may accumulate in the pipe, shall be removed as the work progresses.
- g) Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at manhole terminations, except as noted in the plans and as needed for the installation of service inline tees or wyes. A full standard length pipe shall be used upstream of all manholes.
- h) Joint surfaces shall be cleaned and lubricated immediately before completing the joint. Lubricant other than that furnished with the pipe shall not be acceptable. Pipe jointing shall be accomplished in a relatively dry trench condition.
- i) At manhole connections the Contractor shall take extra care to ensure the pipe is properly bedded to prevent shifting, settlement, deflection, or other failures.
- j) Joints in PVC Sanitary Sewer Pipe:
 - 1) All PVC Sanitary Sewer Pipe shall be jointed utilizing elastomeric gaskets as specified. All pipe, fittings and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and as specified in the latest revision of ASTM D2321.
 - 2) The joint surfaces (external and internal) shall be wiped free of all foreign materials, and the spigot end shall be centered on grade into the bell end and the joint shall be properly seated in accordance with the manufacturer's recommendations.

- 3) Any pipe that is field cut shall have a square end with beveled edge equal to a factory cut and all field repairs shall be performed per manufacturer's recommendations.
- k) Joints in Pipe Material Other than Identified in the specifications: Repairs on existing pipe not otherwise specified in this Section shall be approved by the Engineer.
6. **Protection of the Work:** At the end of each day's work, or when sewer pipe is not being laid, the Contractor shall protect the end of the pipe by a close-fitting stopper to prevent soil, water, or other matter from entering the pipe, and shall take adequate precautions to overcome possible uplift. The elevation of the last pipe laid the previous workday shall be checked the next day before work resumes.
7. **Connections:** When coupling PVC pipe to PVC pipe a PVC repair coupling shall be used. A clamp style coupling shall generally be used when coupling dissimilar pipe materials or for coupling non-PVC pipes. When using the Power seal or Fernco type installation, the Contractor shall encase the coupling in six inches of concrete for one (1) foot either side of the coupling. PVC couplings do not require concrete encasement.
8. **Minimum Cover:** Depth from the top of pipe to finished grade shall not be less than 5.0 feet for Collector Sewers (sewer mains with service connections) or 4.0 feet for Interceptor Sewers (sewer mains with no service connections). In the event adequate cover cannot be achieved by alignment or grade adjustment then, with prior approval of the Engineer, the sewer pipe may be insulated. Refer to Section 11 Utility Excavation and Backfill and Standard Details for insulation requirements in cases where minimum cover cannot be provided. The use of insulation shall only be permitted in those rare instances where the pipe's grade cannot be adjusted, or the finished surfacing grade cannot be adjusted to maintain the minimum cover. Insulation shall be required in instances where less than 18 inches of separation between culverts or storm sewers cannot be achieved.
9. **Dewatering:** Shall be accomplished per Section 11 Utility Excavation and Backfill.
10. **Insulation:** Shall be accomplished per Section 11 Utility Excavation and Backfill.
11. **Sanitary Sewer Force Main:**
 - a) Shall conform to Section 8A Water Piping Systems, subsection 8A.3 Construction Requirements.
 - b) In addition to meeting the above requirements Tracer Wire Access Boxes shall be installed at a minimum of every 500 feet along the length of the force main and at all system valves. Each Tracer Wire Access Box shall be located as identified in Section 8B Corrosion Protection – Plastic Pipe Systems.

- c) PVC force main shall utilize a green dye resin for color in order to represent wastewater or a green locator ribbon with the word “sewer” stenciled shall be used. The green locator ribbon shall be installed with ductile iron pipe. The locator ribbon shall be placed on top of the “select bedding material” approximately 12 inches above the top of pipe and centered horizontally directly over the pipe.

G. Installation of Manholes:

1. **All Manhole Barrel and Cone Sections:** Shall be numbered and/or measured by the Contractor prior to installation to ensure that each furnished manhole component is correct for that location and that the finished manhole will be to the grade specified. External joint seals shall be installed on all manhole joints when ground water is present.

Placement of manholes shall be on a 4-inch (minimum thickness) leveling course of Type 1 Bedding Material. Manholes shall be set level and to the grade specified.

2. **Invert Channels:**

- a) **General:** Channels shall have smooth, clean surfaces and shall be semi-circular U-shaped conforming to the adjacent pipe. Changes in size and grade of the channels shall be made gradually and evenly. In no case shall the invert width through the manhole be greater than that of the outlet pipe. Changes in direction flow and side branch connections shall be made with a full, smooth, and sweeping curve with a radius meeting the requirements per the Standard Details.

Manhole inverts shall be U-shaped with a channel depth equal to the diameter of the outlet pipe and with the channel sides, above the spring line, vertical or slightly laid back at a slope not to exceed (1/10, horz./vert.). Refer to Standard Details. Manhole inverts shall be Class M-6 concrete per Section 56, manufactured using Type II cement.

The manhole invert shall be shaped and finished with a smooth steel trowel finish.

- b) **Inverts for New Manholes:** Materials for new manhole inverts and benches shall be as specified in Section 9.2 Materials. New manhole benches and inverts shall be constructed by the same manufacturer that produces the precast monolithic base and constructed at the production facility. Field cast inverts will not be allowed for new manholes unless pre-approved by the Engineer.

The manhole invert and bench shall have a smooth steel trowel finish.

- c) **Inverts for Existing Manholes:** Materials for existing manhole inverts shall be as specified in Section 9.2 Materials and as further described.

Existing manhole benches and inverts may be reconstructed with hand formed inverts and benches provided the other components of the specification are met. The manhole invert and bench shall have a smooth steel trowel finish.

All sewer flows shall be removed by bypass pumping or other approved methods from the manhole to be reconstructed. The existing invert and bench shall be demolished to the extent necessary to maintain a minimum new concrete invert thickness of 3 inches and side thickness of 8 inches throughout the manhole.

Acceptable methods for demolishing the existing invert include the use of concrete saws, core drilling, jackhammers, chisels and other hand tools. The existing concrete shall be rough and have an approved bonding agent applied to it prior to placing the new concrete. The new invert shall be constructed using a concrete mix as specified with the exception that the concrete shall be low slump.

Sewer flows will not be permitted on the concrete until 4 hours after the initial set has occurred and the Engineer has inspected and approved the reconstructed invert.

3. **Shelves/Benches:** Shall be formed from the top of the channel to the manhole wall and shall slope up from the channel at a minimum rate of 1 inch per foot and a maximum rate of 3 inches per foot.
4. **Steps:** Anytime work is done on the inside of an existing manhole with steps, steps must be removed, and grout applied over any remaining metal or holes from the old steps filled in.
5. **Pipe Connections to New Manholes:** Manhole connections to the sewer main shall be accomplished with a rubber boot or a gasket seal that insures a watertight seal. Ends of pipes, which enter manholes, shall be cut smooth, straight, and at right angles to the pipe axis. The annular space between the boot or gasket and the pipe shall be grouted flush with the inside of the manhole such that a smooth, continuous channel is formed through the manhole. The annular space above the flow channel on top of the pipe shall not be grouted.

Drop manholes shall have the lower connection and 45-degree fitting, outside the manhole, totally encased in concrete. Refer to Standard Details. The interior pipe connections shall have the annular space grouted as described above.

When a sewer main stub is provided for future extension, the sewer main stub shall be capped with a watertight cap.

6. **Pipe Connections to Existing Manholes:** Pipe Connections to existing manholes shall not be allowed unless preapproved by the Engineer. When a connection or

extension is necessary the Engineer may require the manhole be replaced with a new manhole.

If preapproved by the Engineer the manhole connections shall be made by coring the existing manhole and installing a boot-type flexible connector consisting of a rubber gasket or boot, metal expansion ring and a metal take-up clamp, as manufactured by Press Seal Gasket Corporation, or approved equal. Rubber boots and gasket material shall meet or exceed ASTM C-923. Drop manholes shall have the lower connection and 45 degree fitting, outside the manhole, totally encased in concrete. Refer to Standard Details. The interior pipe connections shall have the annular space grouted as described for "Pipe Connections to New Manholes".

The Contractor shall test the existing manhole for water tightness prior to making any modifications as required under Section 9.3.1 - Manhole Tests. If the manhole does not pass a water tightness test prior to modifications, the Contractor will not be required to pass a test after modifications are made to the manhole. Manhole must pass a visual inspection by the Engineer. If the manhole does pass a water tightness test prior to modifications, the Contractor shall test the manhole after modifications are made and if the manhole does not pass the test it shall be the Contractor's responsibility to correct the deficiencies and demonstrate a passing test. The Contractor is responsible for correcting deficiencies in the manhole.

External joint seals shall be installed on an existing manhole for all exposed manhole joints when adding a pipe connection to an existing manhole, when ground water is present and no external joint seals exist.

7. Frames and Covers:

- a) **Grade and Slope:** Manhole frames and covers shall be placed at finished grade. When placed in asphalt, concrete, or gravel surfaces, frames and covers shall match both the crown slope and profile slope of the street. The cover shall be set at an elevation and slope that it is not above the surface and no more than 1/2 inch below the surface at all points around the circumference of the cover. Decreasing the surfacing thickness around the manhole frame and cover, as a method of achieving the above tolerances, is not permitted.

Finished grade for frames and covers located outside of paved areas shall be graded such that positive drainage will be maintained away from the manhole.

Frames shall be blocked and shimmed to correct elevations and slopes prior to placing pavement. The lid shall be adjusted to match both the cross slope of the street and the profile of the street. Following paving, the frame shall be checked for correct placement and adjusted as necessary. The joint between frame and adjusting ring shall then be grouted watertight with non-shrink grout. Blocks and shims shall be placed no closer than 2 inches from the inside edge of the adjusting ring. The internal frame seal shall be installed after the manhole frame and cover has been installed in its final position and is complete.

Vertical Adjustment of manhole frames and covers:

Adjusting rings shall be installed per the Standard Details and as specified herein. Adjustments greater than those shown on the details shall be accomplished by replacing or adding additional barrel sections rather than adjusting rings.

Plastic, rubber or concrete adjusting rings may be used. The plastic or rubber adjusting rings shall be installed as recommended by the manufacturer. No shims or other leveling devices, other than leveling rings provided by the manufacturer, will be permitted with use of the plastic or rubber adjusting rings. The annular space between the adjusting rings shall be sealed using an approved sealant. The first plastic adjusting ring on existing manholes may require leveling with concrete mortar and therefore the first plastic ring may be set in mortar.

The manhole frame and adjusting rings where concrete adjusting rings are used shall be set in a full bed of mortar to the grade and slope as specified. The mortar shall be tuck pointed between rings and shall not be applied to the inside diameter surface of the adjusting rings. Smearing of mortar on the inside of the adjusting rings will be cause for rejection of the work.

- 1) **New Manholes:** New Manhole barrels and cone sections shall be manufactured to a tolerance that provides from 2 inches to 8 inches of vertical adjustment between the top of the cone and the bottom of the frame. Vertical adjustments, between the top of the cone and the bottom of the frame, greater than 8 inches shall be accomplished by installing a new appropriately sized manhole barrel section. Rings shall be vertically aligned to be straight with the top of the cone section without any offset.
- 2) **Existing Manholes:** Existing manhole frames and lids may be adjusted to grade by adding additional adjusting rings. The vertical adjustment between the top of the cone and the bottom of the frame however shall not exceed 18 inches. Vertical adjustments greater than 18 inches shall be accomplished by installing a new appropriately sized manhole barrel section or manhole cone section. Rings shall be vertically aligned to be straight with the top of the cone section without any offset.

Steel adjusting rings that are inserted into the existing frame and allow the cover to be raised are not permitted. All manhole adjustments shall be done as specified above.

External joint seals shall be installed when a vertical adjustment of a manhole occurs on an existing manhole for all exposed manhole joints, when ground water is present and no external joint seals exist.

- b) **Chimney Seal:** Unless pre-approved by the Engineer, manhole chimney seals shall be installed in all cases. Whether an existing manhole is adjusted or a new manhole is installed, the manhole chimney shall be sealed. All manhole chimneys shall be sealed using a manhole internal frame seal. The seal shall be installed according to the manufacturers recommendations and when properly installed will prevent the inflow of water between the manhole cone and the frame and cover.
8. **Coating for Concrete Manholes and Lift Stations Wet Wells:** When indicated on the plans or specified in the detailed specifications a corrosion resistant interior coating shall be provided on manholes or lift station wet wells. The coating may be field applied or applied at the manufacture's site. New manholes shall be coated prior to installation. This includes coating of the manhole walls and bench, unless noted on the plans otherwise. The material shall be applied as per manufacturer's recommendations. Manhole coating color shall be as specified in Section 9.2 Materials.
9. **Manhole Depth:** Manholes 5.5 feet and greater in depth, measured from invert to rim, shall have eccentric cone top section per Standard Manhole Detail. Manholes less than 5.5 feet in depth shall have flat concrete covers designed for AASHTO H-20 wheel loading as per Standard Shallow Manhole Detail.

H. Sewer Main Tests:

1. **General:** A visual inspection, a television inspection, a leakage test, and a pipe deflection test shall be performed as specified herein for all sewer mains and manholes as a condition of acceptance by the City. All tests shall be performed after backfill is complete but prior to any surface restoration.
2. **Pre-Cleaning:** Prior to testing newly installed sewer pipe, the Contractor shall remove all accumulated construction debris, rock, gravel, sand, silt, and other foreign matter from the sewer with an appropriately sized cleaning ball.

The Contractor shall be responsible for all work necessary to make the sewer acceptable for usage including removal of all mud, silt, rocks, or blockages that make said sewer unacceptable for final acceptance and usage. Also included is all work necessary in the manholes and all cleanup work required prior to final acceptance.

The City will not be responsible for cleaning lines prior to televising the sewer. In the event that the line is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to arrange to clean the sewer and make it acceptable for the television inspection work. If not cleaned in a timely manner, the City may cause to take any actions necessary and charge the Contractor one and a half (1½) times the cost incurred.

3. **Visual Tests:** All newly installed sewer main pipe shall pass a visual, or "lamping", inspection by the Engineer, and a television inspection performed by the

Contractor. Refer to Section 205 – Televising for requirements. Straight alignment shall be checked either with lamping or with the laser beam. Lamping shall be conducted by viewing the pipe from inside a manhole to determine proper alignment. The television inspection shall consist of viewing the inside of all sewer main pipe installed to determine proper alignment, joining, properly installed service connections, infiltration, etc. The Contractor shall correct, at their own expense, any defects discovered because of lamping and/or televising the pipe.

Both a visual and television inspection shall be completed unless specified otherwise on the plans or specified in the detailed specifications.

If defective workmanship of material or construction is noted, the Contractor at no expense to the City, shall correct the deficiency. Additional television inspections to review if the repairs were made properly and in accordance with the specifications shall be provided by the Contractor per Section 205. The Contractor shall be responsible for all related costs, including concrete or asphalt resurfacing if the street has been surfaced. The Contractor shall be required to repair all areas of infiltration and other deficiencies. The City may cause to take any actions necessary for any items not completed or repaired in a timely manner and may charge the Contractor one and a half (1½) times the costs incurred.

It is the Contractors responsibility to notify the Engineer/City Inspector that the sewer is ready for inspection and when television inspection will occur. Any surfacing started prior to the television inspection is at the Contractors own risk.

4. **Leakage Tests:** The Contractor shall conduct leakage testing of all newly constructed or reconstructed sewer mains. The Contractor shall furnish all necessary equipment and be responsible for conducting the leakage test in the presence of the Engineer and/or City Inspector.

The preferred Leakage Test method is the “Low Pressure Air Test”, provided groundwater conditions allow it. Alternative leakage tests may be the “Ex-Filtration Test” if groundwater is less than 4 feet above the top of pipe, or the “Infiltration Test” if groundwater is 4 feet or more above the top of pipe.

Leakage tests for sewer mains shall include testing of the mains and service pipe connections including inline sewer service wyes/tees.

When existing sanitary sewers which have service connections are being reconstructed or replaced (example: street reconstruction projects), the leakage test requirements may be waived or other testing methods substituted, subject to the approval of the Engineer.

- a) **Low Pressure Air Test:** This is the preferred testing method. The Contractor may conduct low-pressure air testing of newly installed sewer mains in lieu of ex-filtration testing if the ground water is less than 1 foot above the top of the finished sewer main at the lowest point of the test section as determined by construction records and/or test borings. The test shall conform to the

procedures outlined in Uni-Bell Specification Uni-B-6-98 or latest, Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

The pressurizing equipment shall include a regulator or relief valve set no higher than nine (9) psig to avoid over-pressurization.

Pipeline segments between manholes shall be tested separately. Mechanical or pneumatic plugs shall be placed in the line at opposing manholes and each plug braced as a safety precaution. An aboveground air pressurizing device including shut-off valve, pressure-regulating valve, pressure relief valve, input pressure gage and a continuous monitoring pressure gage shall be provided and connected to the test plug at one end.

Separate hoses for introducing air and for monitoring air pressure shall be provided. The monitoring hose shall be equipped with two (2) accurate pressure gauges. The monitoring gauges shall read in divisions of 0.1 psi with an accuracy of plus or minus 0.04 psi.

Procedure:

- 1) Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test. This cleaning serves to eliminate debris and produce the most consistent results.
- 2) Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.
- 3) Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. All plugs and caps shall be securely braced to prevent blow-out. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source.
- 4) Connect the air hose to the inlet tap and portable air control source. The air equipment shall consist of necessary valves and pressure gauges to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.
- 5) Low pressure air shall be introduced into the line until the internal pressure reaches four (4) psig, and the supply throttled to maintain four (4) psig for at least two (2) minutes. The supply shall then be shut off or disconnected. The pressure shall be allowed to drop to about three and one-half (3 ½) psig at which time the timing shall commence and the time accurately measured for a one (1) psig pressure drop per Table 9-1.
- 6) If the test section fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner

approved by the Engineer. This does not mean that the Low Pressure Air Test has to be repeated but rather a passing test has to be achieved by either the Low Pressure Air Test or the Ex-filtration Test.

- 7) The Engineer may reduce the testing time to one-half the testing time if the pressure drop is less than 0.5 psi for the first one-half the test period listed in Table 9-1.
- 8) Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until all air pressure in the test section has been reduced to atmospheric pressure.

**TABLE 9-1
LOW PRESSURE AIR TEST
ALLOWABLE LEAKAGE FOR A 1 PSIG PRESSURE DROP ***

Pipe Diameter	Time of Test (sec.'s)	Minimum Time of Test (sec.'s)
4	0.380 x L	226
6	0.854 x L	340
8	1.520 x L	454
10	2.374 x L	566
12	3.418 x L	680
15	5.342 x L	850
18	7.692 x L	1020
21	10.470 x L	1190
>21	as per plans	

* Use of Table 9-1:

The time of test shall be calculated using the formula presented in Table 9-1. Time is in seconds and L is in feet of pipe being tested. If the calculated time is less than the minimum time of test then the minimum test time shall govern. For example: 200 feet - 10 inch sewer would have a calculated time of $2.374 \times 200 = 475$ seconds. The minimum test time however is 566 seconds. Thus the minimum length of time for a 1 psig pressure drop would be 566 seconds not the calculated 475 seconds.

If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test considered.

L is the length of the sewer main. If sewer services are included in the air test, no additional time for the test is necessary beyond that needed for the sewer main.

- b) **Ex-Filtration Test:** Shall be used if groundwater is less than 4 feet above the top of pipe as determined by construction records and/or test borings. The test shall be conducted in a manner approved by the Engineer and shall provide a minimum head of 2 feet at the highest point in the test section, but no more than 10 feet of head at the lowest point, with head measured from top of pipe, except when the groundwater surface is above the pipe, in which case head shall be measured from the groundwater surface.

Unless otherwise specified, the pipe shall not allow ex-filtration of water of more than 50 gallons per inch diameter per mile of pipe (50 gallons/inch/mile) in any 24-hour period as per Table 9-2.

The minimum test period shall be for two (2) hours and the values derived from Table 9–2 will need to be adjusted for the actual test time. If the test section fails to meet these requirements the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does not mean that the Ex-filtration test has to be repeated but rather a passing test has to be achieved by either the Ex-filtration Test or the Low Pressure Air Test.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ. However, a separate manhole ex-filtration test will not be required when manholes are tested simultaneously with the sewer pipe ex-filtration test.

The Contractor shall anticipate the need to conduct multiple tests in order to meet the above requirements and shall conduct testing in such a manner and sequence that the requirements indicated above are achieved.

Water used to test ex-filtration shall be clean potable water and will not be allowed to discharge to the sewer system. The Contractor shall be responsible for removing the water by pumping it from the system and discharging it at an approved location.

**TABLE 9-2
ALLOWABLE LEAKAGE ***

PIPE SIZE (Inches)	LEAKAGE RATE (Gallons/Feet/24 Hours.)
8	0.08 x L
10	0.09 x L
12	0.11 x L
15	0.14 x L
18	0.17 x L
21	0.20 x L
24	0.23 x L
27	0.26 x L
>27	as per plans

* Use of Table 9-2:
The length of time for the test in the table is given as a 24-hour period and will need to be adjusted for the actual test time. The allowable leakage shall be calculated using the formula presented in Table 9-2 and L is in feet of pipe being tested.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ.

If the Contractor wishes to concurrently test the pipe and manhole then Table 9–4 may be used to assist in measuring the pipe loss for a concurrent test.

For example the calculated loss for 350 feet - 12 inch sewer would be $0.11 \times 350 = 38.5$ gallons in a 24-hour period. To adjust this loss to the actual test time or if a manhole test is being conducted concurrently the 38.5 gallons would need to be converted, to say, two (2) hours; then $(38.5 / 24 \text{ hrs}) \times 2 \text{ hrs} = 3.2$ gallons. The 3.2 gallons would be the permitted loss or if testing concurrently would have to be added to the loss calculated for the manhole.

- c) Infiltration Test:** Shall be used if ground water is 4 feet or more above the top of the finished sewer main at the highest point of the test section as determined by construction records and/or test borings. Test methods and infiltration measurements shall be conducted in a manner approved by the Engineer.

The allowable leakage into the pipe shall not exceed that set for Ex-Filtration in Table 9-2. The minimum test period shall be for two (2) hours and the table values will need to be adjusted to accommodate for the actual test time. If the test section fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does mean that the Infiltration Test has to be repeated as the other test methods would not be permitted because of the groundwater conditions.

- 5. Pipe Deflection Test:** Deflection tests shall be performed by the Contractor on all PVC sewers. Deflection tests will not be required for reinforced concrete pipe sanitary sewers. Deflection tests for other sanitary sewer pipe materials will be handled on a case-by-case basis by the Engineer. Deflection tests shall be conducted after the final backfill has been in place at least 30 days. Deflection tests shall be made using a deflection gauge (mandrel) device or other approved method. The diameter of the deflection gauge device shall be 95% of the undeflected inside diameter of the flexible pipe. The deflection test shall be performed without mechanical pulling devices. The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed five (5) percent. All pipes exceeding the five (5) percent deflection within the two-year warranty period shall be re-laid or replaced by the Contractor at no additional cost to the City.

I. Manhole Tests:

- 1. General:** Manhole tests shall be performed on all newly installed manholes and on existing manholes where new sewer main connections have been made. The preferred Manhole Leakage Test method is the “Manhole Vacuum Test” rather than the “Ex-Filtration Test”.
- 2. Existing Manhole Modifications:** For existing manholes where new sewer main connections are to be made or any modifications, the Contractor shall test the manhole prior to any modifications to confirm manhole will pass test. Testing is not required when modifications are the addition of chimney seals or manhole

adjustment by use of adjusting rings. If the existing manhole passes the test, Contractor is required to pass the test after modifications are made to manhole. If the existing manhole does not pass the test, Contractor is not required to pass the test after modifications are made to manhole.

3. **Visual Test:** The Engineer/Inspector will visually inspect each manhole exterior and interior for flaws, cracks, holes, or other deficiencies, which may affect the operation or watertight integrity of the manhole. Should any deficiencies be discovered, the Contractor shall correct them to the satisfaction of the Engineer and at no cost to the City. Manhole barrels and cones that have cracks or holes that extend from the interior of the barrel or cone to the exterior shall be replaced. Manhole barrels or cones that have spalls or cracks that extend to or through the O-ring gasketed joint shall be replaced. For other deficiencies or flaws the Contractor may submit to the Engineer a written repair procedure for consideration. The Engineer may or may not permit the proposed repair method and by allowing a repair method does not, in anyway, remove or alleviate any testing requirements.
4. **Manhole Vacuum Test:** Shall be performed in accordance with ASTM C1244. The following procedure is summarized from ASTM C1244 and shall be followed in conjunction with ASTM C1244 unless modified by the Engineer. The vacuum test shall include testing the top of the manhole, excluding the adjusting rings and manhole frame and cover. Testing will be allowed after backfilling has occurred, manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries, Inc. or approved equal. Repair of leaks may require the removal and replacement of manhole sections. Repair of leaks shall be approved by the Engineer.

Procedure:

- a) All lift holes shall be plugged.
- b) All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
- c) The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
- d) A vacuum of 10 inches of mercury shall be drawn on the manhole and then the vacuum line shall be throttled to maintain the 10 in vacuum for at least two (2) minutes. After the two minutes the valve on the vacuum line of the test head shall be closed, and the vacuum pump shut off. The time shall then be measured for the vacuum to drop to 9 inches of mercury.
- e) The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in Table 9-3.

- f) Two (2) accurate vacuum pressure test gauges shall be installed to monitor the test. Vacuum pressure gauges shall have graduation marks, at minimum, for every 0.2 inches of mercury and be capable of interpreting pressure readings within 0.1 inches of mercury. The pressure reading deviation between the two pressure gauges shall not be greater than 0.1 inches of mercury. During the vacuum pressure test the pressure loss indicated between the two gauges shall not deviate by more than 0.05 inches of mercury between the two gauges.
- g) If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained. This does not mean that the Manhole Vacuum Test has to be repeated but rather a passing test has to be achieved by either the Manhole Vacuum Test or the Ex-filtration Test.

**TABLE 9-3
MINIMUM MANHOLE VACUUM TEST TIMES FOR
VARIOUS MANHOLE DIAMETERS PER DEPTH OF MANHOLE**

Manhole Depth (Feet)	48 inch Diam. MH (Seconds)	60 inch Diam. MH (Seconds)	72 inch Diam. MH (Seconds)
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121
>30	as per plans		

5. **Ex-filtration Test:** The Contractor shall furnish all necessary equipment and materials and shall be responsible for conducting, in the presence of the Engineer/Inspector, an ex-filtration test on each manhole. A separate manhole ex-filtration test will not be required when the manhole is tested simultaneously with the sewer pipe during an ex-filtration test.

It is not recommended to conduct the pipe leakage test concurrently with the manhole ex-filtration test, as the allowable parameters for head (H) in the two tests differ. However, a separate manhole ex-filtration test will not be required when manholes are tested simultaneously with the sewer pipe ex-filtration test. If the Contractor wishes to concurrently test the pipe and manhole then Table 9–2 may be used to assist in measuring the pipe loss for a concurrent test.

The manhole shall not allow ex-filtration of water of more than 0.10 gallons per hour per foot diameter per foot head (0.10 gallons/hour/foot diameter/feet head) with head being measured from the top of the water surface in the test manhole to groundwater level outside the manhole or to the bottom of the manhole, whichever is less.

All pipes leading into or out of the manhole shall be plugged to provide a watertight seal and the manhole filled with water to a level 3 inches to 4 inches below the casting rim or lid. The water shall be allowed to stand for 2 hours prior to beginning the test to allow for absorption into the manhole. If the water has dropped at the end of the 2 hour stabilization period, additional water shall be added to bring the water level to at least 3 inches to 4 inches below the casting rim or lid, as initially was done. If the head is greater than 30 feet refer to the plans for ex-filtration testing requirements.

The minimum test period shall be for 2 hours and the values derived from Table 9-4 will need to be adjusted for the actual test time. If the test fails to meet these requirements, the Contractor shall, at their own expense, determine the source of leakage, repair or replace all deficiencies, and retest the installation until passing, all in a manner approved by the Engineer. This does not mean that the Ex-filtration test has to be repeated but rather a passing test has to be achieved by either the Ex-filtration Test or the Manhole Vacuum Test.

The Contractor shall anticipate the need to conduct multiple tests in order to meet the above requirements and shall conduct testing in such a manner and sequence that the requirements indicated above are achieved.

Water used for ex-filtration testing shall be clean, potable water and will not be allowed to discharge into the sewer system. The Contractor shall be responsible for removing the water by pumping it from the manhole being tested and discharge it at an approved location.

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**TABLE 9-4
MANHOLE EX-FILTRATION TEST - ALLOWABLE LEAKAGE ***

Head (Feet)	Allowable water drop in casting and cone per hour					
	4 Foot Diam.		5 Foot Diam.		6 Foot Diam.	
	(gallons)	(Inches)	(gallons)	(Inches)	(gallons)	(Inches)
2	0.8	0.32	1.0	0.40	1.2	0.48
4	1.6	0.64	2.0	0.80	2.4	0.96
6	2.4	0.96	3.0	1.21	3.6	1.45
8	3.2	1.29	4.0	1.61	4.8	1.93
10	4.0	1.61	5.0	2.01	6.0	2.42
12	4.8	1.93	6.0	2.42	7.2	2.90
14	5.6	2.25	7.0	2.82	8.4	3.38
16	6.4	2.58	8.0	3.22	9.6	3.87
18	7.2	2.90	9.0	3.63	10.8	4.35
20	8.0	3.22	10.0	4.03	12.0	4.84
22	8.8	3.55	11.0	4.43	13.2	5.32
24	9.6	3.87	12.0	4.84	14.4	5.81
26	10.4	4.19	13.0	5.24	15.6	6.29
28	11.2	4.51	14.0	5.64	16.8	6.77
30	12.0	4.84	15.0	6.05	18.0	7.26
>30	as per plans					

* Use of Table 9-4:

Example of a concurrent manhole and pipe ex-filtration test:

Given: 370 feet of 10 inch sewer, groundwater approximately 2 feet above the pipe invert at the manhole being tested, the manhole is 5 foot in diameter and the manhole is 17 feet deep from rim to invert.

The calculated pipe loss for 370 feet – 10 inch sewer would be (from Table 9-2) $0.09 \times 370 = 33.3$ gallons in a 24-hour period. To adjust this loss to coincide with the manhole test the 33.3 gallons would need to be converted, to two (2) hours; so $(33.3 / 24 \text{ hrs}) \times 2 \text{ hrs} = 2.78$ gallons. The 2.78 gallons is the permitted loss for the pipe in 2 hours.

The calculated manhole loss for a 5 foot diameter manhole 17 feet deep with groundwater 2 feet above the invert would be (from Table 9-4) 17 feet – 2 feet = 15 feet H, round H down to 14 feet, the corresponding value from the 5 foot Diam. Column results in a manhole loss of 7.0 gallons per hour. This value then needs to be converted to a two hour test. So $7.0 \text{ gallons} \times 2 = 14$ gallons for two hours.

The combined total loss would be 2.78 gallons (pipe) + 14 gallons (manhole) = 16.78 gallons. This loss can be measured in inches of water surface drop in the cone by converting the gallons in Table 9-4 to inches. The 7.0 gals. = 2.82 inches of drop, therefore 16 gallons of loss equals $2 \times 2.82 \text{ inches} = 5.64 \text{ inches}$. The 2.78 gallons would be rounded down to 2.0 gallons, which is equivalent to a 0.80 inch drop. Therefore, the total water surface drop for a two hour test would be $5.64 \text{ inches} + 0.80 \text{ inches} = 6.44 \text{ inches}$.

Another option instead of measuring the surface water drop would be to measure the volume of water required to bring the water surface back to the original level, at the start of the test. In order to achieve a passing test the volume of water needed to fill the cone would have to be less than 16.78 gallons.

J. Abandoning Sanitary Sewer Mains and Manholes:

1. **Existing Sewer Mains:** To be abandoned between manholes shall be plugged at all open ends with concrete extending into the abandoned pipe one foot or one pipe diameter, whichever is greater. Existing sewers to be abandoned at a manhole shall be cut flush with the inside of the manhole and plugged as specified above. The pipe shall be grouted flush with the inside of the manhole and the manhole invert shall then be reconstructed. The reconstructed manhole inverts shall provide for the new flow scheme and comply with the standards for manhole inverts, as specified.
2. **Existing Manholes:** To be abandoned shall have all pipes plugged with concrete extending into the abandoned pipe one foot or one pipe diameter, whichever is greater. The upper 4 feet of the manhole shall be broken or removed and the manhole filled with compacted Select Granular Backfill Material. The floor of the manhole must be fractured to eliminate the manhole from holding water. The Contractor shall not backfill manholes to be abandoned until the Engineer/Inspector has inspected each plug and the fractured floor.

Unless shown otherwise on the plans or specified in the detailed specifications, the Contractor shall salvage manhole frames and covers and deliver to and unload them at the City Utility Maintenance Shop.

K. Service Lines:

1. **Service Line Separation:** Refer to Section 11 Utility Excavation and Backfill.
2. **Permits:** Obtainable from the City Utility Maintenance Division, are required for all connections to the City sanitary sewer system. Applicants must hold a City Sewer & Water Installer Contractor's License.
3. **Horizontal Distance:** Between a water main and a sewer service shall not be less than 5 feet, and a sewer main and a water service shall not be less than 5 feet.
4. **Service Pipe:** Shall be laid at a 2.00% slope or greater. Any service pipe less than 2.00% slope requires Engineer approval. Minimum depth of cover over service lines shall be 3-1/2 feet unless approved by the Engineer to be shallower. Shallower installations will require the use of insulation. Reconstruction of existing sewer service lines shall be laid with the greatest slope possible in order to reconnect into existing conditions.
5. **Cleanouts:** Shall be installed at all changes in horizontal alignment of greater than 45 degrees and at distances not to exceed 75 feet for 4 inch diameter pipe and 100 feet for 6 inch diameter pipe. Cleanouts shall be installed when the summation of the horizontal degree of change in a service line exceeds 135 degrees. Cleanout location and installation shall meet the more stringent of the above requirements or those of the adopted plumbing code.

- 6. Insulation:** For sewer services, when shown on the plans, shall be as specified for sewer mains. The use of insulation requires prior approval of the Engineer.
- 7. Sewer Service New Connections:** Where new service lines are to be installed for undeveloped property or future buildings, the Contractor shall furnish all materials necessary for connection of new service lines to the sewer main, and shall obtain and pay permits and tapping fees as established by Ordinance.
- a) With the construction of new mains, in-line wyes shall be used for 4 inch and 6 inch service lines when connecting to 8 inch and 10 inch sewer mains.
 - b) With the construction of new mains, in-line tees shall be used for 4 inch and 6 inch service lines when connecting to 12 inch or greater sewer mains.
 - c) In all cases when a 6 inch connection is to be made onto an existing 8 inch or 10 inch sewer main, the connection must be made with an in-line wye. If the connection is to an existing main, the in-line wye shall be cut into the existing main.
 - d) For new connections onto existing sewer mains that are not a 6 inch connection onto an 8 inch or 10 inch main, or at location determined necessary by the Engineer, the City will use tapping saddles, furnished and installed by the City.
 - e) In-line wyes, tees, and service lines bends installed at a depth of greater than 14 feet shall be SDR 26. All other in-line wyes and tees shall be SDR 35 minimum.
 - f) In-line wyes and tees shall be furnished and installed by the Contractor as the sewer main is installed.

New service connections and lines shall be, at a minimum, extended to the property line and the service line capped. If the termination point is not at a cleanout, the termination point shall be marked with a minimum 3 foot long steel fence post. The steel fence post shall be buried below the surface at least 8 inches and must be steel to facilitate location by magnetic locators.

- 8. Sewer Service Reconnections:** The Contractor shall furnish all materials necessary for reconnecting service lines existing prior to reconstruction of a sewer main.
- a) With the construction of new mains, in-line wyes shall be used for 4 inch and 6 inch service lines when reconnecting to 8 inch and 10 inch sewer mains.
 - b) With the construction of new mains, in-line tees shall be used for 4 inch and 6 inch service lines when reconnecting to 12 inch or greater sewer mains.

- c) In all cases when a 6 inch reconnection is to be made onto an 8 inch or 10 inch main, the reconnection must be made with an in-line wye. If the reconnection is to an existing main, the in-line wye shall be cut into the existing main.
- d) For reconnections onto existing sewer mains that is not a 6 inch connection onto an 8 inch or 10 inch sewer main, the City will use tapping saddles, furnished and installed by the City.
- e) In-line wyes, tees, and service lines bends installed at a depth of greater than 14 feet shall be SDR 26. All other in-line wyes and tees shall be SDR 35 minimum.
- f) In-line wyes and tees shall be furnished and installed by the Contractor as the sewer main is installed.

The Contractor shall visually inspect the inside of each existing sewer service line to be connected to the new sewer main prior to making the reconnection. When it is discovered that an existing sewer service line beyond the edge of the excavation is not in good physical condition or is plugged, full of roots, or is otherwise not operating properly, the Contractor shall notify the Engineer so they may document the condition and notify the property owner.

Connections between the new service line and existing service line shall be accomplished with a coupling. The Contractor shall encase the Fernco connection in 6 inches of concrete, 6 inches each side of the coupling.

- 9. Abandoning of Service Lines:** Shall be accomplished by cutting and plugging the line at the sewer main unless directed otherwise by the Engineer. The service line shall be plugged in the same manner as specified for plugging sewer mains.
- 10. Service Line Inspection and Taps:** City personnel shall inspect all sewer service connections to the City sewer main, service line installations, and service line abandonments, prior to backfilling. The Contractor shall notify the City Utility Maintenance Division a minimum of four (4) hours prior to the time of wanted inspection. Any trench backfilled without being inspected and approved by authorized City personnel shall be re-excavated by the Contractor to expose the work for the required inspection. Discrepancies shall be corrected by the Contractor and re-inspected by City personnel. City personnel shall tap all City sewer mains, at locations as identified in this Specification. The Contractor shall schedule all inspections and taps between 7:30 AM to 3:00 PM, Monday through Friday.
- 11. Tracer Wire:** Tracer wire shall be installed and extended along with all sewer service lines. The wire shall be installed along the top of the pipe and shall be securely anchored to the pipe every four (4) feet horizontally with an adhesive tape. The tracer wire shall be brought to the surface at each clean out and shall terminate at the service connection point on the main.

At locations where the service line is not being replaced entirely, the Contractor will splice the new tracer wire to the existing tracer wire at the point of reconnection. In instances where a service line is not being replaced entirely and the existing tracer wire is not encountered, the Contractor shall coil approximately five (5) feet of wire at the reconnection location(s) to facilitate a future splice.

All tracer wire connections shall be accomplished in accordance with Section 8B. In addition to meeting these requirements the Tracer Wire specification shall be modified so that the wire insulation is green with a print line saying "SEWER".

9.4 METHOD OF MEASUREMENT

- A. Sewer Main Pipe:** Installed pipe quantities shall be measured from centerline to centerline of all manholes and special items to the nearest even foot. Depth of pipe shall be determined from top of finish grade to flow line of pipe. Standard depth is 0 - 6 feet and extra depth shall be in increments of two (2) feet.
- B. Sewer Service Pipe:** Installed pipe quantities shall be measured from edge of sewer main pipe to fittings or end of pipe to the nearest even foot.
- C. Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole:** 0 - 6 feet, shall be measured on a per each basis for the type and diameter of the particular manhole. Measurement for ancillary items to the manhole, including but not limited to chimney seals, castings, adjusting rings and external joint seals will not be made; such work shall be incidental to the respective bid item.
- D. Extra Manhole Depth:** per diameter of manhole being installed shall be measured to the nearest one tenth (0.1) foot from the top of finish grade to the invert of the manhole minus the nominal 6 foot depth measured under Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole.
- E. Abandon Sewer Mains:** No separate measurement will be made for plugging abandoned sewer mains; such work shall be incidental to the project, unless otherwise specified.
- F. Abandon Manhole:** Measurement will be made on a per each basis for each manhole abandoned.
- G. Sewer Service New Connections and Reconnections with In-Line Sewer Service Wye or Tee:** Sewer service reconnections and sewer service new connections with in-line service wye or tee will be counted on a per each basis. When applicable, saddles will be furnished and installed by the City. The pipe used for connections and reconnections shall be measured and paid for under the bid item for sewer service pipe. Pipe couplings are incidental to the connection to the sewer service. All fittings and appurtenance required for change in direction of the sewer service pipe are incidental to the length of sewer service pipe.

- H. Adjust Manhole Frame and Cover:** Measurement will be made on a per each basis for each manhole frame and cover adjusted and includes adjusting rings for a complete installation. If there is an existing chimney seal the reinstallation of the chimney seal and extensions as necessary for a complete installation shall be considered as incidental to this item.
- I. Manhole Chimney Seal and Extensions:** Measurement will be made on a per each basis for each installation. The chimney seal installation includes the chimney seal and extensions, as necessary. This item is applicable for installations where an existing manhole is being retrofitted or adjusted.
- J. Reconstruct Manhole:** Measurement will be made on a per each basis for each manhole reconstructed. Reconstruct Manhole consists of the removal of or the addition of a new manhole barrel(s) or cone for vertical adjustment. Adjustments of the frame and cover associated with the addition of or removal of a barrel or cone shall be considered as incidental to this bid item.
- K. Reshape Manhole Invert:** Measurement will be made on a per each basis for each manhole that has the invert(s) reshaped and reconstructed.
- L. Sanitary Sewer Caps/Plugs:** Are incidental to the applicable bid item.
- M. Sanitary Sewer Cleanouts:** Measurement will be made on a per each basis for each type and size of cleanout installed.
- N. Sanitary Sewer Cleanout Cover Frame and Casting:** Measurement will be made on a per each basis for each type and size of cleanout cover frame and casting installed.
- O. Connection to Existing Manhole:** Measurement will be made on a per each basis for each connection to an existing manhole.
- P. Remove Manhole:** Measurement will be made on a per each basis for each manhole removed.
- Q. Remove Sewer Main:** Measurement will be made on a linear foot basis and shall be measured to the nearest foot if sewer main to be removed is located in a separate trench of any new utility being installed with the project. If the sewer main to be removed is located in the same trench of any new utility being installed with the project, removal of the sewer main shall be incidental to the installation of the new utility.
- R. Connection to Existing Sewer Main:** Measurement will be made on a per each basis for each connection to an existing sewer main. Pipe couplings are incidental to the connection to existing sewer main.
- S. Sanitary Sewer Force Main, Fittings, Valves, and Ancillary Items:** Installed quantities shall be measured conforming with the applicable provisions of Section 8A - Water Piping Systems and Section 8B - Corrosion Protection – Plastic Pipe Systems.

- T. Bypass Pumping:** Measurement will be made on a lump sum basis for bypass pumping, diversions and/or wastewater flow modifications including pumping equipment and operation of same for a complete installation for the entire project and may be multiple setups, startups, and stops. All other appurtenances to effectuate the bypass pumping are considered as incidental to this item.

9.5 BASIS OF PAYMENT

- A. Sewer Main Pipe:** Payment will be at the unit price bid for the appropriate size and depth of sewer pipe, furnished and installed, including , trenching, excavation, Type 1 bedding material, compacting, backfilling, dewatering, sheeting or shoring, compaction, and testing.
- B. Sewer Service Pipe:** Payment will be made at the unit price bid for the appropriately sized pipe, furnished and installed, including trenching, excavation and backfilling, bedding material, compacting, dewatering, tracing wire, and sheeting or shoring. The cost for any connections between the new service line and existing service lines shall be included in the unit price bid for the appropriate sized pipe.
- C. Standard Manhole, Standard Shallow Manhole, and Termination Manhole:** 0 - 6 feet. Payment will be made at the unit price bid for each type and diameter, furnished and installed including but not limited to the following ancillary items to the manhole: adjusting rings, frame, cover and external joint seals.
- D. Drop Manhole:** 0 - 6 feet. Payment will be made at the unit price bid for each diameter, furnished and installed, including but not limited to the following ancillary items to the manhole: adjusting rings, frame, cover and external joint seals. Price bid shall include the wye and the pipe installed from the wye to the floor of the manhole, and concrete encasement of lower connection and 45 degree fitting. No separate payment will be made for this pipe, wye, bend and concrete encasement.
- E. Extra Manhole Depth:** Payment shall be made at the unit price bid for that depth, per the appropriate manhole diameter, over and above 6 foot, which is paid for as Standard Manhole, Shallow Manhole, Termination Manhole, and Drop Manhole.
- F. Abandon Sewer Mains:** Payment for plugging abandoned sewer mains shall be incidental to the project, unless otherwise specified.
- G. Abandon Manhole:** Payment will be at the bid unit price and shall include all labor, materials, including concrete plugs, and granular backfill.
- H. Sewer Service In-Line Wye or Tee:** Payment will be made at the unit price bid for each size and type of fitting, furnished and installed.
- I. Sewer Service New Connection:** Payment will be made at the unit price bid for connecting new sewer services to the sewer main, including fittings necessary to connect the service line to sewer. When applicable, saddles will be furnished and installed by the City. Sewer service pipe will be paid for separately. Sewer service in-

line wye or tee connection to the main will be paid for separately. Payment for Sewer Service New Connection shall include Right to Work permit, New Account Setup/Inspection permit (tap permit) and tapping fees, unless otherwise specified in the detailed specifications, including all labor and material.

- J. Sewer Service Reconnection:** Payment will be made at the unit price bid for reconnecting existing sewer services to the sewer main, including fittings necessary to connect the service line to sewer. When applicable, saddles will be furnished and installed by the City. Sewer service pipe will be paid for separately. Sewer service wye or tee connection to the main will be paid for separately.
- K. Adjust Manhole Frame and Cover:** Payment will be at the unit price bid for adjusting manhole frame and cover, existing chimney seals, and includes adjusting rings.
- L. Manhole Chimney Seal and Extensions:** Payment will be made at the unit price bid for each installation.
- M. Reconstruct Manhole:** Payment will be made at the unit price bid for Reconstruct Manhole including new manhole barrel(s) and cone, or removal of manhole barrel(s) and cone.
- N. Reshape Manhole Invert:** Payment will be at the unit price bid for reshaping existing manhole inverts, including all materials, labor, equipment, wastewater flow diversions, modifications, and/or pumping.
- O. Sanitary Sewer Cleanouts:** Payment will be at the unit price bid for Sanitary Sewer Cleanout furnished and installed, including all labor and materials.
- P. Sanitary Sewer Cleanout Cover Frame and Casting:** Payment will be at the unit price bid for Sanitary Sewer Cleanout Cover Frame and Casting furnished and installed, including all labor and materials.
- Q. Connection to Existing Manhole:** Payment will be at the unit price bid and shall include all labor and materials.
- R. Remove Manhole:** Payment will be at the unit price bid and shall include all labor, materials, including concrete plugs, and backfill.
- S. Remove Sewer Main:** Payment will be at the unit price bid and shall include all labor, materials, including concrete plugs, and backfill.
- T. Connection to Existing Sewer Main:** Payment will be at the unit price bid and shall include all labor and materials.
- U. Sanitary Sewer Force Main, Fittings, Valves, and Ancillary Items:** Payment will be in conformance with the applicable provisions of Section 8A - Water and Section 8B - Corrosion Protection – Plastic Pipe Systems.

- V. Bypass Pumping:** Payment will be made on a lump sum basis for bypass pumping, diversions and/or wastewater flow modifications including pumping equipment and operation of same for a complete installation for the entire project and maybe multiple setups, startups, and stops. All other appurtenances to effectuate the bypass pumping are considered as incidental to this item.

END OF SECTION

SECTION 10

CLEARING AND GRUBBING

10.1 DESCRIPTION

A. General: This work consists of clearing, grubbing, removing and disposing of vegetation and debris within the limits of the right-of-way, borrow, and easement areas, except such objects designated to remain or to be removed in accordance with the plans and detailed specifications, or other sections of these standard specifications.

B. Related Work:

Section 7	General Conditions
Section 17	Salvaging, Stockpiling, and Placing Topsoil
Section 74	Planting Trees, Shrubs, and Vines
Section 75	Transplanting Trees and Shrubs
Section 201	Construction Stakes, Lines and Grades (Contractor Furnished Staking)

10.2 MATERIALS (not specified)

10.3 CONSTRUCTION REQUIREMENTS

The Contractor shall establish right-of-way lines and construction lines and designate trees, shrubs, plants, and other objects to be removed. This shall be paid for under the bid item "Contractor Furnished Staking", In the case where, "Contractor Furnished Staking" is not included then the Engineer will establish right-of-way lines and construction lines and designate trees, shrubs, plants, and other objects to be removed.

Vegetation and objects not marked for removal shall be preserved free from injury or defacement.

Surface objects, trees, stumps, roots, and other protruding obstructions shall be cleared and/or grubbed as required. Perishable objects beneath the roadway, hard surface, or sidewalk section shall be removed entirely. When authorized, the Contractor may leave stumps and nonperishable solid objects which are located outside of the roadway, hard surface, or sidewalk, and extend a minimum of three (3) feet below the final grade, provided the stumps and nonperishable solid objects are removed to at least 12 inches below final grade.

Except in areas to be excavated, holes resulting from the removal of obstructions shall be backfilled with suitable material and compacted under the same specification as the embankment. All disturbed areas shall be permanently reclaimed.

Materials, debris, and perishables shall be disposed of at an approved licensed location, approved by the Engineer. The cost involved shall be included in the unit price bid.

Low-hanging, unsound, or unsightly branches on remaining trees or shrubs shall be removed by arborist methods and as directed by the Engineer. Branches of trees extending over the roadbed shall be trimmed by arborist methods to provide adequate sight distance for vehicular or pedestrian traffic in accordance with City Ordinance.

10.4 METHOD OF MEASUREMENT

Measurement for clearing and grubbing of trees over six (6) inches in diameter will be on a per each basis by actual count of such trees and includes the removal of the corresponding stumps which are satisfactorily removed and disposed of. The diameter of trees will be measured two (2) feet above the ground. Measurement for clearing and grubbing trees will be in the groupings of: 6 inches to less than 18 inches, 18 inches to less than 30 inches, and greater than 30 inches.

Measurement for clearing and grubbing of existing stumps 12 inches in diameter and greater will be on a per each basis by actual count of existing stumps which are satisfactorily removed and disposed of.

Measurement for clearing and grubbing of existing stumps less than 12 inches and trees less than 6 inches in diameter, vegetation, surface objects, roots, and other protruding obstructions, which are satisfactorily removed and disposed of will be on a lump sum basis for "Clearing and Grubbing".

The removal of low-hanging, unsound, or unsightly branches on trees or shrubs by arborist methods shall be on a lump sum basis for "Clearing and Grubbing".

Field measurement for the bid item "Clearing and Grubbing" will not be made.

10.5 BASIS OF PAYMENT

Payment for clearing and grubbing of trees will be made by the following groupings: 6 to less than 18 inches diameter, 18 to less than 30 inches diameter, and greater than 30 inches diameter.

Payment for clearing and grubbing of existing stumps 12 inches or greater in diameter will be on a per each basis by actual count of existing stumps which are entirely removed and disposed of.

Payment for clearing and grubbing of existing stumps less than 12 inches in diameter and trees less than 6 inches in diameter, vegetation, surface objects, roots, and other protruding obstructions, which are satisfactorily removed and disposed of will be on a lump sum basis for "Clearing and Grubbing".

When these items are not included in the contract, removal of trees and stumps necessary to complete the work will be considered as "Incidental Work".

END OF SECTION

SECTION 11

UTILITY EXCAVATION AND BACKFILL

11.1 DESCRIPTION

A. General: This work consists of excavation, backfill and compaction of trenches for installation of underground utilities, which includes Private Utility Installations, Water Piping Systems, Sanitary Sewers, and Storm Sewers and Pipe Culverts. This includes, but is not limited to, dewatering, rock excavation and disposal, bedding, and shoring and bracing.

B. Related Work:

Section 7	General Conditions
Section 8A	Water
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 9	Sanitary Sewer
Section 10	Clearing and Grubbing
Section 12	Roadway and Drainage Excavation and Embankment
Section 13	Removal Items
Section 17	Salvaging, Stockpiling, and Placing Topsoil
Section 18	Erosion, Sediment, and Water Pollution Control
Section 19	Incidental Work
Section 41	Utility Trench Resurfacing
Section 54	Drainage Pipe Installation
Section 90	Roadway Signs and Delineators
Section 112	Select Granular Backfill
Section 117	Aggregates for Granular Bases and Surfacing
Section 120	Drainage Pipe Materials
Section 200	Controlled Low Strength Material
Section 202	Geosynthetics for Roadways

C. Soil Tests: The Contractor shall provide the Engineer with the results of a modified proctor soil compaction test, as determined by AASHTO T180, for those locations determined by the Engineer. The Engineer's representative shall be present during sample collection. Soil samples shall be submitted to a certified soil testing lab within 24 hours of the Engineer's request. Failure to do so will cause the City to submit the samples and charge the Contractor at one and a half (1½) times the cost incurred. Results shall be delivered to the City directly from the testing Laboratory.

D. Sewer Main / Storm Sewer and Water Main Crossings:

1. Vertical Separation: Sewer and storm sewer mains may cross water mains with a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer or storm sewer main. This shall be the case where

the water is either above or below the sewer or storm sewer with preference to the water main located above the sewer or storm sewer. At the crossings one full length of water pipe shall be located so both joints are as far from the sewer or storm sewer as possible.

In the event that 18 inches of vertical separation cannot be maintained, adhere to one of the following:

- a) The use of bends to lower the water main under the sewer or storm sewer main to meet minimum 18 inches vertical separation.
 - b) Install an encasement pipe around either the water main or sewer main. The encasement pipe shall be 20 feet minimum in length, centered where the pipes intersect. The pipe shall have chocks/spacers, and sealed at both ends with end seals.
- 2. Horizontal Separation:** Sewer and storm sewer mains shall be constructed with a minimum of 10 feet of horizontal separation from any existing or proposed water main. The 10 feet horizontal separation shall be the clear distance (measured edge to edge) and not the centerline distance between the utilities.

The following installation requires Engineer's approval and is appropriate for installations where the 10 feet minimum separation physically is not possible or practical, adhere to one of the following:

- a) A sewer main may be constructed closer than 10 feet to a water main if it is laid in a separate trench, or it is laid in the same trench on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer main.
- b) The sewer main shall be constructed of water main pipe (pressure class pipe) meeting the requirements of Section 8A.2 or equal and pressure tested for water tightness in accordance with AWWA standards for leakage testing.
- c) The storm sewer pipe is constructed with sealed joints and passes a low pressure (5 psi) pressure test. The pressure test shall be maintained for a minimum of 30 minutes. The pressure test shall otherwise comply with the requirements of the "Low Pressure Air Test" in Section 9 Sanitary Sewer. The "Low Pressure Air Test" may be waived by the Engineer for round RCP storm sewer utilizing gasketed joints in compliance with ASTM C443.
- d) Minimum horizontal distance of 3 feet shall be maintained between storm sewer curb inlets and water mains. All other storm sewer structures and culverts shall be considered as storm sewer mains for the purposes of this section.

- e) For the purposes of horizontal separation, sanitary sewer manholes shall be treated the same as sanitary sewer mains.
- E. Sewer Main and Storm Sewer Crossings:** Storm sewer crossing over sewer mains shall have no less than 6 inches of clearance. Special structural support and insulation will be required if there is less than 18 inches clearance. The minimum horizontal clearance shall be 2 feet. Clearance refers to the distance from the outside of the sewer pipe to the outside of the storm sewer pipe.
- F. Service Line Separation:** A 10-foot horizontal separation shall be maintained between water services and sewer services. Where a water service crosses a sewer service a vertical separation of at least 12 inches shall be provided between the water service and the sewer service and the sewer service should be below the water service. The pipe joints shall be placed as far away from the crossing as the material will permit. Water services, where possible, should cross over sanitary sewer mains and storm sewers. Sewer services, where possible, should cross under water mains and storm sewers.

11.2 MATERIALS

- A. Select Granular Backfill and Bedding:** Shall be in accordance with Section 112 - Select Granular Backfill. Contractor shall provide a submittal to the Engineer for select granular backfill and bedding materials used.
- B. Controlled Low Strength Material:** Used for bedding or backfill shall be in accordance with Section 200 - Controlled Low Strength Material. Contractor shall provide a submittal to the Engineer for controlled low strength material when used.
- C. Water and Sewer Main Insulation:** Insulation shall be Extruded-Polystyrene Board Insulation formed from polystyrene base resin by an extrusion process using hydrochloro-fluorocarbons as blowing agent to comply with ASTM C578, Type IV, with 1.60 lb./cu. Ft. minimum density and a compressive strength of 25 lb./ sq. in as specified in ASTM D1622 and ASTM D1621 respectively. The maximum thermal conductivity of the insulation shall conform to ASTM C518, C177, and C578. The maximum water absorption percentage by volume shall be 1% in accordance with ASTM D2842. The range of water vapor permeance shall be 0.4 to 1.0 perm in accordance with ASTM E96.

Type IV Styrofoam Brand—"Square Edge" or "Score Edge" as manufactured by Dow Chemical Company or approved equal shall be used for insulating water and sewer pipes where required. The width and thickness of insulation shall be per standard detail unless otherwise noted in plans. The minimum insulation thickness shall not be less than 2 inches.

- D. Trench Check Dam Material:** Check dam material shall be compacted cohesive clay that contains a minimum of 25% minus no. 200 sieve material, with 70% passing a 3/4 inch sieve. If the normal excavated material is not suitable for construction of the check dam, then the Contractor shall obtain material from outside sources.

Check dam installation and material shall be considered as incidental to the pipe installation.

11.3 CONSTRUCTION REQUIREMENTS

A. Utility Locates: The Contractor shall contact South Dakota One Call (811) for the locations of public and private utilities prior to any excavation. Underground utilities shown on the plans are not necessarily exact and, therefore, must be located by the individual utility company prior to excavation activities. The Contractor shall contact the local residents/owners whenever any excavation may affect their property.

B. Trenching

1. Methods: Under ordinary conditions and where the depth of excavation and soil conditions will allow, excavation shall be by open cut from the surface. Tunneling or boring under sidewalks, curb and gutter, or other surface structures may be allowed by the Engineer on a case by case basis. Tunneling or boring under streets, turfed areas, or areas not addressed above may be required by Engineer for some installations.

The first pavement saw cuts shall be, at a minimum, the same width as the minimum trench width centered over the utility. The second saw cut shall be 1 foot outside the disturbed area on each side of the trench (see Section 41 Standard Detail).

Streets that utilize an engineering geotextile or geogrid underlayment shall be excavated down to the underlayment by hand, or other method that will prevent damage. The underlayment shall be cut longitudinally centered over the utility, laid back, then trench excavation and backfill in normal fashion. When the backfill is completed to the elevation of the original underlayment, the cut ends shall be placed back on the backfilled material. A new piece of underlayment shall be placed over the splice with a minimum overlap of 12 inches each side of the splice, or the manufacturer's minimum overlap, whichever is greater. See Section 41 Standard Details.

The geotextile or geogrid repair shall be inspected by the Engineer prior to placing base course or cushion. After inspection of the geotextile or geogrid, it may be covered with base course to the existing paving base grade. The base course can then be compacted and readied for pavement.

Where surface conditions allow, the Contractor will be permitted to slope or bench the trench sidewalls from a point three inches above the top of the pipe barrel. Below this point, the trench walls shall be vertical. Contractor shall shore as necessary. This requirement does not relieve the Contractor of the responsibility of meeting all applicable OSHA requirements.

Excavated material suitable for backfill shall be deposited a sufficient distance from the trench to limit the potential for cave-in and minimize inconvenience to the public.

All excavated material not used for the project shall be removed from the project by the Contractor at the Contractor's expense, as directed by the Engineer.

Rock, including excavated bedrock, large loose rock, boulders, fieldstones, or other unsuitable material, which cannot be used as backfill, shall be segregated from the rest of the excavated material and removed from the project by the Contractor at the Contractor's expense. Unsuitable material, which cannot be used for backfill, shall be determined by the Engineer.

Established drainage in streets, alleys, or drainage ditches, must be maintained by the Contractor during construction operations.

When either geotextile, geogrid, or under-drains are inadvertently encountered and damaged, the Contractor is responsible to notify the Engineer as soon as practical. No further excavation or repairs of the area shall be effected without the knowledge of the Engineer.

Where the proposed trench intersects an under-drain, the under-drain shall be repaired with similar material 12 inches on either side of the trench width. The pipe joints shall utilize a factory repair coupling. New fabric shall overlap existing fabric a minimum of 12 inches. New clean rock shall be placed across the trench intersection and backfilled with appropriate material. The drain repair shall be inspected by the Engineer prior to placing the clean rock.

Damage to the property of others, such as; geotextile, geogrid, under-drains, private or public utilities, fences, trees, shrubs, lawns, sidewalks, etc. shall be repaired or replaced at the Contractor's expense unless removal of such is shown on the plans or written permission was first obtained from the Engineer.

- 2. Protection of the Excavation:** The Contractor shall be solely responsible for providing a safe trenching operation and shall, as a minimum, comply with all OSHA regulations, regardless of limits of trench width imposed by project plans work limits, site constraints or the direction of the Engineer.

The Contractor shall employ qualified and properly trained personnel to install, design, place, and maintain shoring during progress of work until the trench is backfilled.

Failure to properly shore and/or brace excavations shall be at the risk of the Contractor and any damage to pipes, curb and gutter, street pavement, grassed areas, storm sewer and appurtenances, gas mains, and/or other public or private property occurring through settlements, heaving, water or earth pressures, slides, caving, or other causes due to failure of shoring, improper shoring, or lack of

shoring, or due to negligence on the part of the Contractor, shall be repaired by the Contractor at their own expense and to the satisfaction of the Engineer.

When utilized, the shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction thereof has progressed far enough to provide adequate strength. Unless left in place by written order of the Engineer, shoring shall be removed as work progresses. Shoring devices and methods of construction utilizing shoring devices are the sole responsibility of the Contractor.

- 3. Dewatering:** The Contractor shall be responsible for evaluating soil and groundwater conditions and for furnishing and maintaining necessary and suitable dewatering devices and equipment.

The Contractor shall provide for positive drainage away from the excavation or otherwise take steps to protect the excavation and backfill from becoming excessively wet prior to placing the finished surface.

At all times, the Contractor shall provide and maintain ample means and devices, with which to remove promptly and properly dispose of all water that enters the excavation.

The Contractor shall dispose of water in accordance with all permits (City and/or State) and without damage to adjacent property or without creating a health hazard or nuisance condition. Water may not be discharged to private property or to irrigation ditches without prior approval from the affected property owner or ditch company. No water shall be drained into work built or under construction without prior consent of the Engineer.

Dewatering shall be accomplished by placing well points, sumps or any other acceptable method, which will insure a dewatered trench. Any proposed dewatering method shall be subject to the approval of the Engineer. The Contractor will not be permitted to allow groundwater to drain through completed sewer or water mains. The Contractor will be required to thoroughly clean all debris and sediment from newly installed sewer or water mains as directed by the Engineer.

The Contractor shall provide for positive drainage of water away from the excavation and take the necessary action to protect the excavation and backfill from becoming excessively wet prior to placing the finished surface. If the Engineer determines that any portion of the backfill or trench has become excessively wet due to actions or inactions of the Contractor after the initial excavation, the Contractor shall remove the soil and/or pipe or appurtenance(s) to the satisfaction of the Engineer and furnish an approved backfill material that meets specifications and reinstall the pipe and/or appurtenance(s) as specified herein, all at no expense to the City.

- 4. Trench Dimensions:** The following table shall be used to determine the acceptable minimum trench widths for the City. The table in general is a compilation of AWWA criteria and Uni-Bell criteria. The criteria used in compiling this table are presented in Paragraphs a. and b. For purposes of establishing acceptable minimum trench widths, the dimensions in the table shall govern unless specifically indicated otherwise in plans and detailed specifications.

**TABLE 11-1
MINIMUM TRENCH WIDTH TABLE**

<u>Pipe Diameter</u>	<u>Minimum Width</u>
<8 in	24 in
8 in -12 in	30 in
14 in –18 in	36 in
20 in -21 in	42 in
24 in –36 in	1.25(Pipe OD) plus 12 in
>36 in	Per plans

The Contractor shall adhere as closely as possible to the minimum trench widths for water, sanitary sewer, and storm sewer installations, unless otherwise specified in the detailed plans and specifications.

The Contractor will not be allowed to excavate excessive trench width in lieu of adequate dewatering or shoring.

- a) Pressure Pipe Installation (Water and Force Mains):** For reference, only Table 11-1 will be enforced.

Minimum Trench Width: The minimum clear trench width measured at a point three inches above the top of the pipe barrel shall not be less than 18 inches or the outside pipe diameter, plus 12 inches, whichever is greater or such width as approved by the Engineer.

- b) Non-Pressure Pipe Installation (Gravity Sewer Main):** For reference, only Table 11-1 will be enforced.

Minimum Trench Width: The minimum clear trench width measured at a point three (3) inches above the top of the pipe barrel shall not be less than the greater of:

- 1) Minimum of eighteen (18) inches, or
- 2) The outside pipe diameter, plus sixteen (16) inches, or
- 3) The outside pipe diameter multiplied by 1.25, plus (12) inches, or
- 4) Such width as approved by the Engineer.

- c) Maximum Trench Length:** Not more than 300 linear feet of trench shall be open at any one time in the public Right-of-Way, in easements that contain

City owned utilities, or near roadways, unless prior written approval of the Engineer has been obtained.

5. **Foundations:** Foundations shall be considered as that material which is neither bedding nor backfill, but is used under the pipe or conduit for support in the bottom of the trench.
- a) **Normal Trench Bottom:** The bottom of the normal trench where the undisturbed soil is of a supportive nature for the pipe or conduit laid, as determined by the Engineer, shall be accurate for line and grade to provide uniform bearing and support for each section of pipe or conduit. Bell holes and depressions for joints shall be dug after the trench bottom is graded, and shall be no greater in length, depth, and width than required for making the joint. The undisturbed trench bottom shall be at least 3 inches below the bottom of pipe, to allow for the placement of Type 1 Bedding material.
 - b) **Rock Trench Bottom:** When solid rock, large loose rock, such as field stone, very coarse gravel, or any other material of a similar nature that is stable but will not allow a proper foundation for the pipe or conduit, is encountered at the trench bottom, it shall be excavated to a sufficient depth to allow refilling under the body and joints of pipe or conduit. The undisturbed trench bottom shall be at least 3 inches below the bottom of pipe, to allow for the placement of Type 1 Bedding material.
 - c) **Unstable Trench Bottom:** When the trench bottom is earth that will not support the pipe or conduit, the earth shall be considered an unstable foundation and shall be excavated below grade as directed by the Engineer. A solid foundation shall be built with select granular backfill material or with controlled low strength material.

The amount and type of foundation material required will vary depending upon the soil encountered. Generally, foundation material shall be Type 1 Bedding Material or Type 3 Foundation Material, per Section 112 or Controlled Low Strength Material per Section 200.

In some circumstances, larger foundation material may be necessary and in these cases Type 4 Foundation Material or Stabilization Rock maybe used per Section 112. If Type 4 Foundation Material or Stabilization Rock is used, then a minimum 6 inches of Type 3 Foundation Material shall be placed directly above the material and prior to the placement of the Type 1 Bedding Material. This helps to minimize the potential for the Type 1 Bedding material to migrate into the larger foundation material and result in loss of pipe support. The Engineer shall authorize the use of Controlled Low Strength Material or Foundation materials, in cases of unstable trench bottom.

Foundation material shall be compacted and placed in separate lifts from the trench bottom up to 3 inches below the bottom of the pipe. Foundation material lifts shall not exceed eight inches and each lift shall be compacted

separately. Lifts for Type 4 foundation material will be allowed to be 1.5 times the largest particle diameter.

- 6. Rock Excavation:** Rock excavation shall include solid rock in ledges, bedded deposits, un-stratified masses and conglomerate deposits so firmly cemented as to present the characteristics of solid rock. In order to be considered as Rock Excavation the material must be removed by drilling, blasting, jack hammering, or hydraulic ripper. Shale, regardless of the nature of deposit, or loose boulders or large fieldstone will not be considered rock excavation unless so designated on the plans, or as determined by the Engineer. The responsibility and cost of satisfactorily demonstrating to the Engineer that the material being considered for rock excavation cannot be removed by means other than drilling, blasting, jack hammering, or hydraulic ripper shall be the obligation of the Contractor.

In order for material to be considered as Rock Excavation, at a minimum, it shall be demonstrated that a normal excavating machine being skillfully operated cannot be effectively removed. "Effectively removed" shall be defined as, the normal production rate being reduced to 25% of normal. A normal excavating machine will be considered to be a +230 HP hydraulic excavator, crawler weighing +78,000 pounds with a - 1 CY bucket equipped with ripper teeth.

The Engineer has the sole discretion to determine if the material removed is suitable or unsuitable for backfill. The Contractor shall dispose of all unsuitable excavated material. The Contractor shall provide a disposal site for unsuitable backfill materials. The disposal site shall be approved by the Engineer.

The Contractor shall furnish an approved backfill material to fill the voids left by rock excavation. He shall also provide the results of a modified proctor (AASHTO T-180) test for the furnished backfill. Suitable backfill material to replace excavated rock within the trench shall be incidental to the Rock Excavation bid item.

The Contractor shall keep accurate daily records of the quantity of rock removed so a comparison can be made with the Inspector's records. The Contractor shall deliver their records of Rock Excavation to the Engineer or their representative within 48 hours of request. Records of Rock Excavation delivered after this period shall be declared invalid and no payment for Rock Excavation will be made.

- 7. Blasting and the Use of Explosives:** Where blasting is necessary, the Contractor shall comply with the laws, ordinances, and applicable safety code requirements relative to the handling, storage and use of explosives and the protection of life and property. Suitable covering or shielding shall be provided to confine all materials lifted by blasting to the limits of the trench or excavation, and prevent injury to property or life. The Contractor shall be responsible for all damages caused by the blasting operations. The Contractor shall demonstrate that they are in compliance with all applicable laws, rules, and regulations, and they have the required expertise in advance of any blasting work. The Contractor

shall notify all governmental agencies, property owners and utility owners that may be affected by the blast no less than five (5) calendar days in advance.

All materials removed by blasting which are deemed unsuitable shall be handled and disposed of separately from suitable backfill materials as directed by the Engineer.

The Contractor shall obtain a City permit for any proposed blasting. The Contractor shall be responsible for any safeguards or monitoring required by the Engineer for the blasting operations and shall be responsible for any and all damages resulting from the blasting operations.

- 8. Unsuitable Backfill Material Excavation:** Unsuitable Backfill Material Excavation shall consist of the removal and disposal of material which, in the opinion of the Engineer, is not suitable as backfill. Materials containing organics or contaminated soils are considered unsuitable. Typical soil contaminants are petroleum hydrocarbons, polynuclear aromatic hydrocarbons "PAH's" (such as naphthalene and benzo(a)pyrene), solvents, pesticides, lead, and other heavy metals. If the Contractor encounters material that they suspect to be contaminated because of odor, color, or other indicators, they shall immediately contact the Engineer. The Contractor shall provide an approved disposal site for unsuitable material.

The shortage of backfill material created by the removal of the unsuitable material shall be replaced by the Contractor with an imported backfill material approved by the Engineer. Payment for imported backfill will be considered if the Contractor has not exported suitable material from the project. The Contractor shall provide the results of a modified proctor analysis (AASHTO T-180) for all furnished imported backfill material.

9. Pipe Bedding:

- a) Bedding by Pipe Material:** All water and sanitary sewer pipe, appurtenances, and service lines shall be bedded from 3 inches below the pipe invert to 3 inches above the pipe crown over the full width of the trench. Frozen material shall not be used.

Water and Sewer pipe, appurtenances, and service lines shall be installed as per Sections 8A and 9 with bedding as described below:

- 1) Water Service Lines:** Copper and HDPE water service lines shall be bedded with washed sand, crusher fines, 3/8 inch river rock, or pea gravel. PVC water service lines may be bedded with washed sand, crusher fines, 3/8 inch river rock, pea gravel or Type 1 bedding per Section 112.

- 2) **Sewer Service Lines:** PVC sewer service lines shall be bedded with Type 1 bedding meeting the requirements of Section 112, washed sand, crusher fines, 3/8 inch river rock, or pea gravel.
- 3) **Water and Sewer Mains:** Water and sewer mains shall be bedded with Type 1 Bedding and shall meet the requirements of Section 112.
- 4) **Storm Sewer:** For storm sewer bedding requirements see Sections 54 and 112.

b) Bedding Installation:

1) Granular Material:

- I. Bedding shall be compacted and placed as a separate lift from the trench bottom, or top of foundation material, to the pipe invert and shall be placed and compacted prior to installing the pipe or appurtenance.
- II. Bedding shall be hand tamped and placed as a separate lift from the pipe invert to the pipe spring line. Maximum lift shall not exceed 6 inches.
- III. Bedding shall be hand tamped and placed as a separate lift from the pipe spring line to 3 inches above the pipe crown. Maximum lift shall not exceed 6 inches.
- IV. Bedding material shall be incidental to water and sewer pipe per Sections 8A and 9. Prior to commencing installation of water and sewer pipes, the Contractor and Engineer shall confirm the rates of material to be used for each diameter of pipe being installed, in conjunction with the Contractor's proposed maximum trench width. Weekly, or at the direction of the Engineer, the Contractor shall provide weight tickets to verify the quantity of bedding material used, along with the corresponding quantity of water and sewer pipe installed. The weigh tickets shall clearly state, the type of bedding and that it is incidental. All stockpiled bedding material used for water and sewer pipe installation shall be clearly identified on the project.

- 2) **Select Bedding:** Bedding material from 3 inches above the pipe crown to 12 inches above the pipe crown shall be "Select Bedding Material". Select Bedding Material may include loam, clay, sand, and gravel, but shall be free of cinder, ashes, refuse, organic matter, rock or material determined unsuitable by the Engineer. No material larger than one (1) inch in size shall be permitted. Frozen material shall not be used. See Section 54 for select bedding of drainage pipe.

Select Bedding Material may be native excavated material or material brought from offsite. Select Bedding Material shall be hand-tamped in the trench for its full width on each side of the pipe, simultaneously. Mechanical tampers may be used if pipe damage will not occur.

- 10. Backfill:** Normal Backfill shall start one (1) foot above the pipe or conduit crown and continue to the surface of the trench. The Contractor shall take precautions to backfill trenches in a manner that installed pipe or conduit will not be disturbed.

All backfill material shall be free from cinders, ashes, refuse, vegetation or organic material, boulders, rocks, or stones, or other material, which the Engineer determines to be unsuitable. From one foot above the pipe or conduit crown to two feet above the pipe or conduit crown, the maximum stone size shall be limited to 3 inches in diameter. From 2 feet above the top of the pipe, stones up to 12 inches along their longest dimension may be included in the backfill, unless otherwise specified.

Frozen material shall not be permitted as trench backfill.

Where excavated material is deemed unsuitable, by the Engineer, or where there is a shortage of backfill material, the Contractor shall furnish an approved Imported Backfill. Controlled Low Strength Material will be considered acceptable as backfill material when installed in accordance with Section 200 or as directed by the Engineer.

Should the Contractor cause the trench to be excavated to a greater depth or width than that designated in the plans or detailed specifications, the Contractor shall refill to grade, at their own expense, with an approved material. It may be necessary for the Contractor to bring such material from other localities or to purchase suitable material.

Prior to backfilling, the Contractor shall not sell, remove, or permit to be removed, suitable backfill material required to complete the project. If suitable backfill material is removed, the Contractor shall document the quantity of material removed and provide this information to the Engineer within 24 hours of its removal.

- 11. Insulation:** Insulation shall be placed where noted on the plans. Minimum Cover depth shall be measured from the top of pipe to finished grade. See Sections 8A and 9 for minimum cover. If minimum cover cannot be achieved and plans do not provide provisions for insulation, insulation may be used with approval from the Engineer. Insulation may also be required in instances where adequate separation between culverts or storm sewers cannot be achieved.

Insulation board shall be placed above the pipe bedding and shall be covered with select backfill material. The build-up of insulation sheeting shall be done by staggering the joints. An acceptable adhesive may be used to retain the individual sheets in the final specified dimensions.

12. Controlled Low Strength Material: Maybe used in lieu of Type 1 Bedding or Select Bedding Material as approved by the Engineer or as required in the plans and detailed specifications. Controlled Low Strength Material shall be installed in accordance with Section 200.

13. Check Dam Installation: Check dams shall be installed at intervals of 450 feet for water and sewer mains, at all laterals (tees and crosses), in service line trenches (outside of main trench), and also at locations as indicated on the plans and detailed specifications.

The check dams shall extend at a 1:1 slope vertically from the bottom of the excavation through the bedding material to the "Normal Backfill" zone and shall extend horizontally the full width of the trench. Trench check dams shall extend longitudinally a minimum distance equal to the trench width. At the location where the pipe intersects the trench check dam the length shall not be more than twice the trench width. The check dam shall seal the bedding material to prevent ground water movement in the bedding material along the trench. Check dam material shall be per Section 11.2 and compacted to the density of surrounding soil of the trench. Check dam installation and material shall be considered to be incidental to the installation of the main or service.

14. Embankment: Where embankment is necessary to support pipe or to cover or protect it in any way, it shall be placed to the dimensions shown in the plans and detailed specifications or as directed by the Engineer. The surface of the ground receiving the embankment shall be cleared of all unsuitable material and scarified, or loosened with a disc or multi-toothed hydraulic ripper; moisture adjusted and re-compacted as directed by the Engineer. Embankment shall be an approved material and compacted to the densities specified herein unless otherwise specified. Embankment shall be placed a minimum of 3-feet above invert of pipe prior to laying pipe. Unless otherwise approved, pipe laid in embankment shall be trenched in.

15. Compaction and Testing: The Contractor shall compact all materials to the following densities, unless modified by the detailed specifications or by the direction of the Engineer:

<u>SOIL TYPE</u>	<u>BACKFILL MOISTURE CONTENT</u>	<u>% OF MAXIMUM DRY DENSITY</u>
Cohesive	3% Below to 6% Above Optimum	92% Minimum
Non-cohesive	Workable	95% Minimum

Maximum dry density and optimum moisture content shall be determined by the AASHTO T-180, Modified Proctor Test.

Backfill moisture and density shall be determined at least every 200 feet horizontally and every three (3) feet vertically in each trench. The Engineer shall determine the location for moisture and density tests within each trench. The Engineer has the authority to require/take additional moisture and density tests at any location and depth desired. The Contractor shall, at their own expense, excavate the backfill at the locations and depths required by the Engineer to conduct moisture/density tests. For the purposes of calculating the number of tests required, each service line and each lateral pipe shall constitute a separate trench. If the final vertical test is not within 6-inches of the subgrade surface, a final test shall be taken within 6-inches of the subgrade surface.

- a) **Water and Sewer Vertical Testing:** The location of the first test shall be measured from the top of the pipe bedding for water and sewer.
- b) **Storm Sewer Vertical Testing:** Storm sewer vertical testing: Testing within the below described locations shall alternate from side to side of the pipe or box culvert. If a different source of backfill material or compaction procedure is used on either side, each zone shall be tested on both sides.
 - 1) On round pipe 24 inch or less in diameter or arch pipe 30 inches, or less, one test approximately half way up the pipe then every three (3) feet vertically.
 - 2) On round pipe that is 30 inch up to 72 inch in diameter, arch pipe that is 36 inch up to 84 inch, or box culverts up to 6 feet in height, one test in the lower one-half, one test in the upper one-half and then every three (3) feet vertically.
 - 3) On round pipe greater than 72 inch in diameter, arch pipe 96 inch or greater, or box culverts greater than 6 feet in height, one test in the bottom one-third, one test in the middle one-third, one test in the top one-third and then every three (3) feet vertically.

When specified moisture contents are not met, the Contractor has the options of drying wet soil, furnishing approved materials meeting specifications, or adding water as necessary, to soils that are too dry to meet specifications. If water is added to dry soil, it must be thoroughly mixed with the soil to provide uniform moisture content prior to use.

Backfill material not meeting specified densities shall receive additional compaction or shall be removed and replaced at the Contractor's expense as necessary to meet specified densities.

Wet soils that otherwise meet the requirements for backfill do not necessarily constitute unsuitable material. It is the Contractor's responsibility to either dry the material or furnish other approved material at their expense. When the Contractor furnishes backfill material, he shall also furnish the results of the AASHTO T-180 test for the furnished material.

Controlled Low Strength Material installed in accordance with Section 200 or as directed by the Engineer will not require compaction testing.

The Contractor shall not place gravel cushion, base course, topsoil, grass, etc. until the specified densities are met at each test location and the Engineer has given their approval for placement.

Trench flooding as a method of compaction is prohibited.

- 16. Frost:** When frost in the ground becomes deep enough to inhibit excavation, the Contractor may request a stop-work order. However, it shall be the Contractor's responsibility to prove to the Engineer that the cost of excavation due to the frost is excessive and a stop-work order is justified. The request for the stop-work order shall be made in writing. Regardless of when the request is made, contract time will not stop until the stop-work order is issued, i.e. the order will not be retroactive.

As a prerequisite to issuance of the stop-work order, the Contractor shall backfill and compact all open excavations and clean up the project to the satisfaction of the Engineer.

The Engineer may issue a notice to proceed when conditions improve to the point where frost does not inhibit excavation and a resumption of work is possible.

- 17. Cleanup:** Trenches located in public right-of-way shall be backfilled, compacted, and restored to original condition as soon as practicable. In cases where the permanent surfacing will not be placed within 24 hours of backfill, the Engineer may require temporary surfacing. Temporary surfacing shall be considered as incidental to the bid item for the pipe or conduit for which it pertains unless a bid item is specifically provided for Temporary Surfacing.

Temporary Surfacing shall consist of materials as specified in Section 112, Section 117, or asphalt millings.

- 18. Bedding Boxes and Other Similar Devices:** If bedding material is a unit price pay item the Contractor shall use a bedding box or other similar device for the storage of Type 1 Bedding Material and Select Granular Backfill Materials. The bedding box shall follow the progression of work and shall be used to store the materials prior to their placement in the trench. The use of such devices will minimize contamination and waste of the material. The Engineer may make a deduction in the quantity, for payment purposes, of Type 1 Bedding Material and/or Select Granular Backfill Material if the material is being contaminated or wasted.

- 19. Underground Obstructions:** The location of underground public or private utilities may be shown on the plans, as reported by the various utility companies

and the City, but this does not relieve the Contractor of the responsibility of determining the accuracy or completeness of said locations. The Contractor shall determine the location of all underground ducts, conduits, pipes, cables or structures that will be affected by the work, and shall take steps necessary to support and protect said structures by any means suitable to the owners of the structures involved and the Engineer. When necessary, the Contractor shall conduct operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the work.

Portions of existing utilities may be relocated, altered or reconstructed by the utility companies if they are found to interfere with the line and / or grade of the proposed utility, or the Engineer may order changes in the work to avoid interference.

The Contractor shall expose existing underground obstructions shown on the plans or located in the field and shall determine their elevations far enough in advance of pipe laying that the proposed pipe can be adjusted as necessary. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere with the proposed horizontal or vertical alignment of the pipe being installed, the Contractor shall notify the Engineer so that the Engineer may modify the plans and order a deviation in the line and/or grade, or may arrange for the removal or relocation of the obstruction(s). The Contractor shall not deviate from plan line or grade without the Engineer's approval.

When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct an existing utility, all costs for such work shall be included in the bid price for the associated bid item unless a separate bid item is provided.

Temporary or permanent relocation or alteration of existing utilities requested by the Contractor for the Contractor's convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs. In those instances where existing utility relocation or reconstruction is impractical, the Engineer may order a deviation from line and grade.

The Contractor shall be responsible for notifying the various utility companies if the Contractor's work will expose, affect, or endanger any existing utility. All cost of investigation and any necessary protection, support, removal or relocation of said structures shall be included in the contract bid price for installing pipe, manholes, etc. The Contractor shall not begin construction until all utility companies have been contacted and their respective underground utilities have been located and marked.

All costs for exploratory investigation/excavation necessary for determining the location and depth of utilities shall be included in the contract bid price for installing the proposed utility, unless otherwise stated in the plans.

The Contractor shall be responsible for notifying utility companies if the Contractor's progression of work damages the utility.

11.4 METHOD OF MEASUREMENT

- A. Insulation:** Water and sewer main insulation shall be measured by the square foot.
- B. Protection of the Excavation:** No measurement will be made, as these items are considered to be incidental to utility being installed, unless specifically indicated otherwise.
- C. Dewatering:** No measurement will be made, as this item is considered to be incidental to utility being installed, unless specifically indicated otherwise.
- D. Rock Excavation:** Measurement will be based on the measured and/or calculated volume of the open trench to the nearest whole cubic yard and will be limited to a maximum trench width of six (6) feet. For pipe diameters larger than 30 inches measurement will be limited to a maximum trench width of four (4) feet plus the outside diameter of the pipe being installed unless otherwise indicated in the plans or detailed specifications. At manholes the allowable trench width for computation will be 10 feet wide for a distance of seven (7) feet each side of the manhole center. For manhole diameters larger than 60 inches measurement will be limited to a maximum trench width of four (4) feet plus the outside diameter of the manhole being installed for a distance of seven (7) feet each side of the manhole center unless otherwise indicated in the plans or detailed specifications.
- E. Select Granular Backfill Materials:** Measurement for Select Granular Backfill materials will be in accordance with Section 112. Type 1 Bedding material for water and sewer pipe within 3-inches of the top and bottom of pipe shall be incidental to the pipe. Granular material for foundation or other purpose shall be measured to the nearest 0.1 tons.
- F. Imported Backfill:** Measurement of the Imported Backfill, unless otherwise stated will be to the nearest cubic yard as delivered to the project site. If suitable material was wasted from the project prior to encountering unsuitable material, measurement and payment for Imported Backfill will not be considered.
- G. AASHTO T-180 Soil Test:** This item will be measured per each as submitted to a certified lab and approved by the Engineer.

When the Contractor furnishes backfill material, he shall also furnish the results of the AASHTO T-180 test for the furnished material and these AASHTO T-180 tests will be considered as incidental to the Contractor furnished backfill material.

- H. Controlled Low Strength Material:** Measurement for Controlled Low Strength Material will be in accordance with Section 200.

- I. **Encasement (Casing Pipe):** Measurement for encasements will be measured to the nearest whole linear foot, with lengths as noted in the plans or detailed specifications.

11.5 BASIS OF PAYMENT

- A. **Insulation:** Payment will be at the unit price bid for insulation furnished and installed, including cushion material.
- B. **Protection of the Excavation:** No payment will be made, as these items are considered to be incidental to utility being installed, unless specifically indicated otherwise.
- C. **Dewatering:** No payment will be made, as this item is considered to be incidental to utility being installed, unless specifically indicated otherwise.
- D. **Rock Excavation:** Payment for rock excavation will be made under the bid item Rock Excavation. When no bid item exists and the Engineer agrees to pay for rock excavation, a unit price shall be negotiated. Suitable backfill material to replace excavated rock within the trench shall be incidental to the Rock Excavation bid item.
- E. **Select Granular Backfill Materials:** Payment for Select Granular Backfill materials will be in accordance with Section 112. Type 1 Bedding material for water and sewer pipe within 3-inches of the top and bottom of pipe shall be incidental to the pipe. Payment for select granular backfill materials shall include all associated costs of excavation and disposal of excavated materials, unless otherwise called for in the plans or detailed specifications.
- F. **Imported Backfill:** Payment for Imported Backfill will be made under the appropriate bid item for the material furnished and installed. Payment for Imported Backfill shall include all associated costs of excavation and disposal of excavated material unless otherwise called for. If suitable material was wasted from the project prior to encountering unsuitable material, measurement and payment for imported backfill material will not be considered.
- G. **AASHTO T-180 Soil Test:** Payment for providing the results of the AASHTO T-180 test shall be made on a per-each basis under the bid item "AASHTO T-180 Soil Test" and shall be full compensation for obtaining the soil sample, delivering it to the certified lab, conducting the test, and providing the Engineer with the results. Payment will be made for only those Proctor tests required by the Engineer.

When the Contractor furnishes backfill material, he shall also furnish the results of the AASHTO T-180 test for the furnished material and these AASHTO T-180 tests will be considered as incidental to the Contractor furnished backfill material.

- H. **Controlled Low Strength Material:** Payment for Controlled Low Strength Material will be in accordance with Section 200.

- I. **Encasement (Casing Pipe):** Payment for encasements will be at the contract unit price per linear foot. Payment shall be for the casing pipe, end seals, chocks/spacers, and all other necessary labor and materials. The pipe being encased shall be paid for separately.

END OF SECTION

SECTION 12

ROADWAY AND DRAINAGE EXCAVATION AND EMBANKMENT

12.1 DESCRIPTION

A. General: This work consists of excavation, placement and disposal of material necessary for the construction of the roadway including hauling, watering, and when required, the placement of select subgrade topping.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 13	Removal Items
Section 17	Salvaging, Stockpiling, and Placing Topsoil
Section 19	Incidental Work
Section 203	Submittals

12.2 MATERIALS

A. Unclassified Excavation: All materials except those classified as rock excavation; muck excavation; unclassified excavation, digouts; contractor furnished borrow excavation; and other removal items paid for under Section 13 encountered during the construction of the work, regardless of the nature of the material or manner in which the material is removed, will be considered unclassified excavation.

B. Rock Excavation: Rock excavation shall consist of a sound, solid mass of mineral matter in place and of such hardness and texture that the mass cannot be loosened or broken down by ripping in a single pass with a tractor mounted hydraulic ripper equipped with one digging point. The ripper and tooth shall be of a standard design, adequately sized and used with a large crawler type tractor rated between 370 and 460 net fly wheel horsepower, operating in low gear, with sufficient downward force on the ripper.

The Contractor shall keep accurate records of the quantity of rock removed so that a comparison can be made with the City's records.

C. Muck Excavation: Muck excavation consists of the removal and disposal of saturated mixtures of soils and organic matter which requires additional work or equipment not normally required for unclassified excavation. The Engineer shall have the sole authority to determine what material is considered muck.

D. Unclassified Excavation, Digouts: Unclassified excavation, digouts consists of the removal and disposal of unstable material below an existing surface on which surfacing material is to be placed. When granular material is used for backfill, the

excavated area shall extend to a daylight point or points such that lateral drainage is provided. The exposed undercut surface shall be satisfactorily compacted prior to backfilling. Unless otherwise permitted by the Engineer, existing surface gravel shall be salvaged before and replaced after the unsatisfactory material has been removed.

- E. Contractor Furnished Borrow Excavation:** Material, furnished by the Contractor, from a pit or other source procured by the contractor.
- F. Undercutting:** Undercutting shall consist of excavating, replacing, and compacting the material immediately below the finished subgrade surface, at locations specified and to the depth specified.
- G. Water:** Water for compaction shall be furnished by the Contractor and shall be free from injurious matter. See section 190.

12.3 CONSTRUCTION REQUIREMENTS

- A. General:** The excavation and embankments for the roadway, intersections, and entrances shall be finished to smooth and uniform surfaces. Materials shall not be wasted without written permission. Grading operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, clearing and grubbing shall have been performed in accordance with Section 10.

Borrow material shall not be used until all roadway excavation has been placed in the embankment unless otherwise directed by the Engineer.

Unsuitable material encountered in the subgrade or slopes shall be removed and the area backfilled to the finished graded section with approved material. Unsuitable material shall be disposed of at locations acceptable to the Engineer.

The subgrade shall be finished to within minus 0.08 feet to plus 0.02 feet from the design grade and typical section shown in the plans and to within $\pm 0.5\%$ of the typical section cross slope. The quarter crown within any 12 foot transverse length shall not exceed 0.04 feet above or below a straight edge, string line, or by other suitable equipment measuring between the crown and edge of roadway. The centerline shall be finished to a transverse distance within ± 0.25 feet of the plans shown location of centerline.

The Contractor shall not begin earth moving operations until all sediment control measures are placed beyond the work limits but within the right-of-way and easements.

- B. Classification of Excavation:** Roadway and drainage excavation will be designated as unclassified excavation, rock excavation, muck excavation, or unclassified excavation, digouts. Authority to identify and define the physical characteristics, which determine classification, shall be vested solely in the Engineer.

- C. Salvage of Topsoil:** Topsoil shall be removed from designated areas as described in Section 17. Topsoil that is not designated to be used as topping shall be salvaged to the Owner.
- D. Undercutting and Subgrade Preparation:** When specified, select materials shall be utilized to improve the roadbed. The work shall be performed in such manner that suitable materials may be selected, removed separately, and deposited in the roadbed within the limits and elevation required.

Where undercut is shown in the plans, the Contractor shall undercut to the limits specified. Undercut dimensions shall be to the minimum dimensions shown on the plans, unless otherwise directed by the Engineer. If the Engineer determines field conditions warrant change, the plan limits of the undercutting may be increased, decreased, or eliminated. The excavated material shall be used for backfill and embankment or disposed of as directed by the Engineer.

Where no undercut is specified, the Contractor shall scarify the exposed subgrade surface for the width of the subgrade to a depth of 6 inches below the subgrade and recompact to the required density in cut sections. In embankments less than 1½ feet, not including subbase gravel, the Contractor shall scarify the width of the subgrade, to a depth of 6 inches below the existing ground surface and recompact. Sod existing in the top 6 inches of subgrade shall be removed and replaced with satisfactory material.

E. Embankment:

- 1. Preparation of Embankment Areas:** When undercutting is not required and a compacted road surface containing granular material lies within three (3) feet of the subgrade surface, such old road surfacing shall be scarified or loosened with a disc or hydraulic ripper to a depth of at least six (6) inches. This scarified material shall be re-compacted to specified density.
- 2. Benching Embankment:** When embankment is to be placed and compacted on hillsides, against existing embankments, or when embankment is built one-half (1/2) width at a time, the slopes that are steeper than 4:1, when measured at right angles to the roadway centerline, shall be continuously benched as the work is brought up on horizontal layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous bench cuts. Material thus cut out shall be recompact to the specified density, along with the new embankment material at the Contractor's expense.
- 3. Placing Embankment:** Embankment materials shall be placed in horizontal layers not exceeding a loose depth of eight (8) inches and shall be compacted as specified before the next layer is placed. Material may be placed in lifts greater than eight (8) inches provided it has been demonstrated that the compacting equipment in use has the ability to compact such material to the required density for the entire depth of the lift.

Sod, topsoil, and other organics shall not be used in embankment.

Rocks, broken concrete, or other solid materials shall not be placed in areas where piling is to be driven, underground utilities are to be installed or in other areas as determined by the Engineer.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of 8 inch maximum lift thickness without crushing, pulverizing, or further breaking down the pieces resulting from excavation methods, such material may be placed in the embankment in layers not to exceed the thickness of the approximate average size of rocks. Use of rocks over 2 feet in diameter for embankments shall be approved by the Engineer. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments or earth. Specified density will not be required for these layers; however, the material shall be compacted to the satisfaction of the Engineer. These layers shall not be constructed above an elevation one (1) foot below the finished subgrade.

Excess or unsuitable excavated material, including rock and boulders, that cannot be used in embankments may be placed on the project, with the permission of the Engineer. In cases where it is impossible to dispose of onsite, excess material shall be treated as waste and hauled off by the contractor.

The top six (6) inches of embankments shall be essentially free of rock fragments or stone that cannot be hand-passed through a four (4) inch square opening.

Each lift shall be thoroughly mixed to provide uniform moisture distribution. Effective spreading equipment shall be used to obtain uniform thickness prior to compacting. As the compaction of each lift progresses, continuous leveling and manipulating will be required to assure uniform density and moisture distribution. Construction equipment shall be routed uniformly over the entire surface of each layer.

When specified moisture contents are not met, the Contractor has the options of drying wet soil, furnishing approved soil meeting specifications at their expense, or adding water to dry soil as necessary to meet specifications. If water is added to dry soil, it must be thoroughly mixed with the soil to provide uniform moisture content prior to backfilling.

Embankment moisture and density shall be determined at least every 200 feet horizontally and every three (3) feet vertically. Engineer reserves the right to require additional testing. Embankment shall be properly compacted at all depths. The Contractor shall not place the finished surface (asphalt, curb & gutter, grass, etc.) until the specified densities are met at each location and the Engineer gives his approval. Backfill material not meeting specified densities shall receive additional compaction or shall be removed and replaced at no extra cost to the City as necessary to meet specifications.

In areas composed mainly of bentonite or unstable material, the Engineer may require additional undercutting to a depth necessary to stabilize the area.

Berms for structures requiring slope protection shall be finished to grade with ± 0.1 foot tolerance to provide a positive support for the slope protection. Other berms will be neatly finished to the same tolerance specified for embankment. When portions of foundations for box culverts are constructed of embankment, the embankment shall be constructed to the flow line grade, as specified.

The Contractor shall provide for positive drainage away from the excavation and embankment or otherwise take steps to protect the excavation and embankment from becoming excessively wet prior to placing the finished surface.

Should the Engineer determine that any portion of the backfill or excavation has become excessively wet after placement, the Contractor shall remove and furnish an approved backfill material or dry onsite material to the satisfaction of the Engineer.

The Contractor shall be responsible for the stability of constructed embankments prior to acceptance and shall replace or reconstruct any portions, which have failed at no additional cost to the City.

Watering, and the work incidental thereto, shall be done as set forth in Section 190.

Embankment shall not be constructed on frozen ground and frozen material shall not be used in construction of embankments.

- F. Compaction:** Unless the plan notes indicate otherwise, Specified Density Method shall be the method of compaction used.
- 1. Specified Density Method:** Soil shall be compacted within the moisture specification range in accordance with Table 1, unless otherwise specified in detailed plans and specifications. Optimum moisture will be determined by the AASHTO T 180 (Modified Proctor).

Table 1

Soil Type	Density Specification (Percent of Maximum Dry Density)	Moisture Specification (Percent of Optimum Moisture)
Cohesive	92% or Greater	-3% to +8%
Non-cohesive	95% or Greater	Workable

2. Soil Tests:

- a) **AASHTO T 180 (Modified Proctor):** The Contractor shall provide the Engineer with the results of the modified proctor soil compaction test, as determined by AASHTO T-180. If no locations are indicated on the plans, proctor test results shall be provided for locations determined by the Engineer. Should it become apparent during construction that the soil types encountered are significantly different from the initial samples, additional sampling and testing may be required.

If requested by the Engineer, the Contractor shall provide the Engineer with no less than 25 pounds of each sample appropriately labeled with the project title, the location from which the sample was obtained, the date of sample collection, and name of the person who collected the sample, and the name of the person or firm who conducted with compaction test. A City Inspector shall be present during sample collection.

- b) **AASHTO T 238 (In-place Nuclear Density):** Unless otherwise specified in the Detailed Specifications, field density tests, will be performed by the Engineer. The field density shall be measured with a nuclear density machine in accordance with SD DOT Materials Manual SD114 (AASHTO T 238). Contractor will be required to provide a prepared surface in the embankment shaped to facilitate testing at locations requested by the Engineer.

When embankment contains over 40% by weight of durable material passing an 8 inch square opening and retained on a 3/4 inch sieve, specified density requirements will be waived. Material retained on a 3/4 inch sieve will be considered durable when, after soaking in water for 24 hours, this retained material cannot readily be broken with the fingers and passed through the sieve. The embankment shall be compacted with sheepsfoot or other approved rollers to the satisfaction of the Engineer. Moisture requirements will be determined in accordance with SD DOT Materials Manual SD104, except the optimum and field moisture will be determined using material passing a 3/4 inch sieve.

For non-cohesive soil, embankment shall be spread in layers not exceeding an 8 inch loose depth and adequately compacted, with approved vibratory or pneumatic rollers, at the moisture content needed to obtain stability.

- c) **Proof Rolling:** Proof rolling shall be performed prior to placing base course. Equipment shall be a tandem-axle dump truck or tri-axle dump truck with the third axle raised, and shall have a minimum gross weight of 24 tons. Tires shall be properly inflated to the recommended pressure. Rolling operations shall be done in the center of each driving lane at walking speed. Inspection of the subgrade response at the rear axle shall be performed by the Engineer. To achieve passing results, no more than 1 inch of deflection shall be observed, and no cracking or pumping of the subgrade shall be present.

- G. Waste and Surplus Excavation:** Surplus excavation and waste material shall be disposed of as specified in plans or as directed by the Engineer. All waste material shall be disposed of at the contractor's sole expense.

Excavated material which contains bentonite shall be treated as waste.

Authority to designate what is surplus and waste shall be vested solely in the Engineer.

- H. Unclassified Excavation-Digouts:** This excavation consists of the removal and disposal of unstable material below an existing surface on which surfacing material is to be placed. Where possible, compacted suitable backfill material shall be utilized to achieve final grade.

When granular material is necessary for stability and is used as backfill, the excavated area shall extend to a daylight point or points such that lateral drainage is provided. The exposed undercut surface shall be satisfactorily compacted prior to backfilling. Unless otherwise permitted by the Engineer, existing surface gravel shall be salvaged before and replaced after the unsatisfactory material has been removed.

- I. Contractor Furnished Borrow Excavation:** Suitable materials removed from borrow sources shall be used in the formulation of embankments. Borrow sources shall be left and maintained in a suitable condition for accurate measurement and a natural appearance. Unless otherwise specified contractor shall be responsible to provide a suitable borrow source. Determination of the suitability of the borrow material shall be at the discretion of the Engineer.

Replacement of topsoil, fertilizing, seeding, and other operations necessary for restoration of the borrow source shall be incidental to the contractor provided borrow excavation, or as specified in the contract.

- J. Water:** Sufficient equipment shall be available to apply the quantity of water required to secure the proper compaction before evaporation, absorption, or drainage prevents or interferes with the specified results. Moisture content of material shall be uniform for the full depth and extent of each layer.

12.4 METHOD OF MEASUREMENT

- A. AASHTO T 180 (Modified Proctor):** AASHTO T 180 tests shall be measured by each test. If the contractor elects to import soil for the contractor's convenience which is not required by the contract and not ordered by the Engineer, the contractor shall provide the AASHTO T 180 test and it will not be measured for payment.
- B. Excavation:** Excavation shall be measured to the nearest cubic yard. Plans quantity will be the basis of measurement of excavation unless otherwise noted.

When payment is to be made on a plans quantity basis, whether provided in the contract or by written agreement, measurements will not be made except those necessary to determine that the work has been performed in conformance with the plans and to measure changes in plans or borrow pits which increase or decrease quantities of excavation.

When payment is to be made on a basis other than plans quantity, accepted quantities of various types of excavation will be measured in their original and excavated position by cross sectioning. Quantities of excavation, which conform to the staked lines and grades, may be computed using the original cross-sections and the staked section. Quantities of excavation that do not conform to the original plans lines and grades due to: changes in plans and grades, as directed by the Engineer, will be measured separately and added to the area of the excavation.

The plan-shown quantity of undercutting excavation as described in this section, with deductions made for portions not accomplished and with additions for portions not shown on the plans and ordered by the Engineer, will be measured separately.

Measurement of excavation will include unsuitable material excavated and removed to obtain proper compaction in cut or fill sections. Suitable material temporarily removed and replaced to facilitate compaction, except that removed for undercutting, will not be measured for payment.

Such affected areas will be measured, differences in quantities computed, and deductions or additions made as determined by the Engineer. Volume will be computed in cubic yards by the average end area method.

Where it is impractical to measure material by the cross-section method, acceptable methods involving three-dimensional measurements or measurement in the hauling vehicle may be used.

- C. Embankment:** Measurement of embankments will not be made.
- D. Waste:** This work will not be measured, but shall be incidental work to the associated bid item.
- E. Contractor Furnished Borrow Excavation:** Contractor furnished borrow excavation will be measured in its original position by cross sectioning, or surveyed volume calculation. Volumes will be computed in cubic yards.

Original cross sections or survey will be taken by Contractor prior to removal of any material and final cross sections will be taken following replacement of topsoil. Salvaged topsoil will not be measured.

Vegetation and stabilization of the borrow site will not be measured and shall be incidental to the associated borrow bid item.

- F. Water:** Water will not be measured. See Section 190.

12.5 BASIS OF PAYMENT

A. AASHTO T 180 (Modified Proctor): AASHTO T 180 tests will be paid for at the contract unit price per test. Payment shall be full compensation for obtaining the soil sample, delivering it to the certified lab, conducting the test, and providing the Engineer with the results. If the contractor elects to import soil for the contractor's convenience which is not required by the contract and not ordered by the Engineer, the contractor shall provide the AASHTO T 180 at the contractor's sole expense.

B. Excavation: Completed and accepted work will be paid for at the contract unit price per cubic yard for the class of excavation involved. Payment will be full compensation for excavation; construction and compaction of cuts and embankments; shaping of slopes; finishing of surface; disposal of surplus materials; completion of subgrade, shoulders, and roadway; and maintenance.

Scarifying, shaping, and recompacting, as required, shall be incidental to the unit price bid for excavation. Separate payment will not be made.

1. Unclassified Excavation: Excavation will be paid for at the contract unit price for unclassified excavation unless contract items provide for other classes of excavation.

When no bid item or other mention of Rock Excavation is shown on the plans and rock is encountered, such rock excavation as defined in this specification will be paid for at a negotiated price. Notification shall be given to the Engineer far enough in advance to enable him to ascertain the extent and nature of the rock formation before removal of such rock is begun. Payment as rock excavation will not be made unless such notification is given.

2. Rock Excavation: When an item for rock excavation is provided, payment will be made at the contract unit price.

3. Muck Excavation: When an item for muck excavation is provided, payment will be made at the contract unit price.

4. Unclassified Excavation, Digouts: When an item for unclassified excavation, digout is provided, payment will be made at the contract unit price.

5. Undercutting: Undercutting as described in this specification with corrections made for portions not accomplished and for portions not shown in the plans but ordered by the Engineer will be paid for at the contract unit price. Payment will be full compensation for all work to perform undercutting.

C. Embankment: Embankment will not be paid for directly, but shall be subsidiary work pertaining to several classes of excavation.

D. Waste: Waste will not be paid for directly, but shall be incidental to the associated

bid items.

E. Contractor Furnished Borrow Excavation: Contractor furnished borrow excavation will be paid for at the contract unit price per cubic yard. Payment will be full compensation for excavation and furnishing the material on the project; construction and compaction of embankments; shaping of slopes; finishing of surface; completion of subgrade, shoulders, and roadway; maintenance, and for furnishing materials, labor, and incidentals required for restoration of the borrow site. Topsoil, seed, fertilizer, and mulch for the restoration of the borrow site shall be incidental to the unit price per cubic yard of Contractor furnished borrow excavation.

F. Water: Water will not be paid for.

END OF SECTION

SECTION 13

REMOVAL ITEMS

13.1 DESCRIPTION

A. General: This work shall include, but is not be limited to: the removal and disposal of buildings, fences, structures, pavements; and removal and disposal or salvage of abandoned pipe lines, pipe culverts, and other obstructions which are not designated or permitted to remain, except for obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits. When the proposal does not include pay items for removal items as set out in this section, such work shall be performed under various other contract items.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 19	Incidental Work
Section 90	Roadway Signs and Delineators

13.2 MATERIALS (not specified)

13.3 CONSTRUCTION REQUIREMENTS

A. General: The location of waste disposal shall be properly certified for the type of waste being disposed.

Detailed plans and specifications shall state if beneficial use materials are to be delivered to the City Landfill.

Cavities left by structure removal shall be filled to the level of the surrounding ground and shall be compacted to the satisfaction of the Engineer under the same specifications as embankment. Concrete floors and similar structures shall be broken up to prevent entrapment of water. The substructures of existing bridges and similar structures shall be removed down to 1 foot below the finished ground elevation. Those structure parts in a stream shall be removed down to the natural stream bottom.

Subsurface drains or under drain which will remain and are damaged during construction shall be repaired in kind at no expense to the City unless otherwise indicated in the Contract Documents. Repair of under-drains shall be per Section 11.

Streets that utilize an engineering geotextile or geogrid underlayment which will remain and is damaged by construction shall be repaired in kind at no expense to the City

unless otherwise indicated in the Contract Documents. Repair of engineering geotextile or geogrid shall be per Section 11.

Established drainage in the street, alley, or drainage ditch must be maintained by the Contractor during his construction operations. Contractor shall take necessary precautions to prevent drainage from running into the excavation.

Street and traffic signs within the excavation area shall be removed by the Contractor and delivered to the Rapid City Traffic Operations Division. Care shall be taken to prevent damage to the signs, posts or hardware. New signs not specifically called out in the plans to be installed by the Contractor shall be erected by Traffic Operations Personnel upon notification by the Contractor that construction is sufficiently completed to enable sign installation. The Contractor shall give no less than twenty-four (24) hours' notice to the Traffic Operations Engineer.

Monuments, property pins, survey referenced points, and benchmarks shall not be disturbed without specific written permission from the Engineer. Unless otherwise called for in plans, any such markers disturbed without permission shall be replaced at the Contractor's expense by a licensed Professional Land Surveyor. Plans will indicate known, existing monuments that are scheduled to be disturbed, demolished or removed.

Damage to the property of others, such as fences, trees, shrubs, lawns, sidewalks, etc. shall be repaired or replaced at the Contractor's expense, unless removal of such is shown on the plans or written permission was first obtained from the Engineer.

- B. Remove and Salvage:** Designated salvageable material shall be carefully removed in sections or pieces, which may be readily transported and shall be stored at places specified.
- C. Remove and Reset:** Materials to be removed and reset shall be removed, transported to a location approved by the Engineer and stored, when necessary, so that there will be no damage before resetting. The Contractor will be required to replace materials damaged by his negligence.
- D. Remove and Dispose:** Unusable material shall be destroyed or disposed of off the project.
- E. Paving Surface Removal:** In removing pavement, curb, gutter, sidewalk, and similar structures where portions of the existing structures are to be left in the finished work, the old structure shall be removed to an existing joint or saw cut to provide a true line with a vertical face. Openings in the existing pavement shall be made, by sawing to full depth of the pavement.

Protection of Existing Surface use of steel faced or shod equipment without adequate padding to prevent damage to the existing pavement shall be at the Contractor's risk. Extra care shall be taken to prevent damage from excavator, loader bucket, or other equipment edges/teeth when placing or removing trench spoil or materials piles.

Damaged pavement because of the Contractor's equipment shall be repaired or replaced at no additional cost to the City.

- F. Saw Cutting:** Saw cutting of pavement ahead of trenching or excavation operations shall be required to confine pavement damage to the limits of the trench or excavation. The first pavement saw cut shall be, at a minimum, the same width as the minimum trench width centered over the utility. Asphalt or portland concrete pavement shall be cut to full depth. Pavement removal limits shall be approved by the Engineer prior to sawing. A second full depth saw cut shall be made one (1) foot outside the disturbed limits of the trench excavation on both sides. Final saw cuts shall provide a smooth vertical face, against which to resurface. Care shall be taken to prevent damage to the newly cut edge.

Final removal area limits for portland cement concrete excavation shall be as approved by the Engineer. Removal of half panels shall be in accordance with standard details.

If the asphalt concrete pavement edge is undermined at any time during construction, the pavement must be saw cut back to the undermined location and removed to form a square edge. Removals for portland cement concrete that has become undermined shall be as directed by the Engineer.

13.4 METHOD OF MEASUREMENT

When the contract stipulates that payment will be made for removal of obstructions on a lump sum basis, no separate measurement will be made.

When the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

If detailed plans and specifications require beneficial use material to be delivered to the City landfill, no additional measurement or payment for hauling or disposal shall be made.

When removal of pipe is to be made on a unit basis, the quantity will be measured in linear feet to the nearest whole (1) foot. Quantities will be determined by measuring in place prior to removal.

When removal of AC or PCC pavement or sidewalk is to be made on a unit basis, the quantity will be measured in square feet or square yards to the nearest square foot or nearest tenth (0.1) square yard. Quantities will be determined by measuring in place prior to removal.

Curb and gutter removal shall be paid for by the nearest half (0.5) linear foot. All types of curb and gutter shall be measured the same for removal. Where curb and/or gutter is monolithic or tied to adjacent portland cement concrete pavement to be removed, it will be considered as pavement and will be measured as such.

When a portion of pavement, curb and gutter, sidewalk, or other similar structures will remain, saw cutting to the lines described in the plans or as directed by the Engineer, shall be incidental to the removal item and will not be measured.

13.5 BASIS OF PAYMENT

Obstruction removal, will be considered as Incidental Work unless a bid item for the removal is provided. Payment for removal of obstructions by lump sum or unit price basis will be full compensation for removal and disposal of such items, excavation and subsequent backfill incidental to their removal.

Pipe removal, will be considered as Incidental Work unless a bid item for the removal is provided. Variance from pipe removal quantities, locations, or dimensions shown on the plans or specified herein will not be cause for adjustments in payment for Incidental Work.

AC or PCC pavement or sidewalk shall be paid for at the contract unit price bid, and shall be full payment for removal and disposal.

Removal of curb and gutter shall be paid for at the contract unit price per linear foot. Payment shall be full compensations for removal and disposal of any type of curb and gutter.

If detailed plans and specifications require beneficial use material to be delivered to the City landfill, no additional measurement or payment for hauling or disposal shall be made.

END OF SECTION

SECTION 17

SALVAGING, STOCKPILING, AND PLACING TOPSOIL

17.1 DESCRIPTION

This work consists of excavating, hauling, stockpiling, depositing, and spreading topsoil on prepared areas.

17.2 MATERIALS (Not specified)

17.3 CONSTRUCTION REQUIREMENTS

- A. Salvage:** Topsoil shall be selected from the regular grading areas or from other areas designated by the Engineer.

Areas from which topsoil is to be excavated shall be cleared of objectionable vegetation and all litter such as brush, rock, and foreign material. Topsoil shall be excavated to a minimum depth of four (4) inches.

Salvaged topsoil may be stockpiled in convenient locations within the right-of-way or as approved by the Engineer. The separation of cut and fill piles is not required. Topsoil piles shall be located where the topsoil will not erode into any waterway due to a rain event.

When operations of the Contractor or the contract documents do not permit stockpiling of topsoil within the right-of-way or project limits, it shall be the Contractor's obligation to arrange for stockpile sites at the Contractor's own expense. Stockpile areas shall be stabilized and left in a neat condition.

- B. Preparation of Topsoil Areas:** Areas designated to be covered with topsoil shall be undercut or underfilled so the finished lines conform to the template lines on the cross sections after the topsoil placement. The areas receiving topsoil shall be shaped and smoothed prior to placing topsoil.

- C. Placing:** Topsoil shall be spread evenly and uniformly over the designated areas to the specified depth. If depth is not specified, topsoil shall be placed to a depth of four (4) inches. If topsoil is not available in sufficient quantities to cover the designated areas to the plan specified depth, the Contractor shall spread the available topsoil as required by the Engineer. Excess topsoil shall remain property of the owner.

17.4 METHOD OF MEASUREMENT

- A. Salvaged Topsoil:** Measurement for removal of topsoil from its original position shall be to the nearest whole cubic yard. Plans quantity shall be used for

measurement unless otherwise noted in plans, or as directed by the Engineer. If field measurement is directed, the volume of topsoil will be determined by measuring the topsoil stockpiles by method determined by the Engineer.

- B. Placing Topsoil:** Placing topsoil shall be measured to the nearest full cubic yard and shall be the quantity of topsoil removed from stockpiles and placed on the designated areas. Plans quantity shall be used for measurement unless otherwise noted, or as directed by the Engineer. If required, measurement shall be made prior to removal of the material from stockpiles.
- C. Imported Topsoil:** Imported topsoil shall be measured to the nearest whole cubic yard of topsoil imported and placed.

17.5 BASIS OF PAYMENT

- A. Salvaged Topsoil:** Topsoil will be paid for at the contract unit price per cubic yard for excavation, unclassified. The payment will be full compensation for excavation (which includes necessary undercutting to provide space for topsoil placement) and stockpiling. Payment for salvaging topsoil will be plans quantity unless otherwise noted.

Separate payment will not be made for hauling topsoil under this item.

- B. Placing Topsoil:** The placement of stockpiled topsoil will be paid for at the contract price per cubic yard for placing topsoil. Payment for placing topsoil will be plans quantity unless otherwise noted.

This payment shall be full compensation for labor, equipment, tools and incidentals necessary for removing topsoil from stockpiles, hauling, depositing, spreading and finishing of topsoil.

- C. Import Topsoil:** Imported topsoil will be paid for at the contract price per cubic yard for imported topsoil.

This payment shall be full compensation for labor, equipment, tools and incidentals necessary for hauling, depositing, spreading and finishing of imported topsoil.

END OF SECTION

SECTION 18

EROSION, SEDIMENT, AND WATER POLLUTION CONTROL

18.1 DESCRIPTION

A. General: This work consists of measures necessary to control erosion, sedimentation, and water pollution during the life of the contract. Measures to be used shall be included in the contract.

B. Related Work:

Section 10	Clearing and Grubbing
Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 17	Salvaging, Stockpiling, and Placing Topsoil
Section 65	Riprap
Section 66	Gabions
Section 70	Seeding
Section 71	Fertilizing
Section 72	Mulching
Section 73	Sodding
Section 202	Geosynthetics for Roadways
Section 203	Submittals

C. Definitions:

- 1. Final Stabilization:** Either (1) perennial vegetative cover with a density of 70 percent of the natural background vegetative cover, or (2) permanent non-vegetative stabilization (i.e. rip-rap, etc.) has been implemented to provide effective cover for exposed portions of the site.
- 2. Perimeter Control:** Sediment Control devices installed at or near the perimeter of the site to capture sediment and prevent it from leaving the site.
- 3. Permanent Stabilization:** Practices that result in permanent cover of bare soil. This includes seeding, mulching, installing erosion control blankets (over the top of seeding), turf reinforcement mats, transition mats, channel liners, geotextiles or drainage fabrics covered with rip rap or gabions, and other practices considered long term erosion control. It also includes completion of buildings, wall, drainage structures, and pavement on roads, paths, and sidewalks.
- 4. Temporary Stabilization:** Short-term cover of bare soil during construction. This includes surface roughening or applying mulches, soil stabilizers, and other practices considered temporary erosion control.

18.2 MATERIALS

- A. General:** All materials shall be free of invasive species, noxious weeds, and other contaminants. Material containing any of the aforementioned will be rejected and the Contractor will be required to remove the material from the project.

Materials listed on the SDDOT approved products list meeting the requirements of this specification shall be acceptable.

- B. Water Pollution Control:** The Engineer may require some or all of the items below.

1. Concrete Washout Area: Shall be constructed with an impermeable barrier.

2. Dewatering and Sediment Collecting:

- a) Small scale testing using water samples and various flocculants will be required to select a flocculant due to the varying physical and chemical properties of the sediments to be flocculated out of suspension.
- b) Materials used for filtering floc shall be approved by the Engineer.
- c) Ponds and containers used to hold water that is being treated shall not further contribute to water pollution and shall not leak.
- d) Pumps used to collect sediment laden water shall be floating pumps or shall incorporate a device that siphons clearer water off the surface to reduce the amount of sediment that needs to be removed from the discharge.

3. Temporary Diversion Channel:

- a) Diversion channels must be lined with plastic sheeting or Class 1 non-woven separation fabric and lined with Class A Riprap or shot rock.
- b) The original channel shall be blocked during diversion with Engineer approved sheet piling, sandbags, or an approved Temporary Water Barrier.
- c) Culverts can be used in place of diversion channels.
- d) Pumping water around the site is allowed in place of diversion channels given the diversion is not needed longer than forecasted dry weather and the Engineer approves.

4. Temporary Water Barrier: Shall be from the list in the plans or an approved equal.

C. Sediment Control:

1. Bale Barrier:

- a) Bales shall consist of certified weed free straw.
 - b) Bales shall be approximately 15 inch x 18 inch x 3.5 feet.
 - c) Each bale shall be held in place with two 2"x2"x4' wooden stakes.
- 2. Rock Check Dams:** Shall be constructed using 4" to 6" angular rock.
- 3. Floating Silt Curtain:** Shall be as specified in the plans or an approved equal. The Contractor will determine the water depth and other waterway characteristics such as stream flow velocity and seek technical advice from the manufacturer before ordering the floating silt curtain to make sure it is the correct type for the site.
- 4. Gravel Filter Sock:**
- a) The geotextile sock material shall be from the list in the plans.
 - b) The sock shall be filled with 3/4" rock, 3/8" lime stone chips, clean 1/4" pea gravel, clean sand or material approved by the Engineer.
- 5. Inlet Protection Device:**
- a) The Inlet Protection Device shall be from the list in the plans, or an approved equal. Installation shall be per standard details.
 - b) The device selected shall fit the curb inlet properly and be recommended for that type of inlet by the manufacturer.
 - c) Inlet protection devices can be reused from previous projects, but devices that no longer appear to be functional will be rejected.
 - d) Inlet protection devices shall be replaced when they are beyond repair.
 - e) The Contractor shall provide welded wire support for devices used on curb inlets without grates if the device has no other structural support to ensure devices do not fall into the inlet.
- 6. Interim Sediment Control at Inlets, Manholes, and Junction Boxes:**
- a) Refer to the standard detail for details of installation of high flow silt fence at drop inlets, manholes, and junction boxes.
 - b) The high flow silt fence product provided shall be from the list in the plans.
 - c) The gravel filter socks provided shall be from the list in the plans.
- 7. Silt Fence:**

- a) Silt fence shall consist of a temporary vertical barrier of fabric attached to wood or steel posts and entrenched into the ground. Low flow silt fence shall be supported by woven wire backing.
- b) Woven wire shall be 26 inch wide, 14 ½ gauge and have six horizontal wires with 6 inch or 12 inch spacing of vertical stay wires. Woven wire is not required for high flow silt fence installations unless specified in the plans or ordered by the Engineer.
- c) Posts shall be steel T line posts with 5 foot minimum length or wood posts with 5 foot minimum length and 3 inch diameter.
- d) Silt fence fabric may be selected from the SD DOT approved products list and shall be the type specified in plans, or approved equal.

Silt Fence Fabric Material Specifications

Property and Test Method	Low Flow Silt Fence	High Flow Silt Fence
Material Composition	Woven Monofilament	
Water Flow Rate ASTM D 4491	20-70 gpm/ft ²	71-145 gpm/ft ²
Minimum Ultra-Violet Stability ASTM D 4355 ¹	70%	70%

8. Stabilized Construction Entrance:

- a) The entrance, at a minimum, shall be 15' wide by 50' long.
- b) A drainage pipe and stabilized embankment shall be provided if necessary.
- c) The material options are:
 - 1) Wood options include slash mulches and timber pads
 - 2) Winter options include frost penetrated pad, snow or ice roads.
 - 3) Wash rack option as shown on Standard Detail.
 - 4) Manufactured options shall be selected from the list in the plans, or as approved by the Engineer.
 - 5) Other products or processes as approved during the preconstruction meeting.
 - 6) Aggregate Option as shown on Standard Detail shall be constructed with the following materials:

Stabilized Construction Entrance: Aggregate Option

Granular Materials*	Sieve Size	Percent Passing
Granular Material-- 12" thick over Reinforcement Fabric (MSE)	3"	100%
	2 ½"	50%
	1 ½"	0%

*The granular material will be placed in 6" maximum lifts

Reinforcement Fabric (MSE)**	Test Method	Requirement
AASHTO Class	AASHTO M 288	1 Woven
AOS, US Standard Sieve	ASTM D4751	40-100
Permittivity, Sec-1	ASTM D4491	0.005 Min
Grab Strength, lbs	ASTM D4632	315
Grab Elongation, %	ASTM D4632	35 Max
Trapezoid Tear Strength, lbs	ASTM D4533	110
Puncture Strength, lbs	ASTM D6241	620
UV Strength Retention, %	ASTM D4355	50
Wide Width Strip Tensile Strength, lbs/in	ASTM D4595	200

** The fabric shall be kept as taut as possible prior to placing. Equipment will not be allowed on the fabric until the first lift of granular material is in place. All seams of the fabric will be overlapped at least 2' and shingled.

9. Street Sweeping:

- a) The Contractor shall use a pickup broom having integral self-contained storage to clean the roadway.
- b) The pickup broom used shall be a minimum of 6 feet wide and have working gutter brooms.

10. Triangular Silt Barrier: Shall be from the list in the plans or an approved equal.

11. Wattles:

- a) Wattles shall consist of compost or excelsior encased in ultraviolet degradable or biodegradable netting.
- b) Wattles must be from the list provided in the plans.
- c) Anchors for wattles shall be wooden or biodegradable stakes.

12. Sediment Basins: Shall be constructed using materials provided in the plans, or as directed by the Engineer.

- D. Erosion Control:** Placing topsoil, seeding, mulching, sodding, rip rap, gabions, rock filled wire baskets, slope protection, fabric formed concrete mats, and engineering fabric are also materials used for erosion control. Please refer to their respective sections for material requirements.

1. Dust Control:

- a) Dust control on areas to be vegetated shall be the temporary or permanent stabilization practice provided in the plans.
- b) Dust control on haul routes shall be water, calcium chloride, biopolymers, or other product or practice approved by the Engineer.
- c) Refer to street sweeping for dust control on paved surfaces.

2. Erosion Control Blanket:

- a) Blanket may be selected from the SD DOT approved products list and shall be the type specified in plans, or an approved equal.
- b) Approved equals must meet the following criteria:

Erosion Control Blanket Material Specifications

PROPERTY AND TEST METHOD	Type 1	Type 2	Type 3	Type 4
Material Composition Manufacturer's Data	Processed degradable natural and/or polymer fibers either mechanically interlocked, chemically adhered, or bound by netting to form a continuous matrix.		Processed slow degrading natural or polymer fibers mechanically bound between two slow degrading synthetic or natural fiber nettings to form a continuous matrix.	
Functional Longevity Manufacturer's Data	3 to 6 month Typical	6 to 12 month Typical	12 to 24 month typical	24 to 36 month typical
Minimum Mass Per Unit Area ASTM D 6475	8 oz/yd ²	8 oz/yd ²	8 oz/yd ²	8 oz/yd ²
Minimum Thickness ASTM D 6525	0.2 in	0.2 in	0.2 in	0.2 in
Minimum Tensile Strength ASTM D 6818 Machine Direction	60 lbs/ft	75 lbs/ft	100 lbs/ft	100 lbs/ft
Maximum Shear Stress ASTM D 6460*	1.5 lbs/ft ²	1.75 lbs/ft ²	2 lbs/ft ²	2.25 lbs/ft ²

*(channel applications) blanket can sustain at least this shear stress without damage and without any more that 0.5" soil loss during a 30 minute flow event

3. **Interceptor Ditch:** The non-erodible material used shall be an erosion control blanket, turf reinforcement mat, or 2" thickness of shot rock, base course, or gravel cushion material.
4. **Surface Roughening:** Equipment for surface roughening shall be equipped with tracks that are capable of creating ridges in the soil that are perpendicular to the slope. Alternately, the Contractor could disc perpendicular to the slope to create ridges.
5. **Soil Stabilizers:**
 - a) Soil Stabilizers shall be selected from the list in the plans or an approved equal.
 - b) The Contractor shall apply soil stabilizer in accordance with the manufacturer's application instructions and at the rate specified in the list of approved soil stabilizers.
 - c) Wood fiber mulch that contains green dye will be mixed with the soil stabilizer to be used as a tracer when the soil stabilizer is applied hydraulically.
 - 1) Wood fiber mulch will be added at a rate of 300 pounds per acre or 1 ounce per square yard.
 - 2) Wood fiber mulch shall be used with all Soil Stabilizers unless otherwise noted.
 - 3) The wood fiber mulch shall be a 100% wood fiber product and does not need to contain a tackifier.
6. **Temporary Mulching:** Grass Hay/Straw Mulch as defined in Section 72 may be used as temporary mulching for erosion control.
7. **Temporary Slope Drain:**
 - a) Embankment material shall be free of roots or other woody vegetation, organic material, and other unsuitable material.
 - b) Steel T posts and 16 gauge wire shall be used to secure the pipe in place.
 - c) A minimum of 1 cubic yard of Class A rip rap shall be used at the outlet.
 - d) Corrugated pipe shall be used to convey drainage. The size of the pipe shall be selected based on the drainage area as shown in the table below.

Corrugated Pipe for Temporary Slope Drain

Drainage Area in Acres	Pipe Diameter in Inches
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

8. **Transition Mat:** Transition mat shall be from the list in the plans or an approved equal.

9. **Turf Reinforcement Mat:**

- a) Turf Reinforcement Mat may be selected from the SD DOT approved products list and shall be the class specified in plans, or an approved equal.
- b) Turf Reinforcement Mats on the list meet the following criteria:

Turf Reinforcement Mat Material Specifications

Property and Test Method	Class 1	Class 2	Class 3	Class 4
Material Composition Manufacturer's Data	A product composed of UV-stabilized, non-degradable, synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix. Degradable components may be used within the permanent three-dimensional matrix.			
Unvegetated Shear Stress (psf) ASTM D6460	≥ 2	≥ 2.5	≥ 2.5	≥ 3
Vegetated Shear Stress (psf) ASTM D6460	≥ 6	≥ 10	≥ 12	≥ 14

18.3 CONSTRUCTION REQUIREMENTS

A. General:

1. Ordinances and Regulations:

- a) In the event of conflict between the requirements set forth in the contract and requirements of other Federal or State or local agencies, the more restrictive laws, rules or regulations shall apply.
- b) Local requirements: Rapid City's Municipal Code and Infrastructure Design Criteria Manual.

2. Performance Objectives:

- a) Construction activities shall be scheduled to minimize the total amount of soil exposed at any given time.
- b) Sediment and construction materials shall be kept on site or properly disposed.
- c) Construction fence or silt fence shall be utilized to limit traffic in areas with existing vegetation that do not require grading, excavation, or use for staging.
- d) All erosion and sediment controls shall be placed as directed in the plans or as approved by the Engineer.

3. Preference of Erosion Control (Stabilization) Over Sediment Control:

- a) Erosion control is the preferred method of sediment retention on-site and shall be completed as soon as possible to reduce sediment control maintenance costs.
- b) Disturbed areas that are not at final grade and soil stockpiles that will not be worked or spread within 21 days must be temporarily stabilized within 14 days.
- c) Final stabilization must begin within 14 days of an area reaching final grade.
 - 1) If final stabilization cannot begin due to seasonal limitations or conditions that make seeding or other final stabilization techniques impossible to complete, temporary stabilization must be utilized and sediment controls must be in place.
 - 2) Slopes 3:1 or steeper must be stabilized with erosion control blanket, turf reinforcement mat, bonded fiber matrix, or fiber reinforced matrix.
 - 3) The Contractor shall include multiple mobilizations in the bid for seeding, mulching, and other erosion control items.

4. Storage of Construction Materials:

- a) Soil, base course, and other materials containing soil shall not be placed directly on pavement for more than 24 hours without having the proper sediment controls.
- b) Contractor equipment yards and service areas shall be located or bermed so runoff and pollutants do not reach waterways or impoundments of water.
- c) Refer to plans for other requirements.

5. Inspections:

- a) Inspection reports shall include the inspector's name, the date, current weather and site conditions, sediment controls requiring maintenance, any temporary or final stabilization that is required, good housekeeping, and construction status.
- b) Based on the results of the inspection, the plan shall be revised and implemented, in no case later than seven days following the inspection.

6. Maintenance:

- a) Dirt, mud, and rock tracked into the right of way (includes—road, curb and gutter, sidewalks, and approaches) must be cleaned up by the end of each working day.
- b) Once discovered, washouts and scours shall be repaired before gullies form.
- c) Sediment control devices and rolled erosion control products that have been undercut shall be evaluated for replacement with another device or reinstallation with better trenching-in and staking or stapling.

7. Winter Site Preparation and Management: Engineer may require some or all of the provisions below as necessary.

- a) Do not spread frozen or saturated topsoil.
- b) If topsoil cannot be properly spread prior to freezing, the finished subgrade work should be significantly roughened and stabilized with mulch as directed below.
- c) Saturated soil may be removed on access drives and during trenching and excavation operations and stored above snow storage locations.
- d) Silt ditches shall be placed within soil stockpile areas to direct runoff to treatment BMPs for sediment control and to prevent mixing with surrounding runoff.
- e) Prepare a snow management plan for the site to account for adequate storage of cleared snow through the winter and control of meltwater.
- f) Snow mixed with significant amounts of soil should be stored in separate locations that are designed to handle larger volumes of sediment.
- g) Snow storage locations should be placed down slope of all disturbed areas, but not within natural wetlands or drainage easements.
- h) Keep all equipment travel areas as free of snow as possible to increase frost penetration to reduce track out problems.

- i) Keep drainage structures open. Check for and remove snow and ice dams to ensure drain function during construction.
- j) Snow berms may be used as perimeter control, but care must be taken not to cause offsite ponding of water.
- k) Snow shall not be piled against silt fence.

8. Thawing Condition:

- a) Keep vehicle travel areas free of snow at night and covered with snow during the day to maintain frost penetration and prevent muddy travel areas and track-out.
- b) Ensure that all areas of disturbed soil are adequately protected ahead of a forecasted melt event.
- c) Actively monitor and promptly maintain sediment controls during spring thaw.
- d) Construction activities may need to be suspended until soils are no longer saturated.

B. Water Pollution Control:

1. Concrete Washout Area:

- a) The concrete washout area must be kept in a condition to maintain the capacity for all wasted concrete and washout water on the project.
- b) No washout area is necessary if all concrete trucks are going to wash out at approved site constructed by the concrete supplier.
- c) Concrete washout shall not be buried at the end of the project, it shall be removed and disposed.

2. Dewatering and Sediment Collecting:

- a) The need for Dewatering and Sediment Collecting depends on the Contractor's sequence of operations and execution of the erosion, sediment, and water pollution controls provided contract.
- b) The Contactor has the option to treat sediment laden water trapped within the project limits or to transport sediment laden water off the project.
- c) Water transported off the project limits shall not be disposed of in an area where it can enter a waterway. The disposal site must be approved by the Engineer.

- d) If dewatering into regulated water bodies, the Contractor is required to obtain a SDDANR General Surface Water Discharge Permit For Temporary Discharge.
- e) Flocculants are not to be released into regulated water bodies.
- f) Filtering materials shall be regularly maintained for optimal performance.
- g) Discharge of treated water shall not cause any erosion. The Contractor is encouraged to use drainage fabric and other materials already present on the project as erosion protection at discharge points.

3. Temporary Diversion Channel:

- a) Channel alignment shall prevent scouring and downstream erosion.
- b) Compacted soil shall not be used in the natural channel to divert water due to the damage the removal will cause to the streambed.
- c) Pumping shall not be used if it will adversely affect aquatic species.
- d) Diversion channel construction shall be sequenced to provide the least amount of disturbance to the channel and pollution of the water.

4. Temporary Water Barriers:

- a) Temporary water barriers shall be placed in a manner that creates the least amount of disturbance.
- b) Contaminated water within the work area collected by the water barriers shall be removed and treated.
- c) Properly designed sheet pile is an acceptable alternate temporary water barrier as approved by the Engineer.
- d) Floating silt curtains may be required.

C. Sediment Control:

1. Bale Barrier:

- a) Bale barriers shall be used as perimeter protection and not as ditch checks.
- b) Bale barriers shall be trenched in approximately 4 inches.
- c) Stakes shall be pounded in as far as possible, but no less than 2 inches and no more than 18 inches of the stake shall protrude through the top of the bale.

d) Bales shall tightly about each other.

2. Floating Silt Curtain:

a) Floating Silt Curtain shall not be placed across channels.

b) The Contractor shall install the floating silt curtain in accordance with the manufacturer's installation instructions or as directed by the Engineer.

c) Fish and other aquatic species shall be moved if trapped by the curtain.

3. Gravel Filter Sock:

a) Gravel filter socks shall be used to anchor silt fence around the bottom when it cannot be properly trenched in due to rocky soil.

b) Gravel filter sock shall be used as perimeter control when dirt and mud cannot be kept off paved or compacted surfaces.

4. Inlet Protection Device:

a) Inlet Protection Devices shall be installed prior to working in the vicinity of the drop inlets.

b) Maintenance shall be scheduled to prevent storm water from backing up into the driving lane. At a minimum, weekly maintenance shall be performed and includes sediment, snow, and ice removal and repairs or replacement to ensure the device is in working order.

c) Devices shall remain in place until vegetation of bare soils reaches 70% coverage or until the Engineer approves removal.

d) Utilize the device on Standard Detail for Type B Inlets in the winter.

e) Utilize Gravel Filter Socks in the gutter to protect Type E Inlets during winter snow melt. Remove prior to snow events that will require plowing.

5. Remove Sediment:

a) Sediment Removal shall be done as recommended by the manufacturer or when the device is 1/3 full, whichever happens first, on all sediment control devices.

b) Sediment shall be placed away from the perimeter of the site, waterbodies, water conveyances, drainage inlets and outlets on areas to be vegetated.

6. Rock Check Dams:

- a) The rock check dam shall be imbedded 6 inches.
- b) The bottom of the downhill side of the rock check dam shall be level with the top of the check dam downhill from it if there are multiple check dams installed.
- c) The embankment edges of the rock check dam shall be 6 inches higher than the middle of the check dam.

7. Sediment Basins and Traps:

- a) Outfalls and spillways shall be constructed first and stabilized immediately with the materials provided in the plans.
- b) Embankments shall be compacted in accordance with Section 12.
- c) When sediment fails to fall out of suspension during water storage, temporary sediment basins or traps shall be optimized by adding silt fence baffles, sandbag (gravel filter bag) weirs, flocculent, and/or basin skimmers.
- d) When approved by the Engineer, sediment basins installed as part of post-construction storm water management may be used during construction for sediment control given they are properly maintained, and excavated after construction.
- e) Sediment Traps shall be constructed as shown on Standard Detail.

8. Silt Ditch:

- a) Refer to Standard Detail.
- b) Shall only be used on flat sites where the ditch grade would be 2% or less.

9. Silt Fence:

- a) Low Flow Silt Fence shall be used along site perimeters and around stockpiles.
- b) High Flow Silt Fence shall be used for inlet protection and in ditches to capture sediment before it leaves the site.

10. Stabilized Construction Entrance:

- a) A functional stabilized construction entrance shall be in place until it is replaced by a roadway or until vehicular access is restricted from the site with barriers.
- b) If the Contractor elects to use one of the devices listed in the plans, then the Contractor shall install the product in accordance with the manufacturer's installation instructions or as directed by the Engineer.

- c) The Contractor is allowed to change materials used due to changes in weather, moisture, and temperature.
- d) The Stabilized Construction Entrance shall be maintained as often as necessary for it to prevent track out. Maintenance includes removal of sediment and replacement or addition of materials.

11. Street Sweeping:

- a) Vehicle tracking of sediment from the construction site shall be minimized.
- b) Street sweeping shall be used if erosion and sediment control best management practices are not adequate to prevent sediment from being tracked onto the street.
- c) Street Sweeping shall be performed by the end of the day if track-out occurs.

12. Triangular Silt Barrier:

- a) Triangular Silt Barriers shall be installed per manufacturer's instructions.
- b) Some or all of the triangular silt barriers may be left on the project until vegetation is established.
- c) Triangular silt barriers shall be removed when vegetation is established.

13. Wattles:

- a) Wattles shall be entrenched and staked per manufacturer recommendations and spaced as shown on the standard detail or in the plans.
- b) Wattles shall be removed and replaced while construction progresses if they are in a condition to be reused and they are no longer needed in the previous location.
- c) Wattles shall remain in place until vegetation is established unless they interfere with irrigation heads.
- d) Wattles may be left in place to disintegrate in natural areas that will not be mown.

D. Erosion Control:**1. Dust Control:**

- a) Dust control shall be implemented any time dust is causing visibility or breathing issues for people on or off-site.

- b) Refer to Rapid City Municipal Code Chapter 8.34 Dirt/Dust Control for more information.
2. **Interceptor Ditches:** Refer to Standard Detail.
3. **Rolled Erosion Control Products (RECPs):**
- a) This category includes Erosion Control Blanket and Turf Reinforcement Mat
 - b) Installation shall be as shown on the standard detail and as described below.
 - c) Blankets and mats shall be installed like shingles where the uphill piece is on top of and overlaps the downhill piece.
 - d) Blankets and mats shall be installed parallel to the slope and not across slopes.
 - e) Blankets and mats shall be trenched in at the top of the slope (unless overlapping another blanket or mat) and at the toe of the slope.
4. **Snow Installation:**
- a) Install practices over bare frozen ground or snow (no deeper than 2 inches) using appropriate anchors.
 - b) If necessary, remove snow before placing erosion control blanket.
 - c) RECP's are useful for conveyance systems and other areas where snow mulching practices are not applicable.
5. **Soil Stabilizers:** Shall be used as a temporary stabilization measure when temporary mulching or surface roughening cannot be completed or isn't appropriate for addressing the issue.
6. **Surface Roughening:**
- a) Surface roughening shall be done on slopes 3:1 and steeper as a temporary stabilization practice.
 - b) The final condition of the surface roughening shall be approved by the Engineer.
 - c) Surface Roughening shall be performed per Standard Detail.
7. **Temporary Slope Drain:** Refer to Standard Detail.
8. **Temporary Mulching:** The Contractor shall place mulch on areas that have reached final grade during the last month of seasonal seeding limitations. The

Contractor shall later seed into the mulch. Installation of the mulch shall be as stated in Section 72 - Mulching.

- 9. Transition Mat:** Installation of the transition mat shall be in accordance with the manufacturer's installation instructions. Turf reinforcement mat, sod, or geotextile shall be installed under the transition mat.

18.4 METHOD OF MEASUREMENT

Measurements will only be made of items correctly installed or utilized.

- A. Bale Barrier:** Shall be measured per bale.
- B. Concrete Washout:** No measurement shall be made for Concrete Washout Area.
- C. Dewatering and Sediment Collecting:** Shall be measured per detailed plans and specifications.
- D. Dust Control:** Water and operations for dust control shall not be measured.
- E. Erosion Control Blanket:** Shall be measured to the nearest square yard. Measurement of the overlap and top and bottom folds shall not be made. Erosion control blanket damaged from causes beyond the control of the Contractor shall be replaced and the replacement quantity added to the original quantities used.
- F. Floating Silt Curtain:** Shall be measured to the nearest foot. Silt curtain damaged from causes beyond the control of the Contractor shall be replaced and the replacement quantity added to the original contract amount.
- G. Gravel Filter Sock:** Shall be measured to the nearest foot.
- H. Inlet Protection Device:** Shall be measured per each.
- I. Interceptor Ditch:** Shall be paid for per foot of ditch.
- J. Interim Sediment Control at Inlet:** Shall be measured per foot high flow silt fence and per foot gravel filter bag. Aggregate shall not be measured.
- K. Mulching:** Shall be measured as described in Section 72 – Mulching.
- L. Remove Sediment:** Unless specifically called for in detailed plans and specifications, field measurement for removal of sediment shall not be made. Sediment Removal shall be incidental to the BMP being maintained.
- M. Rock Check Dam:** Shall be measured per cubic yard of 4”-6” angular rock.
- N. Sediment Control Wattle, Remove and Reset Wattle, and Remove Wattle:** Shall be measured to the nearest foot.

- O. Seeding:** Shall be measured as described in Section 70 - Seeding.
- P. Silt Fence and Remove Silt Fence:** Shall be measured to the nearest foot. If removal of silt fence is not included in detailed plans and specifications, removal shall be incidental to the silt fence bid item.
- Q. Soil Stabilizer:** Shall be measured per acre or square yard covered with soil stabilizer.
- R. Sodding:** Shall be measured as described in Section 73 - Sodding.
- S. Stabilized Construction Entrance:** Shall be measured per each location.
- T. Street Sweeping:** Shall be measured per hour.
- U. Surface Roughening:** Shall be paid for to the nearest tenth of an acre.
- V. Temporary Diversion Channel:** Shall be measured per each.
- W. Temporary Mulching:** Shall be measured as described in Section 72 - Mulching.
- X. Temporary Slope Drain:** Shall be measured to the nearest foot.
- Y. Temporary Water Barrier:** Shall be measured for per foot.
- Z. Topsoil:** Shall be measured as described in Section 17 - Salvaging, Stockpiling, and Placing Topsoil.
- AA. Transition Mat:** Shall be measured per square yard.
- BB. Triangular Silt Barrier:** Shall be paid per foot.
- CC. Turf Reinforcement Mat:** Shall be measured to the nearest square yard. Measurement of the overlap and top and bottom folds shall not be made. Turf reinforcement mat damaged from causes beyond the control of the Contractor shall be replaced and the replacement quantity added to the original quantities used.
- DD. Wattle:** Shall be measured to nearest linear foot.

18.5 BASIS OF PAYMENT

Measures, which are required due to the Contractor's negligence, carelessness, or failure to implement as a part of the work as scheduled, shall be performed by the Contractor at no expense to the City.

- A. Bale Barrier:** Shall be paid for at the contract unit price for each bale. Payment shall be full compensation for furnishing, installing, all labor, equipment, and incidentals.

- B. Concrete Washout:** No additional payment shall be made for Concrete Washout Area. Concrete washout done on-site without a Concrete Washout Area shall result in a Stop Work Order and the Contractor shall bring the site into full compliance with all applicable permits before any work on the site can resume.
- C. Dewatering and Sediment Collecting:** Shall be paid per contract unit price.
- D. Dust Control:** Shall be incidental to the project.
- E. Erosion Control Blanket:** Shall be paid for at the contract unit price per square yard. Payment shall be full compensation for shaping and finishing ditches and channels, installing material and the furnishing of labor, equipment, staples, material, and incidentals necessary.
- F. Floating Silt Curtain:** Shall be paid for at the contract unit price per foot. Payment shall be full compensation for materials, labor and equipment necessary to install and remove the floating silt curtain.
- G. Gravel Filter Sock:** Shall be measured to the nearest foot.
- H. Inlet Protection Device:** Shall be paid for one time at each location, regardless of the number of times the sediment control devices are installed, inspected, cleaned, removed, repaired, or replaced. All costs associated with furnishing, installing, inspecting, maintaining, cleaning, sediment removal, and repairing the Inlet Protection Device shall be incidental to the contract unit price per each for "Inlet Protection Device".
- I. Interceptor Ditch:** All costs for constructing, inspecting, maintaining, and removing the interceptor ditch including labor, equipment, and materials shall be incidental to the contract unit price per foot.
- J. Interim Sediment Control at Inlets:** Shall be paid per foot high flow silt fence and per foot gravel filter bag. Aggregate shall be incidental to gravel filter bags.
- K. Mulching:** Shall be measured as described in Section 72 – Mulching.
- L. Remove Sediment:** Shall be paid for at the contract unit price per cubic yard if included in detailed plans and specifications. Payment shall be full compensation for labor, equipment, disposal, and incidentals. If not included in detailed plans and specifications, sediment removal shall be incidental to the BMP being maintained.
- M. Rock Check Dam:** All costs for constructing the Rock Check Dam including labor, equipment, excavation, and rock shall be incidental to the contract unit price per cubic yard for "Rock Check Dam".
- N. Sediment Control Wattle, Remove and Reset Wattle, and Remove Wattle:** Shall be paid at the contract unit price.

- O. Seeding:** Shall be paid as described in Section 70 - Seeding.
- P. Silt Fence and Remove Silt Fence:** Shall be paid for at the contract unit price per foot for the particular bid item. Payment shall be full compensation for furnishing, installing, repairing, labor, equipment, and incidentals. Remove Silt Fence shall include all labor for complete removal and shaping. If removal of silt fence is not included in detailed plans and specifications, removal shall be incidental to the silt fence bid item.
- Q. Sodding:** Shall be paid as described in Section 73 – Sodding.
- R. Soil Stabilizer:** All costs for furnishing and applying the soil stabilizer including wood fiber mulch, hauling, materials, equipment, labor, and incidentals necessary shall be paid for at the contract unit price per acre or square yard for “Soil Stabilizer”.
- S. Stabilized Construction Entrance:** All costs for furnishing, installing, maintaining, and removal of the construction entrance including equipment, labor, materials, and incidentals shall be included in the contract unit price per each for “Construction Entrance”.
- T. Street Sweeping:** All costs for cleaning the roadway with a pickup broom shall be incidental to the contract unit price per hour for “Sweeping”.
- U. Surface Roughening:** All costs associated with surface roughening including labor, equipment, and materials shall be incidental to the contract price per acre for “Surface Roughening”.
- V. Temporary Diversion:** All costs associated with installation and removal of Temporary Diversion Channels including labor, equipment, and materials shall be incidental to the contract price per acre for “Temporary Diversion Channel”.
- W. Temporary Mulching:** No additional payment shall be made for temporary mulching. Mulching shall be paid as stated in Section 72 – Mulching.
- X. Temporary Slope Drain:** All costs for constructing and removing the temporary slope drains including labor, equipment, and materials which include the class A riprap, corrugated pipe, steel T fence posts, wire, and necessary earthwork, shall be incidental to the contract unit price per foot for “Temporary Slope Drain”.
- Y. Temporary Water Barrier:** All costs for furnishing, installing, maintaining, and removal of the temporary water barrier including hauling, materials, equipment, labor, and incidentals necessary shall be paid for at the contract unit price per foot for “Temporary Water Barrier”.
- Z. Topsoil:** Shall be measured as described in Section 17 - Salvaging, Stockpiling, and Placing Topsoil.

- AA. Transition Mat:** All costs for furnishing and installing the transition mat including hauling, materials, equipment, labor, and incidentals necessary shall be paid for at the contract unit price per square yard for "Transition Mat". Sodding, geotextiles, or Turf Reinforcement Mat installed under the Transition Mat shall be paid for per corresponding bid item.
- BB. Triangular Silt Barrier:** All costs for furnishing, installing, and removing the triangular silt barrier including labor, equipment, and materials shall be incidental to the contract unit price per foot for "Triangular Silt Barrier".
- CC. Turf Reinforcement Mat:** Turf reinforcement mat shall be paid for at the contract unit price per square yard. Payment shall be full compensation for shaping and finishing ditches and channels, installing material and the furnishing of labor, equipment, staples, material, and incidentals necessary.
- DD. Wattle:** Wattles shall be paid for at the contract unit price per foot. Payment shall be full compensation for furnishing, installing, labor, equipment, and incidentals. Remove and reset wattle shall be paid for at the contract unit price per foot. Payment shall be full compensation for labor, equipment, and incidentals. Remove wattle shall be paid for at the contract unit price per foot. Payment shall be full compensation for labor, equipment, and incidentals.

END OF SECTION

SECTION 19

INCIDENTAL WORK

19.1 DESCRIPTION

A. General: This work includes all miscellaneous items not included under the regular items covered by unit prices as listed in the plans or specifications or in the proposal, but which must be performed in order to properly complete the contract.

B. Related Work:

(Not specified, but includes all pertinent work items.)

19.2 MATERIALS (Not Specified)

19.3 CONSTRUCTION REQUIREMENTS

This work shall be performed in a skillful manner to properly facilitate the whole of the work and as directed.

19.4 METHOD OF MEASUREMENT

Field measurement for the item of Incidental Work will not be made.

19.5 BASIS OF PAYMENT

Payment for incidental work will be the lump sum bid amount listed in the proposal. In the event Incidental Work is not listed in the proposal then the work shall be absorbed into the most appropriate bid item listed. Payment on this basis shall be full compensation for labor and equipment necessary to perform all work. Partial payment, when allowed, shall be made according to the following schedule, unless otherwise modified by the Engineer in the Contract:

Percentage of Contract Amount Completed (Excluding Incidental Work Itself)	Percentage of Incidental Work Paid
Ten Percent (10%)	Ten Percent (10%)
Twenty-Five Percent (25%)	Twenty-Five Percent (25%)
Fifty Percent (50%)	Fifty Percent (50%)
Seventy-Five Percent (75%)	Seventy-Five Percent (75%)
Project Completion	One Hundred Percent (100%)

END OF SECTION

SECTION 20

GRANULAR BASES AND SURFACING

20.1 DESCRIPTION

A. General: This work consists of providing one or more courses of aggregate on a prepared surface.

B. Related Work:

Section 64	Under-Drains
Section 117	Aggregates for Granular Bases and Surfacing
Section 202	Geosynthetics for Roadways
Section 203	Submittals

20.2 MATERIALS

Granular materials of the type specified in plans or specifications shall conform to the requirements set forth in the appropriate Sections.

Granular additives (sand, rock, etc.) may be necessary to produce material of the type specified.

20.3 CONSTRUCTION REQUIREMENTS

A. General Requirements: Preparation of Roadway: Prior to placement of granular material, required excavation and/or embankment shall be performed so that the finished lines and grades will conform to the template lines on the cross sections and in accordance with the appropriate Sections of these Specifications.

Road Mix Method - Prior to placement, the Contractor shall windrow and equalize the materials, including water, to the satisfaction of the Engineer. The Contractor shall use a blade or other suitable equipment to spread the materials. The Contractor shall windrow granular materials dumped on the prepared surface prior to incorporating additives.

B. Base Course: The material placed shall be limited to the quantity necessary to construct a maximum of a four (4) inch compacted layer when geotextiles are not used. Each layer shall be compacted to the specified density before the next lift is placed and shall be rolled until a uniform and stable surface is obtained.

Rollers for compaction shall have pneumatic tired rollers and shall have an effective roller weight of at least 250 pounds per inch of roller width or satisfactory vibratory compaction equipment. Tires shall be uniformly inflated so their air pressures will not vary by more than 5 psi. Rollers shall be operated with tire pressures and wheel

loads within the manufacturer's recommended range for the size and ply of the tire being used.

Steel face rollers shall furnish a minimum rolling weight of 275 pounds per inch of rolling width.

- C. Testing:** Unless otherwise shown on the plans or in the specifications, the required density shall be ninety-five percent (95%) minimum, of the maximum dry density as determined by AASHTO T 180 (Modified Proctor). Field density shall be measured with a nuclear density machine in accordance with SDDOT Test No. SD114 (AASHTO T 238). Field density tests shall be provided every 200 linear feet per compacted lift of material in each lane of roadway, or as determined by Engineer. The Engineer has the authority to determine testing locations in the sub-grade.
- D. Gravel Surfacing:** When the gravel surfacing is ready to be placed, the Contractor shall spread it evenly to the specified width, or as directed by the Engineer. Watering of the material shall be accomplished during the spreading operation. Rolling shall proceed simultaneously with the spreading and watering operations and continue in parallel overlapping strips until the entire area has been rolled at least twice.

Density requirements are not specified, but a uniform, stable surface shall be maintained.

20.4 METHOD OF MEASUREMENT

Granular materials will be measured to the nearest one-tenth (0.1) ton. The Contractor shall provide weigh tickets for all materials furnished, installed, and accepted, showing gross, tare & net weights, project, truck, time, and initials of the scale operator within 48 hours of placement. Weighing shall be done on a SDDOT certified scale. Weigh tickets meeting the above standards will be considered valid.

Water added during laydown operations will not be measured.

20.5 BASIS OF PAYMENT

The accepted quantities of granular material will be paid for at the contract price per ton complete in place. Tickets delivered after 48 hours will not be considered valid and will not be paid for.

In the event a separate item for ordinary roadway shaping is not provided in the Bid Proposal for use in connection with granular material construction, payment for the granular material will be full compensation for necessary shaping work.

In the event that Contractor provided field density testing is required, payment shall be at the unit bid price provided in the Bid Proposal. In the event that no unit price for field density tests is provided in the Bid Proposal, such work shall be incidental to the granular material and no separate payment will be made for field density testing.

END OF SECTION

SECTION 31

ASPHALT CONCRETE - GENERAL

31.1 DESCRIPTION

- A. General:** This work consists of constructing asphalt concrete pavement using a hot or warm mix asphalt (HMA or WMA).

Asphalt concrete type is designated as Type I or Type II according to 31.3.

B. Related Work:

Section 32	Asphalt Concrete - Class E
Section 35	Prime, Tack, Fog Seal and Flush Seal Coats
Section 37	Asphalt Surface Treatment
Section 38	Recycled Asphalt Pavement (RAP)
Section 39	Cold Mix Asphalt Concrete
Section 41	Utility Trench Resurfacing
Section 115	Aggregates for Asphalt Concrete
Section 116	Aggregates for Asphalt Surface Treatments
Section 118	Asphalt Material
Section 203	Submittals

31.2 MATERIALS

- A. Composition of Mixtures:** The asphalt concrete shall be composed of a mixture of aggregate and asphalt. The several aggregate fractions shall be combined in such proportions that the resulting mixture meets the gradation requirements of the specifications.

The operation of the plant shall not commence until the Contractor has furnished the Engineer, in writing, a job mix formula established by a certified testing laboratory meeting the criteria for the class of asphalt concrete specified. After the job mix formula is established, the mixture shall conform within the range of tolerances for that class of asphalt concrete.

The job mix formula testing for each class of asphalt concrete used shall be updated annually by a certified testing laboratory at the beginning of the construction season and used for that construction season only.

A change in sources of materials will require a new job mix formula to be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may require the Contractor to furnish a new job mix formula, as established by a certified testing laboratory.

- B. Aggregates:** Aggregates shall meet the applicable requirements of Section 115.
- C. Asphalt:** Asphalt, of the type specified in the job mix formula, shall meet the applicable requirements of Section 118 or as called for in the Detailed Specification.

31.3 CONSTRUCTION REQUIREMENTS

- A. Weather and Seasonal Limitations:** Asphalt concrete shall only be constructed or placed when the underlying surface material is dry and unfrozen. Asphalt concrete shall not be placed when weather conditions prevent proper handling, compaction, or finishing. Temperature and seasonal limitations are as follows except as allowed by the Engineer:

MINIMUM AIR TEMPERATURES AND SEASONAL LIMITATIONS				
Compacted Thickness	Surface Course		Subsurface Course & Shoulder Courses	
	Min. Temp	Seasonal Limits	Min. Temp.	Seasonal Limits
1 in. or less	45° F	May 1 to Nov. 1	Not Allowed	Not Allowed
Over 1 in. to 2 in.	40° F	May 1 to Nov. 1	Not Allowed	Not Allowed
Over 2 in. to 3 in.	35° F	May 1 to Nov. 1*	35° F	April 15 to Nov. 1*

*Without written permission from the Engineer

B. Equipment:

- 1. Requirements for All Plants:** All plants shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, Section 320.3.B.1. Blade laid asphalt shall not be allowed.
- 2. Pavers:** Pavers shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, Section 320.3.B.5.
- 3. Rollers:** Rollers shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, Section 320.3.B.6.

The use of fuel oil or other petroleum solvents to prevent "pickup" will not be permitted. Measures shall be taken to prevent oil, grease, or fuels from being dropped on the mat surface.

C. Preparation of the Mineral Aggregate:

- 1. Stockpiling Aggregate:** Stockpiling Aggregate shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.C.1
- 2. Stockpile Tests:** Stockpile Tests shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.C.2.

- 3. **Proportioning of Aggregates:** Proportioning of Aggregates shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.C.4.
- D. **Preparation of the Mixture:** Preparation of the Mixture shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.D.
- E. **Transportation and Delivery of the Mixture:** Transportation and Delivery of the Mixture shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.E.

All loads shall be tarped.

- F. **Blade Laid Asphalt Concrete:** Blade laid asphalt is not allowed.
- G. **Tacking, Spreading, and Compacting:** Tacking, Spreading and Compacting shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.G.
 - 1. **Specified Density Method:** Specified Density Method shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.G.1.
 - 2. **Specified Roller Coverages:** Specified Roller Coverages shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, 320.3.G.2.

- H. **Asphalt Patching:** Asphalt Patching work shall comply with the requirements herein and as follows:

- 1. **Minimum Patch Depth:** Unless specified otherwise, all permanent asphalt patches shall be placed to a minimum depth of five (5) inches. Should existing pavement depths be greater than five (5) inches, the permanent patch shall match the depth of the existing pavement or as directed by the Engineer.
- 2. **Minimum Patch Width:** Minimum patch width shall be two feet (curbside) or the initial saw width for the proposed trench width plus two feet (one foot on each side of the initial saw cut -See Section 41).

All mainline, permanent patches equal to or greater than eight feet in width and longer than 40 feet shall be placed with a paving machine. The use of tow-behind pavers is prohibited.

- 3. **Surface Tolerance:** The patch surface shall be tested with a ten foot straightedge. The maximum permissible surface deviation shall be one-quarter inch in ten feet. The measurements will be made parallel to traffic and up to within one foot of the edge of the existing pavement. Deviation within one foot of the existing pavement shall be no greater than that measured on the adjacent existing pavement.

Areas that exceed the permissible deviation shall be subject to corrective action as directed by the Engineer.

Any corrective measures shall produce a structurally sound, smooth riding surface.

4. Concrete streets with asphalt overlays shall be replaced as described in Section 41. Asphalt overlay thickness shall match existing thickness and shall extend at least six (6) inches beyond edges formed by new and existing concrete paving.

The asphalt shall be tapered at a maximum 10:1 slope longitudinally on each side of any drainage pans and on any areas of existing streets where the overlay begins or ends.

The edges of the new asphalt overlay patch shall be tapered to meet the gutter lip as indicated on the standard detail sheet in the plans.

Under certain conditions where localized ponding problems exist on the existing pavement, the Engineer may require the Contractor to overlay all the way to the face of the curb.

5. If hot-mix asphalt will not be available for a significant period, the Contractor shall place a temporary cold mix patch or overlay as directed by the Engineer

The Engineer shall determine if placement of the cold mix is necessary. The cold mix shall conform to Section 39.

When hot-mix asphalt becomes available, the Engineer will issue written notice to the Contractor to begin placing the pavement asphalt within ten (10) working days of receiving the notice.

6. Measurement and payment for the asphalt patching shall be in accordance with the section pertaining to the class of asphalt concrete being bid.

Measurement and payment for cold mix shall be in accordance with Section 39, COLD MIX ASPHALT CONCRETE.

- I. **Maintenance:** The Contractor shall be responsible for the maintenance of the work during construction and until final acceptance. Maintenance shall include protection and repair of the prepared base course, tack coat, wearing surface mat, shoulders, and seal course. Rich or bleeding areas, breaks, raveled spots, or other nonconforming areas in the wearing surface or base shall be corrected during such maintenance period.
- J. **Traffic Control:** Allowing traffic to travel over the roadway will not be permitted until the surface has been thoroughly compacted and cooled sufficiently to resist marking or distortion.

Where traffic is to be maintained by means of part-width construction, the Contractor shall control traffic by the use of identified flaggers. The Contractor shall schedule work so traffic will not be inconvenienced by long one-way lanes.

K. Density Tests/Frequency: The Contractor is responsible for asphalt density tests. The asphalt tests shall be understood to be incidental work associated with the several classes of asphalt concrete, except when there is a bid item for asphalt compaction testing, per each test included in the Bidder's Proposal or as otherwise specified in the detailed specifications. The Contractor shall submit the following test data for each class of asphalt concrete:

- One (1) Standard Density at the start of paving each day and each time the mix or source of material is changed;
- One (1) Rice Density test at the start of paving each day and each time the mix or source of material is changed;
- The minimum requirement is two (2) in-place, non-destructive (nuclear gauge) density tests per day, for every 200-ton lot of mainline paving mix per lift.
- The minimum requirement is two (2) in-place, non-destructive (nuclear gauge) density tests per day, for every 250 square yards of asphalt patching per lift.

When paid by the City, these field asphalt core density tests will be measured in accordance with Section 31.4.B - Compaction Samples and paid for in accordance with Section 31.5.B

All sampling and testing shall be done by certified testing laboratory personnel, and all test results shall be submitted to the Engineer.

Failing Standard Density tests and Rice Density tests shall result in an adjustment of the warranty period and the contract unit price in accordance with the following table for all classes of asphalt concrete:

Amount of Deviation	0% to -1%	-1% to -2%	-2% to -3%	-3% to -4%	Greater than -4%
Amount of Unit Price Deduction	0% to 5%	5% to 10%	10% to 20%	20% to 30%	Remove & Replace
Additional Warranty Period	1 year	2 years	3 years	4 years	NA

Note: The amount of deviation shall be the difference between the specified density and the average of all densities for that class of asphalt concrete if this average is less than the specified density.

The City reserves the right to order additional tests. The Contractor shall pay for those additional tests that fail to meet specified density, and the City will pay for those additional tests that do meet the specified density.

In addition to this testing, the Contractor may be required to remove and test in-place asphalt concrete to determine field densities by sawing or coring samples from areas to be determined by the Engineer.

The Engineer or his representative shall be present for all field sampling and lab testing performed for the Contractor. Failure to notify the City of pending sampling or testing could result in rejection of submitted data and re-testing by in-place methods.

All test results shall be received by the Engineer before payment for pavement exceeds seventy-five percent (75%) of the total quantity.

31.4 METHOD OF MEASUREMENT

- A. Asphalt Concrete, Various Classes/Incidental Paving:** Asphalt Concrete, Various Classes will be measured to the nearest one-tenth (0.1) ton, material weight. The mixture of mineral aggregate and asphalt for mat will be weighed after mixing, and no deduction will be made for the weight of the asphalt included in the mixture.

Deduction will not be made for material removed from temporary approaches.

- B. Compaction Core Samples:** The measurement of core samples will be by actual count of those samples ordered and accepted by the Engineer for testing purposes.

31.5 BASIS OF PAYMENT

- A. Asphalt Concrete, Various Classes/Incidental Paving:** The accepted quantities of Asphalt Concrete, Various Classes, will be paid for at the contract price per ton, complete, in place, subject to deductions noted herein. Contractor shall provide Engineer with valid weigh tickets for asphalt concrete, furnished and installed. Weigh tickets shall be delivered to the Engineer within 48 hours of placement. Tickets delivered after 48 hours will not be valid and will not be paid for.
- B. Compaction Core Samples** (where required): Will be paid for at the contract price per each.

END OF SECTION

SECTION 32

ASPHALT CONCRETE - CLASS E

32.1 DESCRIPTION

A. General: This work consists of constructing one or more courses of asphalt concrete on a prepared surface.

B. Related Work:

Section 31	Asphalt Concrete - General
Section 35	Prime, Tack, Fog Seal and Flush Seal Coats
Section 37	Asphalt Surface Treatment
Section 38	Recycled Asphalt Pavement (RAP)
Section 39	Cold Mix Asphalt Concrete
Section 41	Utility Trench Resurfacing
Section 115	Aggregates for Asphalt Concrete
Section 116	Aggregates for Asphalt Surface Treatments
Section 118	Asphalt Material
Section 203	Submittals

32.2 MATERIALS

The materials and their use shall conform to the requirements of Section 31, Asphalt Concrete – General, with the following modifications:

The job mix shall fix a single percentage of aggregate passing each required sieve size, a single percentage of asphalt to be added to the aggregate, a single asphalt application temperature, a single temperature at which the mixture is to be emptied from the mixer, and a single temperature at which the mixture is to be delivered on the road.

The following table sets forth the tolerances for the job-mix formula:

3/8 inch	± 7%
No. 4, No. 10, No. 40	± 5%
No. 200	± 2.0%
Asphalt Content.....	± 0.3%
Temp. of mixture when emptied from mixer.....	± 20° F.
Temp. of mixture on delivery to the road.....	+ 30° & -20° F.
Asphalt application temp.....	± 20° F.

32.3 CONSTRUCTION REQUIREMENTS

The construction requirements shall be as prescribed in Section 31, Asphalt Concrete – General, with the following modifications:

- A. The maximum compacted thickness of each lift of Type 1 shall not exceed three (3) inches, and the maximum compacted thickness of each lift of Type 2 shall not exceed two (2) inches, unless modified by the detailed specifications.
- B. The minimum compacted thickness of each lift of Type 1 shall be less than two (2) inches, and the minimum compacted thickness of each lift of Type 2 shall be less than One and a half (1 ½) inches, unless modified by the detailed specifications.
- C. The minimum density requirement for polymer modified asphalt mix (such as PG64-28, PG70-24, and PG70-28) and non-polymer modified asphalt mix (such as PG64-22, PG58-28, and all older style penetration graded oils shall be ninety two percent (92%) of maximum density (Rice method) for all mainline applications and shall be ninety one percent (91%) of maximum density (Rice method) for all narrow alleyways, walkways, parking lots, and similar work where a majority of the placement work is hand work and is not subject to the specified Roller Coverage method or otherwise modified in the Detailed Specifications.

32.4 METHOD OF MEASUREMENT

Measurement will be as prescribed, in Section 31, Asphalt Concrete – General.

32.5 BASIS OF PAYMENT

Payment will be as prescribed, in Section 31, Asphalt Concrete – General.

END OF SECTION

SECTION 35

PRIME, TACK, FOG SEAL AND FLUSH SEAL COATS

35.1 DESCRIPTION

A. General: This work consists of preparing and treating a prepared surface with asphalt material and sand as required.

B. Related Work:

Section 31	Asphalt Concrete - General
Section 32	Asphalt Concrete - Class E
Section 38	Recycled Asphalt Pavement
Section 39	Cold Mix Asphalt Concrete
Section 116	Aggregates for Asphalt Surface Treatments
Section 118	Asphalt Material
Section 203	Submittals

35.2 MATERIALS

A. Asphalt: Asphalt of the type specified on the plans shall conform to the requirements of Section 118.

B. Blotting Sand for Prime: Blotting sand for Prime shall conform to the requirements of Section 116.

C. Sand for Flush Seal: Sand for Flush seal shall conform to the requirements of Section 116.

35.3 CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Requirements:

1. **Tack Coat:** The application of a tack coat will be permitted only:

- a) When air and surface temperature on the project are both at least thirty-five degrees Fahrenheit (35° F) in the shade.
- b) When conditions are dry, except emulsified asphalt may be applied when the surface is slightly damp.
- c) During daylight hours.
- d) When the wind does not adversely affect the spraying operation.

2. **Prime Coat:** The application of a prime coat will be permitted only:
 - a) When the air and surface temperatures on the project are both at least sixty degrees Fahrenheit (60° F) in the shade. The temperature requirement may be waived by the Engineer.
 - b) When conditions are dry.
 - c) During daylight hours.
 - d) When wind does not adversely affect the spraying operation.
 3. **Fog Seal Coat:** The application of a fog seal coat will be permitted only:
 - a) When the air and surface temperatures on the project are both at least sixty degrees Fahrenheit (60° F) in the shade.
 - b) When conditions are dry.
 - c) During daylight hours.
 - d) When the wind does not adversely affect the spraying operations.
 4. **Flush Seal Coat:** The application of a flush seal coat will be permitted only:
 - a) When air and surface temperatures on the project are both at least fifty degrees Fahrenheit (50° F) in the shade.
 - b) When the surface is dry or slightly damp.
 - c) When the wind does not adversely affect the spraying operations.
 - d) During daylight hours.
- B. Dilution of Tack, Fog Seal, and Flush Seal:** Dilution of Tack, Fog Seal and Flush Seal shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, Current Edition, Section 330.3.B.
- C. Equipment:** Equipment shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, Current Edition, Section 330.3.C, with the exception that Rotary Power Brooms shall not be allowed.
- D. Surface Preparation:** Surface preparation shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, Current Edition, Section 330.3.D.
- E. Application of Asphalt:** Application of Asphalt shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, Current Edition, Section 330.3.E.

In addition, Tack shall be applied when the mat has become dirty, or when the mat has been uncovered for more than 24 hours, or when directed by the Engineer.

- F. Application of Sand:** Application of Sand shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, Current Edition, Section 330.3.F.
- G. Traffic Control:** The Contractor shall provide proper flaggers, signs, and barriers to warn, direct, and prevent traffic from getting onto the freshly applied asphalt until it has penetrated and does not track or pickup on the tires of traveling vehicles or the surface has been blotted with sand.

35.4 METHOD OF MEASUREMENT

- A. Asphalt:** Asphalt will be measured to the nearest 0.1 ton. Contractor shall provide Engineer with valid quantity tickets for asphalt, furnished and installed, showing gross, tare and net weights, project, truck, time, and initials of scale operator. Weighing shall be done on a SDDOT certified scale.
- B. Blotting Sand for Prime:** Blotting sand for prime will be paid for at the contract unit price per 0.1 ton complete in place. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.
- C. Sand for Flush Seal:** Sand for flush seal will be paid for at the contract unit price per 0.1 ton complete in place. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.

35.5 BASIS OF PAYMENT

- A. Asphalt:** The accepted quantities of prime coat will be paid for at the contract price per ton in place as computed from valid weigh tickets. Tickets received after forty-eight hours will not be considered valid. Separate payment will not be made for water for dilution of emulsified asphalt.
- B. Blotting Sand for Prime:** Blotting sand for prime will be paid for at the contract unit price per ton complete in place. Payment will be full compensation for furnishing, installing and all incidentals required to complete the work.
- C. Sand for Flush Seal:** Sand for flush seal will be paid for at the contract unit price per ton complete in place. Payment will be full compensation for furnishing, installing and all incidentals required to complete the work.

END OF SECTION

SECTION 36

COLD PAVEMENT PLANING

36.1 DESCRIPTION

A. General: This work consists of removing a portion of the existing asphalt surface course and stockpiling the removed material at specified locations.

B. Related Work:

Section 12	Roadway and Drainage Excavation and Embankment
Section 35	Prime, Tack, Fog Seal and Flush Seal Coats

36.2 MATERIALS (Not specified)

36.3 CONSTRUCTION REQUIREMENTS

A. General: The material shall be removed by cold pavement planing with the specified equipment, without the use of heat. Detailed plans and specifications shall state if material is to be delivered to the City.

B. Equipment: The equipment for cold planing shall consist of a rotating drum equipped with teeth capable of removing material to a minimum depth of three (3) inches in one (1) pass and producing a smooth surface finish. The cold planing machine shall be capable of automatically establishing a longitudinal profile grade within plus or minus one-eighth ($\pm 1/8$) inch, referencing from the existing gutter, pavement, and/or an erected fixed string line and shall be controlled by an automatic system for controlling grade.

The drum shall be capable of tilting to allow feathering of edges to zero cut.

C. Construction Methods:

1. The existing surface of the pavement shall be removed by planing at the depth, width, cross-section, and grade shown on the plans or established by the Engineer.

The resulting pavement surface shall be free of detrimental ridges or grooves.

2. Loose material resulting from the planing shall be immediately picked up and hauled to the specified stockpile sites or disposed of as directed by the Engineer. Prior to allowing traffic on the planed surface, the surface shall be thoroughly vacuumed or wet broomed free of any remaining loose material. It may be necessary to lightly water the planed area prior to brooming to minimize air-borne dust.

36.4 METHOD OF MEASUREMENT

Plans quantity will be the basis of measurement used unless, changes are ordered by the Engineer. If additional areas are ordered planed from the plan-shown areas or areas designated for planing are deleted, these areas will be measured and the plan quantity appropriately adjusted.

36.5 BASIS OF PAYMENT

Pavement planing will be paid for at the contract unit price per square yard of pavement surface planed. If detailed plans and specifications state that material is to be delivered to the City, no additional payment will be made for hauling and stockpiling at the prescribed location.

END OF SECTION

SECTION 37

ASPHALT SURFACE TREATMENT

37.1 DESCRIPTION

A. General: This work consists of an application of asphalt covered with a spread of cover aggregate.

B. Related Work:

Section 35	Prime, Tack, Fog Seal and Flush Seal Coats
Section 116	Aggregates for Asphalt Surface Treatments
Section 118	Asphalt Material
Section 203	Submittals

37.2 MATERIALS

A. Asphalt: Asphalt of the type and grade shown on the plans shall conform to the requirements of Section 118.

B. Cover Aggregate: Cover aggregate of the type specified shall conform to the requirements of Section 116.

37.3 CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Requirements: The application of surface treatments will be permitted only during daylight hours when conditions are dry and when it does not adversely affect the spraying operation.

Minimum temperatures and seasonal limitations are as follows:

COVER AGGREGATE	AIR AND SURFACE TEMP. (IN THE SHADE)	SEASONAL LIMITATIONS (DATES ARE INCLUSIVE)
Type 1	70 degrees F	June 1 - August 31
Type 2	70 degrees F	June 1 - August 31
Type 2A	65 degrees F	June 1 - August 31
Type 3	70 degrees F	June 1 - August 31

B. Equipment: The following minimum equipment shall be furnished in good condition by the Contractor:

1. A vacuum power broom.

2. Equipment for heating and applying the asphalt shall conform to the requirements of Section 35.
3. A self-propelled aggregate spreader, with positive controls capable of depositing the required amount of aggregate uniformly over the full width of the asphalt application. When spreading Type 2 cover aggregate, the spreader shall be equipped with means of applying the larger aggregate to the surface ahead of the smaller aggregate.
4. The rollers shall completely cover an overall surface width of at least sixty (60) inches and furnish a minimum uniform rolling pressure of two hundred fifty (250) pounds per inch of rolling width.

C. Surface Preparation: The surface to be treated shall be thoroughly swept with a vacuum power broom and cleaned of all loose and adhering foreign material. Appurtenances immediately adjacent to the surface to be treated shall be protected from the splatter of asphalt. Freshly primed bases shall be cured prior to the application of surface treatments.

D. Application of Asphalt: Adjacent appurtenances shall be protected from the splatter of asphalt. The asphalt shall be maintained within a temperature range of 120°F to 180°F during application. Asphalt shall be applied by means of a pressure distributor in a uniform and continuous manner. Specified rates shall be applied unless otherwise ordered by the Engineer. Unauthorized increases in rates will not be eligible for payment.

The angle of the spray nozzles and the height of the spray bar shall be set to obtain uniform distribution. A strip of building paper, at least three (3) feet in width and with a length equal to that of the spray bar plus one (1) foot, shall be used at the beginning of each spread. The distributor shall be traveling at the proper speed when the spray bar is opened. Skipped areas and deficiencies shall be corrected as soon as they are discovered. The edges of the spread shall not appreciably overlap. Areas inaccessible to the distributor shall be satisfactorily covered by hand spray methods.

Under no circumstances shall spraying operations proceed when it is evident the asphalt spread will not be covered with aggregate and rolled all in accordance with the prescribed schedule contained in the following sections.

E. Application of Cover Aggregate: Cover aggregate shall be spread immediately following application of the asphalt. Under calm wind conditions, approximately five (5) miles per hour or less, the spread of cover aggregate shall follow within eight (8) minutes of the application of the asphalt. When the wind velocities are greater, the maximum time between applications of asphalt and cover aggregate shall be reduced as determined by the Engineer.

The spreading of cover aggregate following the application of "High Float" Emulsified Asphalt may be adjusted by the Engineer from the time limitations as shown above to fit project conditions.

The Contractor shall protect the treated surface from damage by traffic by continually maintaining a complete aggregate coverage, except that a strip of asphalt application approximately (4) four inches wide along that side of the spread forming a longitudinal joint with the adjacent spread shall be left uncovered. The adjacent asphalt and cover aggregate application shall overlap this strip. In lieu of this procedure, a butt joint may be constructed using special end nozzles.

Longitudinal joints, other than at centerline, will not be permitted within the center twenty-four (24) feet.

The cover aggregate shall be loaded in trucks to minimize segregation, eliminate oversize, and effectively break up or discard material bonded into chunks. When required, aggregate shall be uniformly moistened before or during loading.

Specified rates shall be applied unless otherwise ordered by the Engineer. Unauthorized increases in rates will not be eligible for payment.

Prior to rolling operations, the Engineer may order the Contractor to adjust inequalities in the spread of Type 3 cover aggregate by means of a drag broom.

- F. Rolling Operations:** Rolling shall begin immediately behind the spreader and shall consist of four (4) complete coverages using pneumatic tired rollers. Operations shall be scheduled to complete the rolling within forty (40) minutes after the cover aggregate is applied. Rollers shall not be operated at a speed in excess of five (5) miles per hour. The weight and tire pressures of the rollers shall be varied as directed by the Engineer to obtain the most satisfactory embedment of the cover material without undue crushing of the aggregate. Turning of rollers on the freshly treated surface is prohibited. Rolling at night or when light conditions would create a traffic hazard will not be allowed.

Alternate rolling procedures that provide complete roller coverage directly behind the aggregate spread and completion of the four (4) complete roller coverages within the maximum time of forty (40) minutes may be used if approved by the Engineer.

- G. Traffic Control:** Construction operations shall be coordinated to result in the least delay of traffic. If traffic is permitted, it shall be controlled by flaggers or pilot car, during application of the surface treatment on driving lanes. The traffic shall not exceed twenty (20) miles per hour for a period of four (4) hours after application. The minimum four (4) hour traffic control period may be reduced if ordered by the Engineer.

The width, arrangement, and sequence of the parallel application strips shall be governed so as not to unduly inconvenience traffic.

- H. Maintenance and Repair:** Areas of the surface treatment, which may peel or otherwise be unsatisfactory for any reason shall be repaired with additional asphalt, cover aggregate, and rolling. Additional compensation for repair due to causes not the

fault of the Contractor will be paid at the contract unit price for asphalt surface treatment.

The finished surface of the surface treatment shall be smooth riding and of uniform color. Lack of uniformity such as transverse or horizontal ridges, raveled spots, wheel marks, depressions, abrupt color changes, and other inequalities shall be corrected by the Contractor, as ordered by the Engineer. Payment will not be made for this correction work.

Special attention shall be given to the transverse and longitudinal joints during the process of the rolling work in order to insure a uniform appearance and smooth riding surface. The Contractor shall smooth and correct the appearance of these joints, as ordered by the Engineer, without additional compensation.

Any splatter of asphalt outside of the intended roadway surface, shall be satisfactorily cleaned off by the Contractor.

The loose material left on the surface shall be lightly vacuumed off three (3) to five (5) days after sealing the road. Vacuumed-off material shall be removed and disposed of at a location approved by the Engineer, by the Contractor without additional compensation.

37.4 METHOD OF MEASUREMENT

- A. Asphalt for Surface Treatment:** Asphalt for surface treatment will be measured to the nearest one-tenth (0.1) ton. Contractor shall provide Engineer with valid weigh tickets for asphalt, furnished and installed.
- B. Cover Aggregate:** Cover aggregate will be measured to the nearest one-tenth (0.1) ton or nearest one (1) square yard, as detailed in the plans. Contractor shall provide Engineer with valid weigh tickets for cover aggregate, furnished and installed.

37.5 BASIS OF PAYMENT

- A. Asphalt for Surface Treatment:** The accepted quantities of asphalt for surface treatment will be paid for at the contract price per ton, complete, in place. Weigh tickets will not be considered valid if received more than forty-eight hours after placement.
- B. Cover Aggregate:** The accepted quantities of cover aggregate of the type specified will be paid for at the contract price per ton or square yard, complete, in place. Weigh tickets will not be considered valid if received more than forty-eight hours after placement.

END OF SECTION

SECTION 38

RECYCLED ASPHALT PAVEMENT (RAP)

38.1 DESCRIPTION

- A. General:** This work consists of furnishing Recycled Asphalt Pavement (RAP) for use in mix designs to construct asphalt concrete pavement using a hot mix asphalt (HMA). RAP may be included up to a maximum of 15 percent of the total weight of mixture. No other recycled materials will be allowed. HMA shall conform to the Standard Specifications for Asphalt Concrete – Class E (Section 32).

The use of RAP is only allowed in the bottom lift of any pavement section.

B. Related Work:

Section 31	Asphalt Concrete – General
Section 32	Asphalt Concrete – Class E
Section 115	Aggregates for Asphalt Concrete
Section 118	Asphalt Material
Section 203	Submittals

38.2 MATERIALS

- A. Submittals:** The supplier shall furnish a job mix formula for approval prior to the Preconstruction Conference. All job mix designs shall have a laboratory designation corresponding to the type of asphalt concrete mix. Designation should include binder type and percent of RAP in the mix. An example designation is “PG64-22 10% RAP”. This designation should be printed on all weigh tickets corresponding to the mix design used.

Certificates of compliance from the refiner will be required on the performance graded asphalt binder. The Engineer may accept the mixture on the basis of the job mix formula, certificates of compliance and visual inspection or may test the mixture for specification compliance. All production processes and materials supplied on this contract shall be subject to inspection by the Engineer. Materials not meeting specification will be rejected and replaced at the supplier’s expense.

- B. Aggregate:** RAP shall conform to the requirements specified in this document.

RAP used in asphalt concrete production shall conform to the following gradation (ASTM C136 and AASHTO T27):

Sieve Size	Percent Passing
1 ½ inch	100
1 inch	95 – 100
¾ inch	84 – 100
½ inch	70 – 100
No. 4	38 – 75
No. 200	2 – 15

The supplier is required to run daily production control samples on the aggregate material. All production control test results shall be made available to the City upon request.

- C. Testing:** Representative RAP samples shall be sent into the laboratory designated by the Engineer for material classification, as requested by the Engineer. The cost for this testing shall be borne by the City. The laboratory shall provide the following information for RAP: Asphalt Binder Content, gradation, and Gmm (Maximum Specified Gravity). RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or environmentally restricted materials shall not be used.

38.3 CONSTRUCTION REQUIREMENTS

Construction will be as prescribed in Section 31, Asphalt Concrete – General.

38.4 METHOD OF MEASUREMENT

Hot Mix Asphalt with RAP: Hot Mix Asphalt with RAP will be measured to the nearest one-tenth (0.1) ton, material weight. The mixture of mineral aggregate and asphalt binder will be weighed after mixing, and no deduction will be made for the weight of the asphalt binder included in the mixture.

38.5 BASIS OF PAYMENT

Hot Mix Asphalt with RAP will be paid for at the contract unit price per ton, complete, in place, subject to deductions noted in Section 31. Contractor shall provide the Engineer with valid weigh tickets for HMA, furnished and installed. Weigh tickets shall be delivered to the Engineer within 48 hours of placement. Tickets delivered after 48 hours will not be valid and will not be paid for. No additional payment will be made for Recycled Asphalt Pavement.

END OF SECTION

SECTION 39

COLD MIX ASPHALT CONCRETE

39.1 DESCRIPTION

A. General: This work consists of furnishing and placing a temporary course of cold mix asphalt concrete on a prepared surface. The use of cold mix asphalt is only allowed with prior approval of the Engineer.

B. Related Work:

Section 31	Asphalt Concrete - General
Section 35	Prime, Tack, Fog Seal and Flush Seal Coats
Section 115	Aggregates for Asphalt Concrete
Section 118	Asphalt Material
Section 203	Submittals

39.2 MATERIALS

A. Aggregate: The aggregate shall conform to the requirements of the following table:

Passing 1/2 in sieve	100%
Passing No. 4 sieve.....	80%
Passing No. 8 sieve.....	40-60%
Passing No. 40 sieve.....	15-32%
Passing No. 200 sieve.....	4-12%

One hundred percent (100%) of the aggregate retained on the Number 4 or larger sieve shall have two (2) or more fractured faces.

B. Asphalt: The asphalt material shall be MC-250. When limestone rock is used, the asphalt content shall be four and one-half percent (4 ½%) to five percent (5%). When river rock is used, the asphalt content shall be five and one-half percent (5 ½%) to six percent (6%).

39.3 CONSTRUCTION REQUIREMENTS

The cold mix shall be placed at the locations and depths specified on the plans, in the detailed specifications, and/or as directed by the Engineer.

The Contractor will be responsible for satisfactorily maintaining the cold mix until the permanent patch is placed. Should any maintenance work be required on any cold mix, the Contractor shall do so within forty-eight (48) hours of receiving notice from the Engineer. If the Contractor does not accomplish the necessary work within forty-eight (48)

hours, the City will have the work done and will charge the Contractor one and one-half (1 ½) times the cost incurred.

39.4 METHOD OF MEASUREMENT

Measurement will be as prescribed in Section 31, Asphalt Concrete – General.

39.5 BASIS OF PAYMENT

Payment will be as prescribed in Section 31, Asphalt Concrete – General.

END OF SECTION

SECTION 40

PORTLAND CEMENT CONCRETE PAVEMENT

40.1 DESCRIPTION

A. General: This work consists of constructing Portland Cement Concrete (PCC) Pavement with or without reinforcement on a prepared surface.

B. Related Work:

Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 103	Fly Ash
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Preformed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 123	Concrete Reinforcement
Section 203	Submittals

40.2 MATERIALS

A. Cement: Shall conform to the requirements of Section 100. Type II cement shall be used for all concrete pavement.

B. Admixtures: Shall conform to the requirements of Sections 101 and 102.

C. Water: Shall conform to the requirements of Section 104.

D. Fine Aggregate: Shall conform to the requirements of Section 105.

E. Coarse Aggregate: Shall conform to the requirements of Section 107.

F. Reinforcing Steel: Shall conform to the requirements of Section 123.

G. Preformed Expansion Joint Filler: Shall conform to the requirements of Section 113.

H. Joint Sealer: Shall conform to the requirements of Section 114.

I. Curing Materials: Section 108.

J. Dowel Bar Assemblies: Section 123.

K. Fly Ash: Section 103.

L. Epoxy Resin Adhesive: Epoxy resin adhesive shall be of the type intended for horizontal applications, and shall conform to the requirements of ASTM C881, Type IV, Grade 3 (equivalent to AASHTO M 235, Type IV, Grade 3) Class A, B, or C. The minimum gel time shall be 5 minutes.

40.3 CONSTRUCTION REQUIREMENTS

A. Quality of Concrete, Proportioning and Mix Design: When the Contractor proposes to use materials for PCC Pavement from sources not previously accepted by the City, the Contractor shall obtain independent, certified laboratory tests that verify that the materials meet the requirements of the applicable sections listed in Section 40.2. Minimum number of tests is once each year per source unless otherwise ordered by the Engineer.

When the Contractor proposes to use a mix design not previously accepted by the City, the Contractor shall obtain independent, certified laboratory tests that verify that the mix design meets the following minimums:

1. Minimum cementitious material content of 600 pounds with a fly ash content of 20 to 25%.
2. Minimum coarse aggregate content of 55% by weight of total aggregates.
3. Minimum 28 day compressive strength of 4,000 psi.

Minimum number of tests is once each year unless otherwise ordered by the Engineer. Test results shall include three each of: seven (7), fourteen (14), & twenty-eight (28) day compressive strength; water-cement ratios; slump (to be consistent with proposed placement method); and air content. These results shall be obtained from separate batches of the same mix design.

These mix design results will be used to monitor and adjust, if necessary, the PCC Pavement placed on the project.

In case satisfactory plasticity, workability, or strength is not secured using the design mix designated, the Engineer may alter proportions as necessary. Adjustment will not be made to compensation due the Contractor because of design mix alterations.

For the Stationary Side Form Method, the slump of the concrete at the time of placement shall be maintained between one (1) and three (3) inches.

For the Slip-Form Method, the concrete shall be held at a uniform consistency, having a slump of not more than two (2) inches.

The concrete shall contain 6.5% entrained air with an allowable tolerance of +1% to -1.5%. Air shall be entrained by an approved air-entraining admixture.

B. Equipment: Vehicles tracking foreign substances, including but not limited to; soil, rock, vegetation, hardened concrete, partially hydrated concrete, fuel, and oil will not be allowed to drive through or back into fresh mixed concrete. Equipment dropping foreign substances, including but not limited to; soil, rock, vegetation, hardened concrete, partially hydrated concrete, fuel, and oil from the unit shall not be allowed over or in contact with the fresh mixed concrete.

1. Batching Equipment: Batching equipment shall be computerized and automatic. Manual operation will be permitted when automatic controls fail, provided concrete meeting specified results is produced. However, the automatic operation shall be restored before work may commence the day following the failure.

The Contractor shall provide safe and satisfactory means for obtaining necessary material samples from the batching plant.

Batching plant structures shall be leveled so the accuracy of the weighing mechanism is maintained.

Hoppers shall fully discharge without jarring the scales.

Clearances between scale parts, hoppers, and bin structure shall be maintained to avoid displacement of, or friction between, parts due to material accumulations, vibration, or other cause. Pivot mountings shall be designed so the parts will not jar loose, and constructed to assure unchanging spacing of knife edges under all circumstances. Exposed fulcrums, clevises, and similar working parts shall be kept clean.

To maintain accuracy, weighing hoppers and other parts which are affected by wind action shall be protected by shelters or wind breaks.

The equipment for weighing aggregates, cement, water, and admixtures shall be an integral part of the batching equipment. The scales/load cells shall be accurate within 0.5% at any point throughout the range of the scale/load cell. Graduations shall be not greater than 0.1% of the capacity of the scale/load cell. The scales/load cells shall be sensitive to the weight indicated by one graduation.

The following controls shall apply to the aggregate batching equipment:

- a) The batching equipment shall operate within a delivery tolerance of 1.5% of the net weight for each aggregate weighed.
- b) The hopper inlet mechanism shall be interlocked against opening when the discharge gate is open.

- c) The hopper discharge mechanism shall be interlocked against opening while the hopper is being charged.

The hopper discharge mechanism shall be interlocked against opening if any material in the hopper is either overweight or underweight by more than 1.5% of the specified weight.

The cement batching equipment shall operate within a delivery tolerance of 1% of the net weight of the cement per batch. The cementitious material (cement and fly ash) batching equipment shall also operate within a delivery tolerance of 1% of the net weight of the total cementitious material per batch.

Water may be measured by volume or weight. The measuring equipment shall operate within a delivery tolerance of 1% of the net weight or volume of water.

When water is measured by volume, means for determining the accuracy of the measuring device shall be provided.

Air-entraining or other admixtures may be measured by volume or by weight. The measuring equipment shall operate within a delivery tolerance of 3% of the net weight or volume per batch.

- 2. Ticket Requirements:** A printed, computer generated, ticket shall be automatically produced for each load of concrete batched. The printed computer ticket shall accompany each load of concrete to the project and shall be presented to the Engineer prior to discharging the load at the project site unless an alternate procedure is approved.

The printed ticket must contain the following minimum information:

- Truck Number
- Date and Time batched
- Total volume of the load, in cubic yards
- Mix Design Number or Mix Type
- Actual weight (mass) or volume of each component of the mix:
 - Coarse Aggregate
 - Fine Aggregate Cement
 - Fly ash
 - Water (batch water) Admixtures
 - Air Entraining
 - Admixtures
 - Water Reducers
 - Retarders
 - Accelerators
 - Others
- % Moisture in Aggregate (either % free moisture or % total moisture)
- Maximum Water Allowed

- (maximum water allowed = weight of mix design water - weight of free water)
- W/C ratio (as-batched)

The final W/C ratio, for acceptance, shall be calculated using the following formula and rounded to the nearest 0.01:

$$\text{W/C ratio} = \left(\frac{\text{weight of free water} + \text{weight of batch water} + \text{weight of added water}}{\text{weight of cement} + \text{weight of supplementary cementitious material}} \right)$$

% free moisture = % total moisture in aggregate - % absorption of aggregate
 weight of free water = % free moisture x weight of aggregate
 weight of batch water = total weight of water added to the batch either at the plant or in the truck
 weight of added water = total weight of water added after batching process (typically added at point of delivery)

The weight of free water shall be calculated for both the fine aggregate and the coarse aggregate.

The above information must be automatically printed in such a manner that the Engineer may verify the mix adheres to the proportions specified by the design mix.

- 3. Mixing and Hauling Equipment:** Mixers and agitators shall have attached in a prominent place, the manufacturer's plate showing the various uses for which the equipment is designed and the capacity of the drum in terms of volume of mixed concrete.

The pick-up and throw-over blades in the drum shall be restored or replaced when any part or section is worn $\frac{3}{4}$ -inch or more below the original height of the manufacturer's design. The Contractor shall maintain a copy of the manufacturer's design, showing dimensions and arrangement of blades in reference to the original height and depth. Mixers that have an accumulation of hard concrete or mortar shall not be used.

Mixers, except truck mixers, shall be equipped with a timing device to track the total mixing time of the concrete batch.

Truck mixers shall be equipped with counters to record the number of revolutions of the drum or blades.

Mixers shall be capable of combining the concrete ingredients into a thoroughly mixed and uniform mass and shall uniformly discharge the concrete.

The hauling bodies of non-agitating equipment shall be smooth, mortar-tight metal containers equipped with gates and vibrators that will permit uniform control of the discharge of the concrete.

- 4. Spreading and Finishing Equipment:** Shall consist of a mechanized device to place and provide a rough strike off of the concrete. The concrete shall be unloaded into an approved mechanical concrete spreader and deposited uniformly across the subgrade or subbase as close as possible to its final position. The use of a mechanical spreader may be waived provided the concrete hauling equipment is equipped with a discharge system capable of distributing the concrete uniformly without segregation across the width of paving and meets the approval of the Engineer. The spreader shall run on forms when forms are used or on wheels or tracks when slip forming. The mechanical concrete spreader shall be self-propelled and shall be capable of spreading the concrete mix to the desired cross sections. The spreader shall be easily adjustable to spread different elevations of concrete.

Slipform paving equipment shall have the direction of forward motion and grade (vertical elevation) controlled by an electronic sensing device. The electronic sensing device shall either follow a taut string line or shall be controlled by a GPS/Total Station system capable of meeting the alignment, grade, surface test, and cross slope requirements.

The paving equipment shall spread, consolidate, screed, and finish the freshly placed concrete to provide a dense and homogenous pavement with a minimum amount of hand finishing.

The paving equipment shall not cause flotation of aggregate particles or show evidence of an accumulation of laitance on the surface of the concrete either during or after placement.

- 5. Vibrators:** Shall be either the surface pan type or the internal type. They may be attached to the spreader, the finishing machine, or mounted on a separate carriage. Vibrators shall be interlocked with the machine's travel mechanism so vibration is stopped when the forward motion stops. Vibrators shall not come in contact with the joints, load transfer devices, reinforcement, subgrade, subbase, or side forms.

The frequency of the surface vibrators shall not be less than 3,500 impulses per minute. The frequency of the internal vibrators shall not be less than 7,000 impulses per minute. When spud type internal vibrators are used adjacent to forms they shall have a frequency of not less than 3,500 impulses per minute.

Vibrators shall not be operated in excess of this frequency to such a degree that flotation of aggregate particles is caused and is evident or visible either during or after placement or that it causes an accumulation of laitance on the surface of the concrete.

A vibrating reed tachometer, hand type, shall be provided with each paver. The vibrating reed tachometer shall have a range from at least 4,000 to 10,000 vibrations per minute.

Vibrators shall not be used to level or spread the concrete, but shall be used only

for purposes of consolidation.

6. **Concrete Saw:** The Contractor shall provide sawing equipment, adequate to complete the sawing to the required dimensions and at the required rate. The Contractor shall also provide at least one standby saw in good working order.

If an early entry saw is used, the early entry saw shall use a dry cutting operation with up cutting blade rotation and a skid plate straddling the blades to minimize raveling and tearing of the concrete at the joint.

7. **Forms:** Shall have a depth not less than the prescribed edge thickness of the pavement. Built up forms with horizontal joints shall not be used.

When staked in place, forms shall withstand the pressure of the concrete and the impact, vibration and loading of any equipment they are required to support, without significant springing, settlement, or lateral displacement meeting the following requirements:

- a) The top face of any form shall not vary from a true plane by more than 1/8 inch in 10 feet, nor shall the contact face of a straight form vary from a true plane by more than 1/4 inch in 10 feet.
- b) Bent, twisted, or broken forms and those with battered top surfaces shall be removed from the work. Repaired forms shall not be used until inspected and approved.
- c) Flexible or curved forms of proper radius shall be used for curves of 100 foot radius or less. Flexible or curved forms shall be of an acceptable design.

C. Preparation:

1. **Insert Steel Bar in PCC Pavement:** When specified in the plans and at the locations specified in the plans, the Contractor shall insert steel bars into drilled holes in the existing concrete pavement. An epoxy resin adhesive must be used to anchor the steel bar in the drilled hole.

Epoxy resin adhesive shall conform to Section 40.2 L.

The diameter of the drilled holes in the existing concrete pavement for the steel bars shall not be less than 1/8 inch nor more than 3/8 inch greater than the overall diameter of the steel bar. Holes drilled into the existing concrete pavement shall be located at mid-depth of the slab and true and normal. The drilled holes shall be blown out with compressed air using a device that will reach to the back of the hole to ensure that all debris or loose material has been removed prior to epoxy injection.

The Contractor shall mix the epoxy resin as recommended by the manufacturer and apply by an injection method approved by the Engineer. If an epoxy pump is

utilized, the pump shall be capable of metering the components at the manufacturer's designated rate and be equipped with an automatic shut-off. The pump shall shut off when any of the components are not being metered at the designated rate.

The Contractor shall fill the drilled holes 1/3 to 1/2 full of epoxy, or as recommended by the manufacturer, prior to insertion of the steel bar. Care shall be taken to prevent epoxy from running out of the horizontal holes prior to steel bar insertion. Rotate the steel bar during insertion to eliminate voids and ensure complete bonding of the bar. Insertion of the bars by the dipping method will not be allowed.

- 2. Stationary Side Form Method:** Forms shall be set to line and grade. The granular surface shall be final graded and dowel assemblies, if required, accurately placed in advance of concrete placement.

The foundation under the forms shall be compacted and true to grade. The form shall be firmly in contact with the granular surface for the entire length of the form. Forms shall be staked into place with not less than three pins for each 10 foot section. A pin shall be placed at each side of every joint.

Form sections shall be tightly locked and free from play or movement. Forms shall be cleaned and oiled prior to placing concrete.

Alignment and grade elevations of the forms shall be checked and corrections shall be made before placing concrete. When forms have been disturbed or the grade has become unstable, the forms shall be reset and rechecked.

After side forms have been set to line and grade and securely fastened, the surface on which the concrete paving is to be placed shall be brought to final grade by an approved method. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement.

An automatic subgrader operating from a preset grade line or automatic grade control may be used prior to setting of the side forms. After grading has been completed by the automatic subgrader, the forms shall be set, the surface checked, and high and low areas corrected.

The finished subgrade surface shall be maintained in a smooth and compacted condition until the pavement is placed.

- 3. Slip Form Method:** The surface, on which the concrete is to be placed, shall be brought to final grade by an approved method, which may include automatic subgrader operating from a preset grade line or automatic grade control, or motor grader/blade.

The finished subgrade surface shall be maintained in a smooth and compacted condition until the pavement is placed.

- D. Handling, Measuring, and Batching Materials:** The separate aggregate components shall not become intermixed prior to being weighed.

Aggregates shall be transported from stockpiles or other sources to the batching plant in a manner that maintains a uniform grading of the material. The use of track-type dozing equipment will not be permitted in handling coarse aggregates from stockpiles.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. If the aggregates contain non-uniform moisture, storage or stockpile periods will be required to equalize the moisture content.

The separate aggregate components for each batch may be weighed cumulatively in a single hopper or weighed separately in individual hoppers. A separate scale and hopper shall be used for weighing cementitious materials.

- E. Mixing Concrete:** Concrete shall be mixed at a central stationary plant. Truck mixing will be permitted only when approved by the Engineer.

Mixing and agitating speeds shall be as designated by the manufacturer of the equipment. Mixers may not be charged in excess of their rated capacity.

Manual operation of the central plant will be permitted only in case of failure of the automatic control. Automatic operation must be restored before work may commence the day following the failure.

Mixing water shall not be heated above 160°F. Aggregates shall not be heated above 100°F and shall be free of frozen lumps, ice, and snow.

A portion of the mixing water shall be charged into the drum in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. Concrete mixed less than the specified time shall be disposed of at the Contractor's expense.

When a concrete batch is transported in a truck mixer or agitator and the batch is smaller than 60% of the rated capacity of the truck mixer or agitator, the following percentage of additional cementitious material at the same proportions as listed on the mix design shall be added to the batch:

Percent of Rated Capacity	Additional Cementitious Material Required
40% to 60%	5%
20% to 39%	10%
10% to 19%	15%
0% to 9%	20%

The above provisions regarding additional cementitious material shall also apply

to the mixing of small batches in central plants. Additional cementitious material will not be required when the small batch is mixed in a drum that is sufficiently coated with mortar to withstand the loss of cementitious material. Sufficient mortar coating, as determined by the Engineer, may include mortar coating the drum from a previously mixed batch during continuous mixing operations. Additional cementitious material will be required if more than 30 minutes has passed from the mixing of the previous batch, if the drum has been cleaned following the previous batch, or if the mortar coating the drum has been disturbed following the previous batch.

1. **Central Plant Mixing:** Concrete shall be mixed for a period of not less than one (1) minute after all materials, excluding water, are in the mixer.
2. **Truck Mixing:** Original mixing time for truck mixed concrete shall not be less than 70 or more than 100 revolutions of the drum at mixing speed after all ingredients, including water, are in the drum. Additional revolutions beyond 100 shall be done at agitating speed.

The mixing water shall be added at the time of batching. When approved by the Engineer, additional water, admixtures, and cement may be added to the batch after completion of the original mixing, in which case the batch shall be mixed an additional 30 revolutions at mixing speed. The Contractor shall provide means to accurately measure the amount of additional materials added.

F. Delivery Requirements: The rate of delivery of concrete shall be uniform.

When concrete is continuously agitated in the hauling unit, it shall be discharged within 90 minutes after the cement has been placed in contact with the aggregates and discharged and screeded within 105 minutes. When the concrete temperature is 85°F or above, the time limitation shall be reduced to discharged within 45 minutes and discharged and screeded within 60 minutes.

When concrete is not continuously agitated in the hauling unit, the concrete shall be discharged within 45 minutes after the cement has been placed in contact with the aggregates and discharged and screeded within 60 minutes. When the concrete temperature is 80°F or above, the time limitation shall be reduced to discharged within 30 minutes and discharged and screeded within 45 minutes.

The hauling unit shall be thoroughly cleaned and flushed with water as necessary to insure hardened concrete will not accumulate in the concrete hauling compartment. All wash water shall be completely discharged before recharging the hauling unit with fresh concrete.

G. Placing Concrete: Placement of concrete on a frozen surface will not be permitted. The surface temperature of forms, steel, and adjacent concrete which will come in contact with the concrete shall be raised to a temperature above freezing prior to placement.

Concrete temperature at time of placement shall not be less than 50°F or more than 90°F.

The subgrade surface shall be uniformly moist when the concrete is placed. Moisture shall be applied without forming pools of water.

The concrete shall be deposited on the grade so as to require as little rehandling as possible. Free fall of concrete shall not exceed 5 feet.

Necessary hand spreading shall be done with shovels. Rakes or vibrators shall not be used for spreading concrete. Workmen shall not be allowed in the freshly mixed concrete with boots or shoes coated with foreign substances.

The concrete shall be consolidated against and along the faces of all forms by vibrators. Vibrators shall not come in contact with a joint assembly, the grade, or a side form. The vibrator shall not be operated longer than 10 seconds in any one location.

All concrete material which falls on or is worked into the surface of a completed slab shall be removed immediately.

- H. Test Specimens:** The Contractor shall furnish concrete from the mixture for making test specimens.
- I. Placement of Reinforcement and Dowel Bar Assemblies:** The reinforcement shall be free from dried concrete, dirt, oil, paint, grease, mill scale, and rust which could impair bond with the concrete. Epoxy coated dowel bars and tie bars shall meet the requirements of Section 123.

The reinforcement shall be positioned on approved supports in advance of the concrete placement. No hand placement will be allowed. Automatic dowel bar inserters will not be allowed. The use of an automatic tie bar inserter will not be allowed for any longitudinal joint. The Concrete shall be consolidated around the tie bar.

Tie bars shall be held in the specified position parallel to the slab surface and perpendicular to the centerline by a supporting device. Tie bars or tie bar baskets shall be securely staked to the roadbed and shall hold the bar at the correct spacing, alignment, and elevation.

Tie bars will not require supports if inserted into the side of the pavement during slip form paving of the longitudinal construction joint operation. Failure to acquire the correct tie bar locations or position in the construction joint shall require the bars to be corrected and a change made to the operation which may include drilling and epoxying bars or other methods as approved by the Engineer.

The final position of each tie bar shall be within the following tolerances:

- a) Vertical Placement:** $\pm T/6$ for any part of the tie bar (T = slab thickness)

- b) Transverse Placement (side shift): ± 3 inches when measured perpendicular to the longitudinal joint line

If the tie bar does not meet the requirements and tolerances specified, corrective action shall be performed at the Contractor's expense to the satisfaction of the Engineer.

Dowel bar assemblies shall be installed where specified. Anchor pins for the dowel bar assemblies shall be installed as detailed in the plans. Dowel bar assemblies shall be fabricated in single units for the appropriate lane prior to being placed on the subgrade. After the dowel bar assemble is staked and prior to concrete installation, it is the Contractor's option to cut and bend spacer wires that pass through the contraction joint.

The free ends of the epoxy coated dowel bars [minimum of 1/2 of the dowel length plus two (2) inches] shall be given a thin uniform coating of form oil or multipurpose grease. This coating shall be applied within two (2) hours of being covered by concrete.

In lieu of this manual coating, dowel bar assemblies may be pre-coated by dipping the complete assembly in a bond breaker meeting the requirements of Section 123. Pre-coated dowel bar assemblies must be free of foreign materials at the time of placement.

Dowel bars shall be placed parallel to the subgrade and parallel to the centerline of the pavement as specified in the plans. The final position of each dowel bar shall be within the following tolerances:

- a) Vertical Placement: $\pm 1/8$ inch for any part of the dowel bar
- b) Transverse Placement (side shift): $\pm 1/2$ inch when measured perpendicular to the longitudinal joint line

If the dowel bar does not meet the requirements and tolerances specified, corrective action shall be performed at the Contractor's expense to the satisfaction of the Engineer.

The Contractor shall accurately mark the location of doweled contraction joints to assure accurate placement of the weakened plane of the joint during subsequent operations. The marks must be within one (1) inch of the center of the dowel bars as placed.

J. Final Strike-Off, Consolidation, and Finishing:

1. **Sequence:** The sequence of operations shall be; the strike-off and consolidation, floating and removal of laitance, straight edging, and final surface finish.

The addition of water to the surface of the concrete to assist in finishing operations

will not be permitted. In isolated areas where extreme conditions exist, the Engineer may determine the addition of water would be beneficial if applied with an approved fog sprayer.

Concrete shall be finished before initial set has occurred. Concrete not finished before initial set has begun shall be wasted. Re-tempering of concrete will not be allowed. Concrete shall not be mixed and placed unless natural light is sufficient for finishing operations. The Contractor shall remove and replace concrete placed that is not workable or able to be finished properly.

The concrete shall be struck-off, consolidated, and finished, so the surface of the pavement conforms to the cross section and elevation specified. The Contractor shall consolidate the concrete in a manner that results in a dense homogenous mass without segregation, holes, voids, or layers.

Concrete shall not be constructed above or more than 1/8 inch lower than adjacent placed concrete pavement.

2. **Finishing at Joints:** The concrete adjacent to joints shall be placed without voids or segregation against the joint material, under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as per this section.
3. **Machine Finishing:** Vibrators meeting the requirements of this section shall be used for full width vibration of concrete paving slabs.

Immediately after placement, the concrete shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at the intervals necessary to produce a surface of uniform texture, to provide proper consolidation, and to provide a dense homogenous mixture free of segregation, holes, voids, and layers. The Contractor will be responsible to remove and replace pavement that is not properly consolidated or contains segregation, holes, voids, and layers.

Excessive finishing over a given area shall be avoided. The top of the forms shall be kept clean by an effective cleaning device attached to the machine. The travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation affecting the precision finish.

During the first pass of the finishing machine, a ridge of concrete shall be maintained ahead of the front screed for its entire length.

The finishing machine shall be operated with a continuous forward movement. All operations of mixing, delivering, spreading, and vibrating concrete shall be coordinated to provide uniform progress and minimize the stopping and starting of the paver.

Except in an emergency, no tractive force shall be applied to the machine, except that which is controlled from the machine.

- 4. **Hand Finishing:** Hand finishing methods will not be permitted except when narrow widths or irregular areas that cannot be finished with mechanical equipment are encountered.

In the event of mechanical equipment breakdown, the concrete already deposited on the grade shall be hand finished and additional concrete placement shall be terminated. Hand finishing shall be done in a manner that produces an acceptable finished surface.

- 5. **Floating:** Long handled floats shall be used to smooth and fill open-textured areas in the pavement. The use of long-handled floats shall be kept to a minimum and shall not be used to float the entire surface of the pavement. Care shall be taken so the crown is not worked out of the pavement during the operation.
- 6. **Final Finish:** Before the concrete has attained its initial set, the surface shall be given a final finish with a carpet drag drawn over the surface in a longitudinal direction. The drag shall be mounted on a bridge and shall be sized so that a strip of the carpet at approximately two (2) feet wide is in contact with the pavement surface while the drag is operated.

The condition of the drag shall be maintained so the resultant surface is of uniform appearance with corrugations approximately 1/16 inch in depth. Drags shall be maintained clean and free of encrusted mortar. Drags that cannot be cleaned shall be discarded and replaced.

The carpet shall meet the following requirements:

Facing Material	Molded polyethylene pile face	Blade
Length	7/8 inch, ±1/8 inch	
Total Fabric Weight	70 ounces per square yard	minimum

The backing shall be of a strong, durable material, not subject to rot, which is adequately bonded to the facing.

Plain Jointed concrete pavement shall be either longitudinally or transversely tined if called for in detailed plans and specifications. Tining shall be per SDDOT Standard Specifications for Roads and Bridges, Current Edition, section 380, or as approved by the Engineer.

Tining depth and spacing shall be determined according to SDDOT test SD 418.

Brooming may be used on irregular areas in lieu of the carpet drag and tine finish. The broom shall be drawn transversely across the pavement with adjacent strokes slightly overlapping. Brooming shall be uniform in appearance and shall produce grooves approximately 1/16 inch deep. Texturing shall be completed while the

concrete surface can be broomed without being torn or unduly roughened by the operation.

The finished surface shall be free from rough and porous areas, irregularities, and depressions resulting from improper handling of the broom.

- 7. Edging at Forms and Joints:** After the final finish, and while the concrete is still plastic, the edges of the pavement along each side of the slab, and on each side of transverse construction joints, shall be worked with an approved tool and rounded to the specified radius. Edging will be permitted along longitudinal construction joints provided the radius does not exceed 1/4 inch. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

Any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming, belting, or burlap dragging the surface without disturbing the rounding of the corner of the slab. Where preformed expansion joint filler is used, the Contractor shall remove all concrete on top of the preformed expansion joint filler.

All joints shall be tested with a 10 foot straightedge before the concrete has set and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

- K. Protection of Concrete:** For the protection of the pavement surface, the Contractor shall have available covering materials, including but not limited to, insulating blankets, curing blankets, and plastic sheeting. The Contractor shall maintain the concrete surface temperature above 35°F until the concrete has attained a compressive strength of at least 1,500 psi. In addition, when the air temperature is forecasted to be below 32°F for more than four (4) hours, the Contractor shall cover the concrete surface with the covering material. This protection shall be in addition to one of the curing methods specified in this section. The Contractor shall remove and replace concrete damaged by cold weather at the expense of the Contractor.

The pavement shall not be opened to traffic until meeting the requirements of this section.

When rain appears imminent, paving operations shall stop and the unhardened concrete shall be covered with the protective covering. Pavement not properly protected from weather shall be subject to corrective action as determined by the Engineer.

The Contractor shall protect the concrete pavement and its appurtenances against all traffic. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, cross-overs, etc. Cross-overs will not be permitted until the concrete is at least 24 hours old.

Any damaged or defective pavement shall be repaired or removed and replaced as

directed. When pavement must be removed and replaced, the Engineer will determine the dimensions of the pavement to be removed.

- L. **Joints:** Curing membrane damaged or protective cover removed during the sawing operation shall be repaired or replaced by the Contractor as directed by the Engineer at no cost to the City.

- 1. **Longitudinal Sawed Joints:** Deformed steel tie bars shall be placed perpendicular to the longitudinal joints by approved methods. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves.

Longitudinal sawed joints shall be cut to the dimensions specified. Suitable guidelines or devices shall be used to assure cutting the joint to a true line. The sawed joint will not require reapplication of curing compound. The joint shall be sealed as required in this section.

Sawing of the longitudinal joint shall commence as soon as the concrete has hardened sufficiently to permit sawing without raveling. All joints shall be sawed to the specified depth as shown on the plans before uncontrolled shrinkage cracking occurs.

Repair or correction of uncontrolled cracks shall be as directed by the Engineer and at the expense of the Contractor.

- 2. **Longitudinal Construction Joints:** When adjacent lanes of pavement are constructed separately, a keyway shall be formed along the construction joint. The keyway may be omitted at the Contractor's option if the longitudinal joint is tied with deformed steel tie bars.

When adjacent lanes of pavement are constructed separately, epoxy-coated deformed steel tie bars of specified length, size, spacing, and material shall be placed across the longitudinal construction joint to tie the lanes together. The epoxy-coated tie bars installed in drilled holes along the vertical edge of the first lane placed, shall be installed with an approved epoxy resin adhesive to provide a minimum pull requirement of 8,200 pounds. Holes shall be blown clean and dry prior to placing the adhesive. The installation shall be with methods and tools conforming to the adhesive manufacturer's recommendations.

The drilled holes shall be filled from the back to the front 1/3 to 1/2 full of epoxy or as recommended by the manufacturer, prior to insertion of the steel bar. Care shall be taken to prevent epoxy from running out of the horizontal hole prior to steel bar insertion. Rotate the steel bar during installation to eliminate voids and ensure complete bonding of the bar. Insertion of the bars by the dipping method will not be allowed.

If an epoxy pump is utilized, it shall be capable of metering the components at the manufacturer's designated rate and be equipped with an automatic shut-off. The pump shall shut off when any of the components are not being metered at the

designated rate.

The Contractor shall load test tie bars at the direction of the Engineer. The Engineer has the authority to halt construction until the load test has been performed to the satisfaction of the Engineer.

For each bar that fails to pass the minimum requirements, two more bars selected by the Engineer shall be tested. Each bar that fails to meet the minimum load requirement shall be reinstalled and retested. The equipment and method used for testing shall meet the requirements of ASTM E488. All tests shall be performed within 72 hours of installation. The tie bars shall be installed and approved before concrete is placed in the adjacent lane.

3. **Transverse Contraction Joints:** Shall be created by sawing. The initial saw cut shall commence when the concrete has hardened sufficiently to permit sawing without raveling. If required, the widening cut shall not commence until completion of the concrete cure period. Joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the initial sawing operations shall be performed both day and night, regardless of weather conditions. The initial sawed joint will not require reapplication of curing compound.

If an early entry saw is used, the cut may remain approximately one (1) inch from the edges of the concrete slab to control spalling at the edge. Unless specified otherwise, the early entry saw cut shall be to a minimum depth of one (1) inch. If an early entry saw is used, the Contractor shall complete the initial saw cut on all joints where a crack has not developed for the entire width and to the required depth before the end of the 72 hour curing period. The Engineer will not require the Contractor to complete the saw cut to the final required depth at joint locations where the early entry saw cut resulted in the concrete pavement cracking, as determined by the Engineer. The early entry saw shall not induce micro cracking along the saw cut. The Contractor shall repair damaged areas resulting from incorrect early entry sawing practices.

When PCC pavement is installed adjacent to existing curb and gutter, the transverse contraction joints shall match the joint spacing in the curb and gutter.

4. **Random Cracks:** The sawing of a joint shall be omitted if a crack occurs within three (3) inches of either side of the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. Any procedure which results in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of cutting the joints or the time interval involved between the placing of the concrete or removal of curing media and the cutting of joints.

Longitudinal random cracks penetrating the full depth of the pavement shall be repaired to the satisfaction of the Engineer. The method of repair shall be approved by the Engineer. The methods will include, but are not limited to, cross-stitching, epoxy injection, routed and sealed, or removal and replacement. Cross stitching

and epoxy injection repair methods will not be allowed for pavement panels cracked into more than two pieces or pavement panels where the random crack is diagonal in orientation (approximately 45° from the centerline or transverse joint).

Repair or correction of uncontrolled or random cracks shall be as directed by the Engineer and at the expense of the Contractor.

If an uncontrolled crack develops within 6 feet of the contraction joint, a minimum of six (6) feet of pavement removal and replacement will be required. Removal and replacement of the pavement shall be done at the Contractor's expense. If cracking occurs on both sides of the joint, the dowel bar assembly and a minimum of three (3) feet of pavement each side of the joint shall be removed and replaced. Removal and replacement of the pavement shall be done at the Contractor's expense.

If an uncontrolled crack develops on one side of the contraction joint in the mid panel area between 6 feet from the joint and the midpoint of the panel, the entire panel shall be replaced on that side of the joint within the lane containing the cracking. Removal and replacement of the pavement shall be done at the Contractor's expense.

No section of pavement less than six (6) feet in length will be allowed to remain in place.

The City will provide guidance for repair procedures to the Contractor. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed in a manner approved by the Engineer prior to initial set of the concrete.

- 5. Transverse Construction Joints:** Shall be made at the end of each day's run and where an interruption is of duration long enough that the concrete is no longer plastic and cannot be vibrated.

The transverse construction joint shall be located at a contraction joint location. Supplemental hand vibrators shall be immediately available to provide satisfactory consolidation at joints.

Paving in the area of a transverse construction joint will not be permitted for 12 hours after installation.

- M. Curing:** Immediately after the finishing operations have been completed and marring of the concrete will not occur, the entire surface, and exposed edges of the pavement, shall be properly cured. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period. Curing shall be maintained for at least 72 hours after concrete placement. One of the following curing methods shall be used:

- 1. Curing Blankets and White Polyethylene Sheeting Method:** The surface of the concrete pavement and both pavement edges shall be covered with curing

blankets. The mats shall be thoroughly saturated with water and placed with the wettest side down.

Immediately after placement, the curing blankets shall be covered with white polyethylene sheeting placed in accordance with this section.

Combination burlap-polyethylene sheeting may be substituted for the layer of curing blanket and the polyethylene sheeting with the Engineer's approval.

The curing blankets shall be kept moist by periodic applications of water.

2. **White Opaque Polyethylene Sheeting Method:** The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be placed and weighted down to maintain intimate contact with the surface covered. The sheeting shall be sized so each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. In cold weather the substitution of dark sheeting for white sheeting will be permitted.
3. **Liquid Membrane Curing Compound Method (Linseed Oil Cure):** The entire surface of the pavement shall be sprayed uniformly with white pigmented linseed oil-based curing compound immediately after the finishing of the surface. If the pavement is cured initially with curing blankets, the impervious membrane shall be applied immediately upon removal of the curing blankets. The curing compound shall not be applied during or immediately after rainfall.

Curing compound shall be applied under pressure by approved self-propelled mechanical sprayers. The curing compound may be applied in one or two applications. If applied in two applications, the second shall be applied within 30 minutes after the first.

The Contractor shall apply curing compound at the minimum application rate of one (1) gallon per 150 square feet for carpet drag or broom finished surfaces and one (1) gallon per 125 square feet for metal tined finished surfaces.

The sprayer equipment shall be equipped with a tank agitator and shall be fully atomizing. The spray fog shall be protected from the wind by a shield. During application the compound shall be thoroughly mixed and continuously agitated by mechanical means. Hand spraying of odd width or shapes and concrete surfaces exposed by form removal will be permitted.

Curing compound shall not be applied to the inside faces of joints to be sealed, unless the compound is completely removed by subsequent sawing operations. Curing membrane damaged or protective cover removed on the surface of the pavement during the sawing operation shall be repaired or replaced by the Contractor as directed by the Engineer at no cost to the City.

Should the film become damaged within the curing period, the damaged portions

shall be repaired immediately with additional compound.

The sides of the exposed slab shall be protected with a curing treatment equal to that provided for the surface.

N. Removing Forms: Forms shall not be removed until concrete has set for at least 12 hours, except for auxiliary forms used temporarily in widened areas. Forms shall be removed without damaging the pavement. After the forms have been removed, the exposed sides of the slab shall be cured by one of the methods indicated above, unless the forms are left in place for more than 72 hours.

O. Surface Test (10 Foot Straightedge): The pavement surface shall be tested with a 10 foot straightedge. The permissible longitudinal and transverse surface deviation shall be 1/4 inch in 10 feet.

Areas where the maximum deviation exceeds the permissible deviation by not more than three-eighths (3/8) inch will be subject to the following at the discretion of the Engineer:

- a) Grind down to an elevation where the area or spot will be within the permissible deviation and receive 100% pay.
- b) Accept affected area without corrective action with price reduction at a rate noted below.

Areas where the maximum deviation exceeds the permissible by more than three-eighths (3/8) inch will be subject to the following at the discretion of the Engineer:

- a) Grind down to an elevation where the area or spot will be within the permissible deviation.
- b) Remove and replace deficient area to the satisfaction of the Engineer.

The Contractor shall accomplish corrective grinding with specially prepared circular diamond blades mounted on a horizontal shaft. The Contractor shall day light corrective grinding to the outside edge of the pavement. The Contractor shall repair and replace joint sealant damaged by corrective grinding as directed by the Engineer and at no additional cost to the City. The Contractor shall not leave ground areas smooth or polished. The Contractor shall ensure ground areas have a uniform texture equal in roughness to the surrounding unground concrete. The Contractor shall reestablish the tining with a mechanical tining machine in areas where directed by the Engineer. The Contractor shall remove and replace all joint sealant within the area where tining is replaced. The Contractor will replace all permanent pavement markings damaged, destroyed, or removed during corrective grinding at no additional cost to the City.

If the Engineer accepts the deficient area without correction, a price reduction at the following rates will be deducted from the contract:

- a) Twenty Percent (20%) reduction of payment for contract unit price per square yard for those areas where the maximum deviation exceeds the permissible deviation by not more than one-eighth (1/8) inch.
- b) Thirty Percent (30%) reduction of payment for contract unit price per square yard for those areas where the maximum deviation exceeds the permissible deviation by more than one-eighth (1/8) inch but not more than three-eighths (3/8) inch.

Measurements for determining the limits and degree of deficient areas shall be per SD DOT test SD417, and shall be conducted by the Engineer.

Where the transverse surface test is out of specification, the maximum length and maximum width at a particular site shall be used in computation of the area.

- P. **Sealing Joints:** Joints shall be sealed with hot-poured elastic joint sealer or low modulus silicone sealant as specified. Joints shall be sealed immediately after completion of the curing period, before the pavement is opened to traffic. If joint sealing material is not specified in plans, hot-poured elastic joint sealer shall be used, or material as directed by the Engineer.

Joint grooves with spalls greater than 1/2 inch in depth shall be patched with an approved epoxy resin mortar in accordance with SDDOT Standard Specifications for Roads and Bridges, Current Edition. All loose concrete shall be removed from the spalled area and the spalled surface shall be thoroughly cleaned. After cleaning, the spalled surface shall be primed and an epoxy resin mortar of troweling consistency shall be placed in the spalled area and finished as the original pavement surface. The epoxy binder components shall be proportioned and mixed as recommended by the manufacturer. After the epoxy binder is thoroughly mixed, dry silica sand shall be blended into the mixture to give an epoxy resin mortar of trowelable consistency.

After the epoxy resin mortar has cured, the forming material shall be carefully removed.

The finished joint shall have vertical faces and the joint width shall be maintained.

Patching of spalls shall be done only within the temperature range recommended in AASHTO M 235, for the class of epoxy used.

Joints to be sealed shall be thoroughly clean and dry. All materials such as old sealant, oil, asphalt, curing compound, paint, rust, and other foreign materials shall be completely removed. Cleaning shall be accomplished by sand blasting and other tools as necessary. Joints to be sealed with silicone sealant shall be sand blasted utilizing a mechanical device that holds the sand blaster at the appropriate angle and distance from the joint to ensure proper cleaning. The device shall have a mechanism attached that will correctly guide the device in the joint.

Just prior to sealing, each joint shall be blown out using a jet of compressed air, at a

working pressure of not less than 90 psi, to remove all traces of dust. Air compressors used for cleaning joints shall be equipped with traps capable of removing all free water and oil from the compressed air.

Joint sealer application will not be permitted when the air or pavement temperature near the joint is less than 40°F or is 40°F and falling, or per manufacturer's recommendations.

The sealant shall be applied without spilling on the exposed surface. Sealant on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

Failure of the joint material in either adhesion or cohesion will be cause for rejection. Repair shall be at the expense of the Contractor.

1. **Hot-Poured Elastic Joint Sealer:** Shall be stirred during heating so that localized overheating does not occur. All joints shall be sealed with an approved pressure sealing device, equipped with a nozzle inserted into the joint, so sealing material will be forced from the bottom of the joint to the top.
2. **Silicone Sealant:** Shall be applied with a mechanical device equipped with a nozzle or spout shaped to fit into the joint. The joint sealant shall be applied under pressure from the inside of the joint to remove entrapped air and ensure good joint contact.

Backer rod shall be installed to the proper depth to produce the width and depth of sealant specified.

The sealant surface shall be tooled to produce a slightly concave surface below the pavement surface. Tooling shall be accomplished before a skin forms on the sealant surface. The use of water, soap, or oil as a tooling aid will not be permitted.

Seasonal Limitations: Silicone sealing operations will only be permitted between May 1 and October 15, inclusive, unless the Contractor has received written permission from the Engineer to continue sealing later than October 15. Silicone sealing operations will only be permitted when the air and pavement surface temperatures are 40°F or greater and rising. Without approval from the Engineer to continue silicone sealing operations after the October 15 seasonal limitation, the Contractor shall only perform the initial cut at all joints. Beginning no sooner than May 1 of the following year the Contractor shall widen the joints, install the backer rod, and seal joint with silicone according to this section. All costs related to the sealing seasonal limitations including additional labor, materials, equipment, traffic control, mobilization, and incidentals shall be at the expense of the Contractor.

- Q. Application of Live Load:** The pavement shall not be opened to traffic until the concrete has attained a compressive strength of 4,000 psi. The pavement shall be cleaned prior to opening to traffic.

When concrete is placed adjoining a previously constructed pavement, the paving machines, mechanical spreaders, and other heavy equipment shall not be operated on the existing pavement until the existing concrete has attained a compressive strength of 3000 psi. Equipment operated on a previously constructed pavement that has attained a compressive strength of at least 3000 psi but less than 4000 psi shall be tracked type equipment. Hauling units shall not be allowed on the concrete until it has attained a compressive strength of 4000 psi. Working platforms and tining, curing, and other lightweight finishing equipment may be operated on the edge of the existing concrete 72 hours after the concrete was placed. With the approval of the Engineer, lightweight sealing equipment, including but not limited to, pickup and trailer, hot kettle, and air compressor may be operated on the slab more than 72 hours after the concrete was placed if the concrete has reached 80% of design strength.

When operating on previously constructed lanes, measures shall be taken to protect the previously constructed lane from becoming marred by the equipment.

- R. Tolerance in Pavement Thickness:** The pavement thickness will be determined by average caliper measurement of cores tested in accordance with AASHTO T 148. Cores shall be sampled in accordance with AASHTO T 24.

One initial core shall be taken at random per unit by the Engineer. A unit shall be minimum one (1) lane of paving for one block (or 500 linear feet maximum unit). Parking shall be considered a lane for the intent of pavement cores.

- 1. Measurements:** When the measurement of the core from the unit is not more than 0.20 inch from the plan thickness, the core measurement shall represent the unit.

When the measurement of the core from a unit is deficient by more than 0.20 inch and not more than one (1) inch from the plan thickness, two additional cores, at an interval of 50 feet ahead and behind the deficient core, will be taken by the Engineer. Random offsets will be used for the additional cores. The average thickness of the three (3) cores will be used as the average thickness for that unit.

When the measurement of any core is deficient by more than one (1) inch, the following will apply:

- a)** Additional cores will be taken by the Engineer at not less than 25 foot intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which is not deficient by more than 0.20 inches.

The point at which the pavement is deficient by exactly 0.20 inches will be found by assuming a straight line relationship between the cores. The deficient area will be defined by the point that is deficient by more than one (1) inch to the points on each side within 0.20 inches of the specified depth. The deficient area shall be removed and replaced at no cost to the City.

- b)** After the deficient area has been isolated, additional core(s) must be taken by the Engineer to represent the remaining portion of the unit.

- c) After removal and replacement, a final core per unit or repaired area shall be taken by the Contractor at a location determined by the Engineer to represent the repaired area.
2. **Averaging:** Measurements of cores will be averaged for a unit and the thickness will be reported to the nearest 0.01 inch.

Measurements of cores that are in excess of the specified pavement thickness by more than 0.20 inch will be considered as the specified thickness plus 0.20 inch.

Location of cores will not be a factor in determining average thickness of a unit.

3. **Payment:** Payment for units will be in accordance with Table 2.

Table 2

Portland Cement Concrete Pavement		
Deficiency in Thickness Determined by Cores		Proportional Part of Contract Price allowed
From	Through	
0.00 inch	0.20 inch	100%
0.21 inch	0.30 inch	80%
0.31 inch	0.40 inch	72%
0.41 inch	0.50 inch	68%
0.51 inch	0.70 inch	57%
0.71 inch	1.00 inch	50%

- S. **Concrete Patching:** Concrete replacement for utilities, storm sewer, or similar work shall comply with the requirements of Section 40 standard details.

Replacement of less than one full panel shall meet the following criteria:

1. Less than one full panel replacement with a new transverse joint shall be minimum of 6 feet from the next transverse joint.
2. Replacement of a portion of a concrete panel creating a new longitudinal joint requires approval from the Engineer, and in no case shall be less than one half of the panel.

- T. **Strength and Thickness Tests:** The Contractor shall submit the following test data. All sampling and testing shall be done by American Concrete Institute (ACI) certified testing laboratory personnel.

1. Slump, air content, seven (7) and twenty-eight (28) day compressive strength.
2. One test per 250 lineal feet of main line paving.
3. One test per 250 square yards of patching.

4. Thickness cores per Section 40.3R. Some cores provided by Engineer.
5. Results from concrete testing shall be provided to the Engineer within 3 days of the test being performed.

Failing strength tests shall be pro-rated as follows:

$$D = [(A - B) / A] * C$$

A = Specified strength

B = Average of all tests below specified strength

C = Number of failing tests divided by total number of tests times one hundred (100)

D = Percent reduction in unit price bid

If C is twenty percent (20%) or greater, the Contractor shall extend the pavement warranty period an additional two years. The City reserves the right to order additional tests. The Contractor shall pay for those additional tests that fail to meet specified strength and the City will pay for those additional tests that do meet the specified strength.

The Engineer or their representative shall be present for all field sampling and lab testing performed by/for the Contractor. Failure to notify the City of pending sampling or testing could result in rejection of submitted data and re-testing by in-place methods.

All required data shall be received by the Engineer before payment for pavement exceeds seventy-five percent (75%) of the total quantity.

40.4 METHOD OF MEASUREMENT

- A. **PCC Pavement:** Will be made to the nearest 0.1 square yard.
- B. **Dowel Bar Assemblies:** Will be measured by the actual number of bars furnished and installed.
- C. **Insert Steel Bar in PCC Pavement:** Will be measured by the actual number and type of steel bars furnished and installed.

40.5 BASIS OF PAYMENT

- A. **PCC Pavement:** Shall be paid for at the contract unit price per square yard or adjusted unit price as set forth in this section.

Payment will be full compensation for furnishing all materials (including reinforcing steel), concrete, labor, equipment, and all incidentals necessary. Payment will also be full compensation for trimming and water used to moisten the subgrade ahead of the paver, curing the concrete, sawing, and sealing joints.

- B. **Dowel Bar Assemblies:** Will be paid for at the contract unit price per each dowel bar.

Payment will be full compensation for labor, materials, equipment, and all incidentals necessary to furnish and install the assemblies.

- C. Insert Steel Bar in PCC Pavement:** Will be paid for at the contract unit price per each steel bar. Payment will be full compensation for labor, materials, equipment, and all incidentals necessary to furnish and install the steel bar.

END OF SECTION

SECTION 41

UTILITY TRENCH RESURFACING

41.1 DESCRIPTION

- A. General:** This work consists of furnishing and installing surface patching of utility trenches. This includes all equipment, tools, materials, labor, and other incidentals to provide utility trench patching to prepare the surface for regular use, and restore non-paved areas to their original condition.

Patching of trenches will be matching the in-place surface material with asphalt, concrete, gravel, grass, etc. or as specified by the Engineer.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 20	Granular Bases and Surfacing
Section 31	Asphalt Concrete - General
Section 32	Asphalt Concrete - Class E
Section 39	Cold Mix Asphalt Concrete
Section 40	Portland Cement Concrete Pavement
Section 64	Under-Drains
Section 70	Seeding
Section 73	Sodding
Section 90	Roadway Signs and Delineators
Section 117	Aggregates for Granular Bases and Surfacing
Section 202	Geosynthetics for Roadways

- C. Submittals:** Asphalt mix design, concrete mix design, seed mixture.

41.2 MATERIALS (Not specified)

41.3 CONSTRUCTION REQUIREMENTS

- A. Sub Grade Preparation:** Contractor shall not resurface the trench until all density tests have been met and the Engineer gives approval.

The subgrade shall be brought to proper grade elevation, for the specified depth of surfacing to be placed. The subgrade surface shall be smooth and level, with no loose material.

B. Resurfacing:

- 1. Saw Cut of Pavement Edges:** The first pavement saw cuts shall be, at a minimum, the same width as the minimum trench width centered over the utility.

- The second saw cut shall be 1 foot outside the disturbed area on each side of the trench (see Section 41 Standard Detail).
2. **Asphalt Street:** The asphalt patch shall be placed to a minimum depth of five (5) inches. If the existing pavement is greater than five (5) inches thick, the patch shall be placed to a depth matching the existing pavement. The asphalt base shall be Class E, Type 1, and/or class E, type II, as approved by the Engineer. The asphalt patching shall be in accordance with Sections 31 and 32.
 3. **Cold Mix Asphalt:** A temporary asphalt patch shall be placed when hot asphalt is not available and/or the Engineer gives approval. The Contractor shall be responsible for maintenance of the temporary patch at no extra cost to the City. The depth of the temporary patch shall be a minimum of five (5) inches. The cold mix shall be in accordance with Section 39.
 4. **Concrete Street with Asphalt Overlay:** After saw cutting per specifications, the concrete base patch shall be poured to the depth of the existing concrete. The concrete shall be allowed to attain a compressive strength of 4000 psi, or the Engineer has given approval, before the asphalt overlay can be accomplished. The asphalt overlay shall be Class E, Type I and/or Class E, type II as approved by the Engineer. The concrete and asphalt patch shall be in accordance with Sections 31, 32, and 40.
 5. **Concrete Street:** After saw cutting as per specifications, the concrete pavement patch shall be installed in accordance with Section 40.3T. The pavement patch shall not be opened to traffic until the concrete has attained a compressive strength of 4000 psi. The concrete patch shall be in accordance with Section 40.
 6. **Gravel Resurfacing:** The gravel shall be placed to a thickness equal to the in-place gravel thickness or five (5) inches, whichever is greater, or as approved by the Engineer. The gravel surface material and placement shall be in accordance with Section 20 and Section 117.
 7. **Seeding:** The area to be seeded shall be as specified on the plans and specifications and/or by the Engineer. The seeding shall be in accordance with Section 70.
 8. **Sodding:** The area to be sodded shall be as specified on the plans and specifications and/or by the Engineer. The sodding shall be in accordance with Section 73.
 9. **Geotextile or Geogrid:** If Engineering fabric is encountered during excavation, the Contractor shall immediately notify the Engineer. Damaged fabric shall be repaired as shown on the appropriate standard detail or as directed by the Engineer. Fabric removal and replacement shall be per Section 11. Final saw cuts shall be as specified in this section. Also see Section 202 Geosynthetics for Roadways.

10. Under-Drains: If subsurface or edge drains are encountered during excavation, the Contractor shall immediately notify the Engineer. Subsurface or edge drains shall be repaired as shown on the appropriate standard detail or as directed by the Engineer. Repair of under-drains shall be per Section 11. Final saw cuts shall be as specified in this section. Also see Section 64 Under-Drains.

41.4 METHOD OF MEASUREMENT

All trench resurfacing shall be measured for in accordance with the respective section.

41.5 BASIS OF PAYMENT

All trench resurfacing shall be paid for in accordance with the respective section.

END OF SECTION

SECTION 50

PRECAST CONCRETE

50.1 DESCRIPTION

A. General: This work consists of fabricating and furnishing precast concrete items. Fabrication facility shall be on the SD DOT Contractor / Supplier List in order to supply precast concrete products for the City of Rapid City.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 54	Drainage Pipe Installation
Section 55	Cast in Place Concrete Structures
Section 58	Concrete Box Culvert
Section 62	Drop Inlets
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 103	Fly Ash
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 123	Concrete Reinforcement
Section 202	Geosynthetics for Roadways
Section 203	Submittals

50.2 MATERIALS (Not Specified)

A. Concrete:

B. Fine Aggregate: Section 105.

C. Coarse Aggregate: Section 107.

D. Water: Section 104.

E. Chemical Admixtures: Section 101 and 102.

F. Fly Ash: Section 103.

G. Cement: Section 100. Type II cement shall be used, unless otherwise specified. For pretensioned prestressed concrete beams, Type I, II, or III cement may be used.

- H. **Reinforcing Steel:** Section 123. Epoxy coated rebar is not required unless otherwise specified in detailed plans and specifications, or per standard details.
- I. **Drainage Fabric:** Shall meet the requirements of Section 202, Class 2 nonwoven geotextile.

50.3 CONSTRUCTION REQUIREMENTS

- A. **General Requirements:** The Contractor shall satisfy the following for all precast concrete items.
 1. **Notification:** The Fabricator shall notify the Engineer seven (7) days prior to the fabrication of precast concrete items. Engineer reserves the right to inspect precast fabrication facility, equipment, and materials.
 2. **Concrete Mix Requirements:** The mix design shall include all aggregate sources and admixtures proposed for use. When a plant has been in operation and satisfactorily producing material, the fabricator will only be required to submit a concrete mix design annually for precast concrete, unless changes have been made to the pre-approved mix design or the material used in the mix design.

Shop Drawings: Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for review and approval. If deviating from the standard detail, contractor or supplier shall provide engineered drawings and calculations verifying the structure is designed per HL93. The Contractor shall furnish a checked design with the shop drawings. A checked design includes the design calculations and check design calculations performed by an independent Professional Engineer registered in the State of South Dakota. The Contractor shall not begin fabrication prior to the City's review and final approval of shop drawings. Shop drawing shall be submitted to the Engineer in accordance with Section 203 Submittals. The shop drawings shall consist of fabrication details including reinforcing steel and spacer placement and configurations, total quantities for the complete structure, and all information necessary for fabrication and erection.

a) Wet Cast Concrete Mix Requirements:

- 1) The concrete shall attain a 28 day compressive strength equal to or greater than the minimum compressive strength specified.
- 2) The water/cementitious material ratio shall not exceed that specified in the concrete mix design.
- 3) The absolute volume of the mix design proportions shall yield 27.0 to 27.4 cubic feet.

- 4) The mix design for box culverts shall contain a minimum of 58% coarse aggregate by weight. All other precast products shall contain a minimum of 50% coarse aggregate by weight.
- 5) The entrained air content shall be 6% plus or minus 1.5%.
- 6) Concrete without high range water reducing admixtures (HRWRA) shall have a maximum slump of 5 inches.
- 7) When HRWRA are used, the slump at the time of placement shall be from 4 to 8 inches.
- 8) The HRWRA shall be compatible with the concrete mix. The HRWRA shall not be used in amounts that cause segregation or rapid slump loss that would hinder concrete placement.
- 9) The minimum fresh concrete temperature at time of placement shall be 50°F.
- 10) Equipment and methods used for batching, mixing, and transporting of concrete shall be approved by the Engineer.

b) Dry Cast Concrete Mix Requirements:

- 1) The concrete shall attain a 28 day compressive strength equal to or greater than the minimum compressive strength specified.
- 2) The absolute volume of the mix design proportions shall yield 27.0 to 27.4 cubic feet.
- 3) The minimum fresh concrete temperature at time of placement shall be 50°F.
- 4) Equipment and methods used for batching, mixing, and transporting of concrete shall be approved by the Engineer.

3. Forms: Shall comply with Section 55 and the following:

The forms shall be designed to withstand the fluid pressure of the concrete and the added forces due to vibration and impact without distortion. The forms shall be mortar tight and free from warp. Joints in sectional forms shall have a tight fit without excessive offset.

The form surface area in contact with the concrete shall be treated with an approved form oil or wax before the form is set in position. The forms shall be thoroughly cleaned of all other substances.

4. Fabrication: Welding of mild reinforcing steel will not be permitted.

Steel wire bar supports shall be used to maintain proper reinforcement location and concrete cover. Cutting of reinforcement and bending to the form surface, for support, will not be permitted. Steel wire bar supports, in contact with the casting forms, shall be stainless steel, hot dipped galvanized, or plastic tipped extending at least 1/2 inch from the form surface.

The surface temperature of the forms and reinforcing steel, which come into contact with the concrete being placed, shall be raised to a temperature above freezing prior to concrete placement. All deleterious material shall be removed from the forms prior to concrete placement. For cold weather placements, concrete surfaces shall be protected from freezing throughout the pour and until covered for the waiting period before application of live steam or radiant heat.

The dry casting method of fabrication for precast concrete box culverts will not be allowed except single barrel precast concrete box culverts with dimensions of 7 foot by 7 foot and smaller.

The precast units shall have sufficient strength to prevent damage to the units during removal of the forms and yarding. Precast units shall have a minimum concrete compressive strength of 800 psi prior to form removal. Precast units shall have a minimum concrete compressive strength of 3000 psi prior to yarding. Final 28 day compressive strength shall be minimum 4000 psi, or as specified in detailed plans and specifications. The Engineer may allow a different minimum concrete strength for form removal and yarding, based upon fabricator demonstrated results or as shown on design details submitted with the shop plans.

The fabricator shall make a minimum of one group of test cylinders for each class of concrete for each day's production, not to exceed 150 cubic yards per group of cylinders.

At a minimum, a group of test cylinders shall consist of the following:

- a) Two test cylinders are required for the 28 day compression test.
- b) Additional cylinders will be required for determining concrete strength, when the Contractor desires permission from the Engineer to make delivery prior to the 28 day compression test.

For low pressure steam or radiant heat curing, the test cylinders shall be cured with the unit, or in a similar manner (similar curing method and concrete curing temperature, as approved by the Engineer) as the unit, until minimum compressive strength has been obtained.

The precast units shall be in accordance with Section 55 except that the fabricator shall be responsible for the sampling, preparing, and properly curing of all concrete cylinders for concrete compressive strength, and the fabricator shall

be responsible for all costs. The precast units will be accepted when the minimum design concrete compressive strength requirements have been met. Accepted precast units represented by that test group of cylinders may be delivered to the project but will still require the 28 day cylinder test be provided to the Engineer.

5. **Concrete Cure:** The concrete shall be cured by low pressure steam, radiant heat, or as specified in Section 55. When curing in accordance with Section 55, the concrete temperature requirements of Section 55 shall apply.

Low pressure steam or radiant heat curing shall be done under an enclosure to contain the live steam or the heat and prevent heat and moisture loss. The initial application of the steam or heat shall be three hours after the final placement of concrete to allow the initial set to occur. When retarders are used, the waiting period before application of the steam or radiant heat shall be five hours. When the time of initial set is determined by ASTM C 403, the time limits described above may be waived.

During the waiting period, the minimum temperature within the curing chamber shall not be less than 50°F and live steam or radiant heat may be used to maintain the curing chamber between 50°F and 80°F. During the waiting period the concrete shall be kept moist.

Application of live steam shall not be directed on the concrete forms causing localized high temperatures. Radiant heat may be applied by pipes circulating steam, hot oil, hot water, or by electric heating elements. Moisture loss shall be minimized by covering exposed concrete surfaces with plastic sheeting or by applying an approved liquid membrane curing compound to exposed concrete surfaces. The top surface of concrete members for use in composite construction shall be free of membrane curing compound residue unless suitable mechanical means for full bond development are provided.

During the initial application of live steam or radiant heat, the concrete temperature shall increase at an average rate not exceeding 40°F per hour until the curing temperature is reached. The maximum concrete temperature shall not exceed 160°F. The maximum temperature shall be held until the concrete has reached the specified strength. After discontinuing the steam or radiant heat application, the temperature of the concrete shall decrease at a rate not to exceed 40°F per hour until the concrete temperature is within 20°F of the ambient air temperature.

6. **Surface Finish and Patching:** If a precast item shows stone pockets, honeycomb, delamination, or other defects which may be detrimental to the structural capacity of the item, it will be subject to rejection at the discretion of the Engineer. Minor surface irregularities or cavities, which do not impair the service of the item, and which are satisfactorily repaired will not constitute cause for rejection. Repairs shall not be made until the Engineer has inspected the extent of the irregularities and has determined whether the item can be satisfactorily

repaired. If the item is deemed to be repairable, the repair method and procedures shall be agreed upon by the City and fabricator prior to the work commencing.

If a finishing aid is used, the finishing aid cannot be used for finishing of the concrete surface immediate after application of the finishing aid and the finishing aid must be applied uniformly to the surface of the concrete with a sprayer.

Depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the proportions which are similar to the specific class of concrete in the unit. A sack rub finish is also required on sloped surfaces of box culvert end sections.

B. Precast Box Culverts: The following shall apply to box culverts:

1. **Design:** Precast concrete box culverts shall conform to ASTM C1557 and ASTM C1433. Configurations in variance with those provided by ASTM will be accepted provided the materials, design, fabrication specification, and the requirements of this Section are met.

Box culvert end sections (inlet or outlet) materials, design, and fabrication shall conform to the current edition of the AASHTO Standard Specifications for Highway Bridges and Materials Specifications.

Precast box culverts shall be designed to specified load conditions. The design shall conform to the AASHTO design requirements for the depth of fill, including surfacing, etc., as well as live load or specified loading. The specified live load shall apply to all barrel sections.

Minimum reinforcing steel clear cover shall be 1 inch for all member faces except box culverts covered by a fill of less than 2 feet, including surfacing, shall have a minimum reinforcing steel clear cover of 2 inches in the top of the top slab.

The Contractor shall furnish a checked design with the shop drawings. A checked design includes the design calculations and check design calculations performed by an independent Professional Engineer registered in the State of South Dakota.

A checked design for barrel sections will not be required to be submitted if the proposed fabrication dimensions and reinforcement conform to ASTM C1557 and ASTM C1433. A checked design for the end sections and special sections will be required.

2. **Fabrication:** The Contractor shall notify the Engineer seven (7) days prior to fabrication.

The minimum length of precast section shall be 4 feet.

Joint ties shall be provided with all sections.

50.4 METHOD OF MEASUREMENT

- A. Precast Drop Inlets:** Precast drop inlets shall be measured per Section 62.
- B. Precast Box Culvert:** Precast box culvert shall be measured per Section 58.
- C. Precast Concrete Pipe:** Precast concrete pipe shall be measured per Section 54.

50.5 BASIS OF PAYMENT

- A. Precast Drop Inlets:** Payment for precast drop inlets shall be per Section 62.
- B. Precast Box Culvert:** Payment for precast box culvert shall be per Section 58.
- C. Precast Concrete Pipe:** Payment for precast concrete pipe shall be per Section 54.

END OF SECTION

SECTION 51

STRUCTURE EXCAVATION

51.1 DESCRIPTION

A. General: This work consists of the necessary foundation excavation for box culverts and structures.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 58	Concrete Box Culvert
Section 63	Storm Sewer Junction Boxes and Manholes

51.2 MATERIALS (Not Specified)

51.3 CONSTRUCTION REQUIREMENTS

A. Depth of Excavation: The elevations of the bottoms of footings shown on the plans are approximate and the Engineer may order, in writing, such changes in elevations of footings as necessary.

B. Treatment of Foundation: Rock or other hard foundation material shall be free of loose material, cleaned, and cut to a firm surface. The surface may be level, stepped, or serrated as approved by the Engineer.

Where concrete is placed on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Concrete shall not be placed until the depth of excavation has been checked and the suitability of the foundation material approved.

Foundation excavation may be trimmed to the exact size of the footing and the footing forms omitted, when approved by the Engineer.

Removal of unstable material below the bedding grade of box culverts shall be performed as set forth in Section 58.

C. Disposal of Excavation Material: The excavated material shall be used for backfill and embankment or disposed of as directed. Excavated material shall not be placed in stream beds.

D. Inspection: The Engineer shall be notified as soon as each excavation is completed. Backfill material shall not be placed until the Engineer determines that the depth and size of the excavation and the foundation material are acceptable.

- E. Backfill Above Bedding Grade:** Material used for backfill shall be of an acceptable quality and shall be free from large or frozen lumps, wood, and other extraneous material.

Spaces not occupied by permanent work shall be backfilled to match the surface of the surrounding ground.

Backfill shall be satisfactorily compacted in horizontal layers not to exceed six (6) inches.

The slope bounding the excavation for wingwalls shall be stepped or roughened to prevent wedge action of the backfill against the concrete.

Backfill placed around box culverts and walls shall be deposited equally on both sides of the structure. Backfill shall be compacted in accordance with Section 12.

51.4 METHOD OF MEASUREMENT

Unless specifically mentioned in detailed plans and specifications, structure excavation shall not be measured. It shall be incidental to the structure being installed. If provisions for structure excavation are provided, the plan shown quantity will be the quantity accepted for payment. Field measurements for structure excavation quantities will not be made, unless the Engineer determines that conditions warrant such measurements.

Plans quantity shall be the volume of material that must be removed for the installation of the structure, and shall not include undercut. Plans shall state assumptions on the volume of excavation required to install the structure, including trench side slope and width. Structure excavation will be calculated to the nearest cubic yard.

51.5 BASIS OF PAYMENT

Structure excavation shall be incidental to the structure being installed, unless otherwise stated in the detailed plans and specifications.

If provisions for payment of structure excavation are provided, payment will be made at the contract unit price per cubic yard for structure excavation, box culvert; structure excavation, retaining wall; or structure excavation, miscellaneous.

Payment will be considered full compensation for furnishing materials, labor, equipment, tools, and incidentals, including furnishing, installing, and removing any temporary works necessary to excavate material for construction of the structure.

END OF SECTION

SECTION 54

DRAINAGE PIPE INSTALLATION

54.1 DESCRIPTION

A. General: This work consists of furnishing and installing culverts and drainage piping. Pipe culverts shall be in accordance with Section 11 except as modified by the provisions contained here within. Pipe materials and minimum sizes allowed for Public Works Construction are determined by the Engineer, adopted Infrastructure Design Criteria, and City policy.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 112	Select Granular Backfill
Section 117	Aggregates for Granular Bases and Surfacing
Section 120	Drainage Pipe Materials
Section 203	Submittals
Section 205	Televising

54.2 MATERIALS

A. Pipe Materials: Materials shall be per Section 120.

B. Bedding:

1. **Reinforced Concrete Pipe (RCP):** Bedding shall conform to Granular Material for Storm Sewer in Section 112.
2. **PVC Pipe:** Bedding for PVC drainage pipe shall be Type 1 bedding per Section 112.
3. **Dual Wall Polypropylene:** Dual wall polypropylene (PP) pipe shall be bed with Type 1 bedding per Section 112, or per detailed plans and specifications.

54.3 CONSTRUCTION REQUIREMENTS

A. General: Drainage piping shall be accurately laid to the lines, grades, stations, and elevations identified in plans. Equipment capable of gently lowering the sections of pipe into place shall be provided. Dropping the pipe into place will not be permitted.

- B. Reinforced Concrete Pipe (RCP) Culvert:** RCP pipe shall be laid with the groove or bell end upstream and inserting the tongue end into the downstream bell or groove.

All RCP flared end sections shall be tie bolted. A minimum of two joints past the flared end shall also be tie bolted, or as shown in the plans. Tie bolts shall be installed at the 10 o'clock and 2 o'clock position on the pipe. Pipes installed on slopes 4:1 and greater shall have all joints tie bolted.

Rubber gaskets at joints shall be installed according to the manufacturer's instructions when called for in the detailed plans and specifications. Joints whether gasketed or not shall comply with ASTM C443.

For pipes not utilizing gaskets each joint shall be effectively protected against infiltration of backfill soil by filling the joint space with an approved sealer, or by providing a circumferential wrap of drainage fabric on the outer exposed portion of the pipe joint above the cradle or bedding material. Drainage fabric shall be minimum 1-foot wide and centered on the joint. The Engineer shall require the use of construction adhesives if the Contractor's method of installation does not secure the drainage fabric over the center of the joint while placing backfill. A combination of sealer and drainage fabric materials will be allowed.

Lift holes shall not be permitted for round pipe 36-inch diameter and less. For pipe greater than 36 inches diameter, lift holes shall be plugged using a manufactured product intend for the purpose of plugging lift holes.

- C. Dual Wall Polypropylene (PP) Pipe:** PP pipe shall have water tight gaskets, and shall be installed per manufacturer's recommendations.
- D. PVC Pipe:** PVC drainage pipe shall be installed the same as sanitary sewer pipe per Section 11 of these specifications.
- E. Excavation:** Trenches shall be excavated to a width sufficient to allow for proper jointing of the pipe and thorough compaction of the bedding and backfill material under and around the pipe. Where soil type allows, trench walls shall be vertical to an elevation atop the pipe. Minimum trench width shall be per Section 11.

The trench foundation shall be adequate to furnish a uniform stable support. Removal of unstable material or rock below bedding grade shall be performed as set forth in Section 11.

F. Bedding:

- 1. RCP Pipe:** Bedding for RCP storm sewer pipes 72 inches and smaller shall be one of the following methods. Bedding for pipes larger than 72 inches in diameter shall be per detailed plans and specifications.
- a) Granular Bedding Method:** See detail 54-1, bedding thickness below the pipe in inches shall be the outer pipe diameter (OD) in inches divided by 24 (OD/24)

and no less than three (3) inches. Bedding beneath the pipe shall be in contact with the pipe for a distance no less than $1/3$ the outer diameter (OD/3). The bedding shall extend the full width of the trench. Minimum trench widths for pipes 36 inches and less shall be per Section 11. Minimum trench widths for pipe larger than 36 inches shall extend a minimum of one (1) foot beyond the outer edge of the pipe on both sides. This is similar to the American Concrete Pipe Association's Type 3 installation, except the trench compaction above the bedding shall be per Section 11 of these specifications.

b) Undercut Method: Material shall be excavated from below the bottom of the pipe grade for a depth of one (1) foot and for a width equal to the external diameter of the pipe plus one (1) foot. The excavated area shall be backfilled with select bedding material as defined below. Backfilling shall occur in maximum six (6) inch compacted lifts. The material shall be thoroughly compacted to provide a firm uniform foundation. The foundation shall then be shaped as a "cradle" to fit the lower ten percent (10%) of the pipe's overall height. Over excavation to accommodate the bell end of the pipe is required. When the pipe foundation is entirely in new embankment, the twelve (12) inch undercut will be waived, provided select bedding material was used for the embankment one (1) foot beneath the pipe.

2. PVC and PP Pipe: Bedding shall be per water or sewer main specifications in Section 11, or detailed plans and specifications.

G. Backfill: Backfill and compaction shall be per Section 11.

1. Select Bedding Material: shall begin above the bedding (54.3.F.1.a) or trench bottom (54.3.F.1.b above) and extend to 12 inches above the top of pipe.

H. Pipe Culvert Connections: Prefabricated tee connections are required up to and including twenty four inch (24") x twenty four inch (24"). Connections larger than twenty four inches (24") can be made by field connections. Field Connections shall be made using M6 concrete minimum 2 feet wide and 6 inches thick and shall be reinforced with 6 inch x 6 inch W2.9 wire mesh. Inserta Tee™ or approved equal shall be allowed up to 18 inches.

I. Pipe Culvert and Storm Sewer Testing and Inspection:

1. General: A visual inspection and a TV inspection shall be performed as specified herein for all pipe culverts and storm sewers as a condition of acceptance by the City. All tests shall be performed after backfill is complete but prior to any surface restoration. When called for in the plans and detailed specifications the contractor may also be required to perform a leakage test.

2. Pre-Cleaning: Prior to testing newly installed pipe culverts and storm sewers, the Contractor shall remove all accumulated construction debris, rock, gravel, sand, silt, and other foreign matter from the pipe. The Contractor shall be responsible for

all work necessary to make the pipe culverts and storm sewers acceptable for final acceptance.

- 3. Inspection:** All newly installed pipe culverts and storm sewers sewer shall pass a visual inspection by the Engineer, and a television inspection. Straight alignment shall be checked during installation using a laser beam. The television inspection shall consist of viewing the inside of all pipe culverts and storm sewers installed to determine proper alignment, grade, joining, etc. The Contractor shall, at his own expense, correct any defects discovered during visual or television inspection of the pipe.

- a) City Provided Televising:** If the City will be providing television inspection of storm sewer, it shall be explicitly stated in the plans. The expense of the initial television inspection prior to surfacing and final inspection after surfacing will be borne entirely by the City. If defects in workmanship, material, or construction are noted, the Contractor shall, at no expense to the City, correct the deficiencies including necessary concrete or asphalt surfacing. The City will perform one (1) additional television inspection to review if the repairs were made properly and in accordance with the specifications. The expense of any additional television inspections beyond the initial, final, and follow-up inspections will be borne entirely by the Contractor. The City may take any actions necessary for items not completed or repaired in a timely manner and may charge the contractor one and a half (1½) times the costs incurred.

It is the Contractors responsibilities to notify the City Inspector once the pipe culverts and storm sewers are ready for inspection. The City will not be responsible for cleaning lines prior to televising the pipe culverts and storm sewers. In the event that the pipe is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to clean the pipe culverts and storm sewers and make them acceptable for the television inspection. If not cleaned in a timely manner, the City may take actions necessary and charge the Contractor one and a half (1½) times the cost incurred. Contractor shall allow at least two (2) weeks from the time they notify the engineer that the system is ready to the time actual television inspection. Contractor shall allow one (1) additional week after the inspection for the City's approval or request for corrections. Any surfacing started prior to televising is at the Contractors own risk.

- b) Contractor Provided Televising:** Per section 205. Unless otherwise specified in plans, television inspection of storm sewer shall be provided by the contractor.

- 4. Pipe Deflection Test, Corrugated Polyethylene Pipe, and PVC Pipe:** When called for in detailed plans and specifications, deflection testing will be performed by the Contractor. For pipe diameters up to and including 18 inches in diameter, deflection testing is to be performed using a mandrel with at least five points and shall be inspected by the Engineer. The mandrel shall be pulled through by hand without the use of excessive force. Pipe through which the mandrel does not pass

shall be examined more closely to determine the reason for non-passage. Deflection testing shall be performed no earlier than thirty (30) days after completion of final grades and surfacing. Pipe that is determined to be over deflected shall be removed and reinstalled if the pipe is not damaged, or replaced with acceptable pipe. All pipe exceeding 7.5 percent deflection within the two-year warranty period shall be reinstalled or replaced by the contractor at no additional cost to the City.

- 5. Leakage Tests:** If required by plans and detailed specifications, the Contractor shall conduct leakage testing of all newly constructed or reconstructed pipe culverts and storm sewers. The Contractor shall furnish all necessary equipment and shall be responsible for conducting the leakage test in the presence of the Engineer.

Refer to the detailed specifications or notes in the plans for specific testing methods and requirements. Pipeline segments between drop inlets or storm sewer manholes shall be tested separately. Mechanical or pneumatic plugs shall be placed in the line at opposing drop inlets or storm sewer manholes and each plug braced as a safety precaution.

54.4 METHOD OF MEASUREMENT

- A. Furnishing and Installing Pipe Culverts and Storm Sewer:** Will be measured up to the nearest even two (2) linear feet of the respective type, classes, and sizes of pipe furnished, installed, and accepted. The footage will be obtained by measuring from the inside wall of structure to the inside wall of structure, and shall not include flared ends or end treatments.
- B. Furnishing and Installing Bends, Tees, and End Sections:** For the respective type and sizes of pipe culverts will be measured by the number of complete bends, tees, and end sections installed and accepted, including tie bolts or bands.

54.5 BASIS OF PAYMENT

- A. Furnishing and Installing Pipe Culverts:** Will be paid for at the contract unit price per linear foot for the respective designated types, classes, and sizes installed.

Payment for this item will be full compensation for furnishing and installing the pipe, gaskets, connecting devices, tie bolts, coupling bands, and joint fabric, and lift hole plugs. It will also be full compensation for necessary bedding operations, cost of selecting and placing backfill, furnishing and installing required bedding materials, undercut, testing, and necessary excavation.

- B. Furnishing and Installing Bends, Tees, and Flared End Sections:** Will be paid for at the contract unit price per each for the respective type and size installed, including tie bolts or bands.

END OF SECTION

SECTION 55

CAST IN PLACE CONCRETE STRUCTURES

55.1 DESCRIPTION

A. General: This work consists of false work and form construction and the furnishing, handling, placing, curing, and finishing of concrete for structures.

B. Related Work:

Section 57	Reinforcing Steel
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 103	Fly Ash
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 106	Masonry Mortar Sand Section
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Preformed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 123	Concrete Reinforcement
Section 203	Submittals

55.2 MATERIALS

A. Cement: Shall conform to the requirements of Section 100. Type II cement shall be used for all concrete.

B. Fine Aggregate: Shall conform to the requirements of Section 105.

C. Coarse Aggregate: Shall conform to the requirements of Section 107.

D. Water: Shall conform to the requirements of Section 104.

E. Admixtures: Shall conform to the requirements of Section 101 and 102.

F. Reinforcing Steel: Shall conform to the requirements of Sections 57 and 123. Epoxy coated rebar is not required unless otherwise specified in detailed plans and specifications, or per standard details.

G. Curing Materials: Shall conform to the requirements of Section 108.

H. Preformed Expansion Joint Filler: Shall conform to the requirements of Section 113.

- I. **Joint Sealer:** Shall conform to the requirements of Section 114.
- J. **Fly Ash:** Shall be per Section 103.
- K. **Grout:** Shall be a commercially available non-metallic, non-shrink grout capable of attaining a minimum compressive strength of 4500 psi and shall conform to the requirements of ASTM C1107.

55.3 CONSTRUCTION REQUIREMENTS

- A. **Quality and Proportion:** The Contractor shall design and be responsible for the performance of all concrete mixes used in structures. Mix designs shall be modified during the course of the work when necessary to assure compliance with the requirements for strength and consistency. All mix designs and any modification thereto, including changes in admixtures, shall be approved by the Engineer prior to use. The mix design shall produce a concrete conforming to the following requirements:

- Minimum cementitious material: 585 lbs/CY
- Maximum water cementitious material ratio: 0.45
- Slump Range at time of placement: 1 - 4½ inches
- Entrained air content range: 5.0 to 7.5 percent
- Minimum course aggregate content: 55 percent
- Minimum 28 day compressive strength: 4000 PSI

If contractor proposed using a well graded concrete mix design, the design shall be per SDDOT Standard Specification for Roads and Bridges Section 460.

The absolute volume method as described in the American Concrete Institute Publication 211.1 shall be used in selecting mix proportions. The mix design shall be based upon obtaining an average concrete compressive strength 1200 psi above the specified minimum 28 day compressive strength.

- 1. **Concrete Mix Design Performance:** When the Contractor proposes to use materials for concrete structures from sources not previously accepted by the City, the Contractor shall obtain independent, certified laboratory tests that verify that the materials meet the requirements in this section. Minimum number of tests is once each year per source unless otherwise ordered by the Engineer.

Satisfactory performance of the proposed concrete mix design shall be verified by laboratory tests on trial batches. The trial batches must be performed by a testing facility that also performs SDDOT trial batch testing. Trial batches shall be conducted in accordance with the American Concrete Institute Publication ACI 211.1, ACI 318, ASTM C192 and the following:

- a) A minimum of three trial batches shall be performed.
- b) The slump of each trial batch shall be within $\pm 3/4$ inch of the maximum specified.
- c) The air content of each trial batch shall be +0.5% to -1.0% of the maximum specified.

The results of each trial batch test shall be furnished by the Contractor to the Engineer at the time the proposed mix design is submitted. The as-batched results shall include the following: material weights, aggregate moistures, fresh concrete test results (slump, air content, unit weight, and mix temperature), water cementitious material ratios, aggregate gradations, compressive strengths, and aggregate qualities. In addition, aggregate supplier production test results shall be provided.

- 2. **Alternate Concrete Mix Design:** A concrete mix design previously approved will be considered in compliance with the mix design requirements provided all of the following conditions are met:

- a) The concrete mix proportions are in accordance with this section.
- b) The mix design, including all material and admixtures, are identical to those previously used and tested.
- c) The average 28 day compressive strength of 10 or more test results from an approved testing facility is at least 1.34 standard deviations above the specified strength. These test results and associated batch tickets shall be submitted to the Engineer. No more than 1 in 10 compressive strength test results may be below specified strength.
- d) The Contractor submits all supporting information for the mix design, including but not limited to, fresh concrete tests and material properties.

- B. **Determination of 28 Day Compressive Strength and Acceptance Criteria:** The Contractor will be responsible for the sampling, preparing, properly curing, and breaking of all concrete cylinders for concrete compressive strength in accordance with the SDDOT Materials Manual. The 28 day compressive strength shall be determined in accordance with SDDOT test SD 420. Results from concrete testing shall be provided to the Engineer within three (3) days of the test being performed.

The 28 day compressive strength acceptance criteria shall be as follows:

- 1. **Concrete Cylinder Testing:** If the 28 day cylinder compressive strength is greater than or equal to the specified 28 day compressive strength, the quantity of concrete represented by the cylinder shall be accepted.

If the 28 day cylinder compressive strength is less than the specified 28 day compressive strength, the backup cylinder shall be broken as soon as possible after breaking the 28 day cylinder. The compressive strength for the backup cylinder will be the strength at the time it was broken and will not be corrected back to a 28 day strength.

- 2. Backup Concrete Cylinder Testing:** If the backup cylinder compressive strength is greater than or equal to the specified 28 day compressive strength, the quantity of concrete represented by the cylinder shall be accepted.

If the backup cylinder compressive strength is less than the specified 28 day compressive strength by no more than 500 psi, the Engineer will determine if the unit is structurally adequate at the average compressive strength of the 28 day and the backup cylinder. If structurally adequate, the concrete will be allowed to remain in place and will be subject to price adjustment based on the average compressive strength of the two cylinders. If the analysis shows the average cylinder compressive strength is not structurally adequate, the concrete will be removed and replaced at the Contractor's expense.

If the average compressive strength of the 28 day and the backup cylinder compressive strength is more than 500 psi, below the specified 28 day compressive strength, the concrete represented by the cylinders shall be removed and replaced.

- 3. Suspect Test Results:** If there is some reason to suspect that the compressive strength test results are not valid due to a damaged concrete cylinder, malfunction of testing equipment, etc., or if the City or Contractor believes that the test results are not representative of the in place concrete, the City may require the Contractor to core the concrete represented by the cylinders. When cores are deemed necessary the additional testing and all costs will be borne by the Contractor. The coring and compressive testing shall be in accordance with the current edition of AASHTO T 24.

If the average core compressive strength is greater than or equal to the specified 28 day compressive strength, the quantity of concrete represented by the cylinders shall be accepted.

If the average core compressive strength is less than the specified 28 day compressive strength by no more than 500 psi, the Engineer will determine if the unit is structurally adequate at the lower compressive strength. If structurally adequate, the concrete will be allowed to remain in place and will be subject to price adjustment. If the analysis shows the average core compressive strength is not structurally adequate, the concrete will be removed and replaced at the Contractor's expense.

- 4. Coring & Compressive Testing:** If coring is directed by the City or chosen by Contractor as specified in this section, the Contractor shall arrange for an independent testing laboratory to perform the coring and compressive testing

within 14 calendar days of notification. The independent testing laboratory must be approved by the Engineer prior to starting the coring and compressive testing. The coring and compressive testing shall be in accordance with the current edition of AASHTO T 24.

The independent testing laboratory will take three (3) cores of the area representing the cylinders in which the compressive strength is in question and test them for compressive strength. The coring and compressive testing shall be witnessed by the Engineer.

The Contractor will be responsible to locate the reinforcing steel prior to coring. It is critical that the coring operation avoids all reinforcing steel. The core holes shall be grouted with a grout that conforms to Section 55.2.K

The average compressive strength of three (3) cores will be used for the determination of acceptance of concrete represented by each set of 28 day cylinders. One core's compressive strength may be 15% below the specified strength if the average of the 3 core's compressive strength is above the specified strength. ASTM E178 (Standard Practice for Dealing With Outlying Observations) will be used with the 10% significance level to deal with excessively high or low core strengths. If a core compressive strength is an outlier, then the set of cores will be averaged using the 2 remaining cores.

The average compressive strength of the cores will prevail over all other compressive strength determination methods.

If it is determined by the additional testing that the 28 day compressive strength is less than that specified, all costs for the coring and compressive testing will be borne by the Contractor and the concrete shall be either accepted or rejected as per this section.

The following information shall be provided for each core taken:

- Include City project number and project name.
- Core identification number & location of each core (representing cylinder number, structure number, location of cores sketch, date concrete was cast, date cores taken, date cores tested)
- Age of the concrete at the time of testing.
- Length & diameter of each core tested.
- Unit weight of each core.
- End preparation (capped or neoprene).
- Date of last calibration of the compression machine.
- What, if any, correction factor was used to compute the compressive strength.
- Actual calculations including load & cross-sectional area.
- Type of fracture as per ASTM C39. Note if the bond to the coarse aggregate is not adequate due to cement adhesion.
- Any defects in either the core or the cap.

C. Equipment: Shall be available in advance of the start of construction operations to allow for thorough examination by the Engineer.

1. Batching Equipment: Shall be automatic or previously approved by the Engineer.

The Contractor shall provide satisfactory means for obtaining material samples from the batching plant.

Batching plant structures shall be leveled so the accuracy of the weighing mechanism is maintained.

Hoppers shall fully discharge without jarring the scales.

Clearances between scale parts, hoppers, and bin structure shall be maintained to avoid displacement of, or friction between, parts due to materials accumulations, vibration, or other cause. Exposed fulcrums, clevises, and similar working parts shall be kept clean.

To maintain accuracy, weighing hoppers and other parts which are affected by wind action shall be protected by shelters or wind breaks.

The scale display shall be completely enclosed in weather proof cases and provided with glass opening to permit observation and reading.

The equipment for weighing aggregates, cement, water, and admixtures shall be an integral part of the batching equipment. The scales/load cells shall be accurate within 0.5% at any point throughout the range of the scale/load cell. Graduations shall be not greater than 0.1% of the capacity of the scale/load cell. The scales/load cells shall be sensitive to the weight indicated by one graduation.

The following controls shall apply to the aggregate batching equipment:

- The batching equipment shall operate within a delivery tolerance of 1.5% of the net weight for each aggregate weighed.
- The hopper inlet mechanism shall be interlocked against opening when the discharge gate is open.
- The hopper discharge mechanism shall be interlocked against opening while the hopper is being charged.

The hopper discharge mechanism shall be interlocked against opening if any material in the hopper is either overweight or underweight by more than 1.5% of the specified weight.

The cement batching equipment shall operate within a delivery tolerance of 1% of the net weight of the cement per batch. The cementitious material (cement and fly ash) batching equipment shall also operate within a delivery tolerance of 1% of the net weight of the total cementitious material per batch.

Water may be measured by volume or weight. The measuring equipment shall operate within a delivery tolerance of 1% of the net weight or volume of water.

When water is measured by volume, means for determining the accuracy of the measuring device shall be provided.

Air-entraining or other admixtures may be measured by volume or by weight. The measuring equipment shall operate within a delivery tolerance of 3% of the net weight or volume per batch.

2. Computerized Batching Equipment: The following provisions shall apply to all Class A or Class M concrete batched by computerized batching equipment:

A printed, computer generated, ticket shall be automatically produced for each load of concrete batched. The printed computer ticket shall accompany each load of concrete to the project and shall be presented to the Engineer prior to discharging the load at the project site unless the Engineer approves an alternate procedure.

The printed ticket must contain the following minimum information:

- Truck Number
- Date and Time batched
- Total volume of the load, in cubic yards
- Mix Design Number or Mix Type
- Actual weight (mass) or volume of each component of the mix:
 - Coarse Aggregate
 - Fine Aggregate Cement
 - Fly ash
 - Water (batch water)
 - Admixtures
 - Air Entraining
 - Water Reducers
 - Retarders
 - Accelerators
 - Others
- % Moisture in Aggregate (either % free moisture or % total moisture)
- Maximum Water Allowed
(maximum water allowed = weight of mix design water - weight of free water)
- W/C ratio (as-batched)

The final W/C ratio, for acceptance, shall be calculated using the following formula and rounded to the nearest 0.01:

$$\text{W/C ratio} = \left(\frac{\text{weight of free water} + \text{weight of batch water} + \text{weight of added water}}{\text{weight of cement} + \text{weight of supplementary cementitious material}} \right)$$

% free moisture =	% total moisture in aggregate - % absorption of aggregate
weight of free water =	% free moisture x weight of aggregate
weight of batch water =	total weight of water added to the batch either at the plant or in the truck
weight of added water =	total weight of water added after batching process (typically added at point of delivery)

The weight of free water shall be calculated for both the fine aggregate and the coarse aggregate.

The above information must be automatically printed in such a manner that the Engineer may verify the mix adheres to the proportions specified by the design mix.

- 3. Mixing and Hauling Equipment:** Mixers and agitators shall have attached in a prominent place, a manufacturer plate or plates showing the various uses for which the equipment is designed and the capacity of the drum or container in terms of volume of mixed concrete.

The pick-up and throw-over blades in the drum shall be restored or replaced when any part or section is worn 3/4 inch or more below the original height of the manufacturer's design. The Contractor shall maintain a copy of the manufacturer's design, showing original dimensions and arrangement of blades. Mixers that have an accumulation of hard concrete or mortar shall not be used.

Mixers, except truck mixers, shall be equipped with an approved timing device to track the total mixing time of the concrete batch.

Truck mixers shall be equipped with counters to record the number of revolutions of the drum or blades. The revolution counter on the truck mixers shall be set to zero as each new load is batched.

Mixers shall be capable of combining the concrete ingredients into a thoroughly mixed and uniform mass and shall uniformly discharge the concrete.

The hauling bodies of non-agitating equipment shall be smooth, mortar-tight metal containers equipped with gates and vibrators that will permit uniform control of the discharge of the concrete.

- 4. Wood Forms:** Forms shall be designed, built, and maintained to sustain the pressure and weight of the concrete and construction loads. The design of the forms shall consider the effect of vibration of the concrete as it is placed.

Forms and form lumber shall be clean and in good condition. Lumber that is split, warped, bulged, marred, or that has other defects shall not be used.

Forms for concrete surfaces shall be constructed to produce mortar tight joints with smooth even concrete surfaces. Forms shall be filleted at all sharp corners and shall be given a bevel or draft in all projections, such as girders and copings.

Metal ties and anchorages within the forms shall be constructed to permit placement without injury to the concrete. Ties used in the presence of epoxy coated reinforcement shall be epoxy coated or made of other corrosion resistant material. If ordinary or epoxy coated wire ties are permitted, all wires shall be cut back at least 1/4 inch from the face of the concrete after the forms are removed. Fittings for metal ties shall be designed so on removal the resulting cavities will be the smallest practical size.

Forms shall be set and maintained true to the line designated. When forms appear to be unsatisfactory, either before or during the placing of concrete, the Engineer may order the work to be stopped until the defects have been corrected.

Forms shall be surface treated with an approved form oil or saturated with water immediately before placing the concrete. For members with exposed faces, the forms shall be surface treated with an approved form oil to prevent the adherence of concrete. Material which will adhere to or discolor the concrete shall not be used.

5. **Metal Forms:** The requirements for wood forms in regards to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, reuse, and oiling shall apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. Bolt and rivet heads shall be countersunk. Clamps, pins, and other connecting devices shall hold the forms rigidly together and allow removal without injury to the concrete. Metal forms, which do not present a smooth surface or line up properly, shall not be used. Special care shall be exercised to keep metal forms free from rust, grease, and other foreign matter, which will discolor and contaminate the concrete.
 6. **False Work:** False work associated with bridge construction shall require structural engineering design calculations and shall be in accordance with SDDOT Standard specifications for Roads and Bridges.
- D. Handling, Measuring, and Batching Materials:** The separate aggregate components shall not become intermixed prior to being weighed and the weigh hopper or hoppers shall be charged so the batched weights are within the tolerances of this section.
1. Cement shall be measured by the sack or by weight. When cement is weighed, separate scales and hoppers shall be used with a device to indicate positively the complete discharge of the batch of cement into the mixing drum.
 2. Admixtures shall be used in accordance with the manufacturer's recommendations. When multiple types of admixtures are being used, the admixtures shall be individually dispensed. Compatibility of the admixtures shall be verified prior to use.
 3. The amount of batch water and aggregates added to the mix shall be adjusted accordingly using the results of the most recent moisture tests. Moisture shall be

measured by the supplier at regular intervals. Automatic moisture sensing equipment may be used, and shall be properly calibrated.

- E. Mixing Concrete:** Concrete shall be mixed at a central stationary plant site or in truck mixers.

Mixing and agitating speeds shall be as designated by the manufacturer of the equipment. Mixers shall not be charged in excess of the rated capacity.

When a concrete batch is transported in a truck mixer or agitator and the batch is smaller than 60% of the rated capacity of the truck mixer or agitator, the following percentage of additional cementitious material at the same proportions as listed on the mix design shall be added to the batch:

Percent of Rated Capacity	Additional Cementitious Material Required
40% to 60%	5%
20% to 39%	10%
10% to 19%	15%
0% to 9%	20%

The above provisions regarding additional cementitious material shall also apply to the mixing of small batches in central plants. Additional cementitious material will not be required when the small batch is mixed in a drum that is sufficiently coated with mortar to withstand the loss of cementitious material. Sufficient mortar coating, as determined by the Engineer, may include mortar coating the drum from a previously mixed batch during continuous mixing operations. Additional cementitious material will be required if more than 30 minutes has passed from the mixing of the previous batch, if the drum has been cleaned following the previous batch, or if the mortar coating the drum has been disturbed following the previous batch.

- 1. Central Plant Mixing:** The batch shall be charged in the drum so a portion of the mixing water enters in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period.

Concrete shall be mixed for a period of not less than one minute after all materials, are in the mixer.

Concrete mixed less than the specified mixing time shall be discarded and disposed of.

- 2. Truck Mixing:** Original mixing time for truck mixed concrete shall be not less than 70 or more than 100 revolutions of the drum at mixing speed after all ingredients, including water, are in the drum. Additional revolutions beyond 100 shall be done at agitating speed.

The mixing water shall be added at the time of batching. Additional water, cement, or admixtures may be added to the full load after completion of the original mixing, provided that slump, entrained air, and water cement specifications are adhered to. Addition of water, cement, or admixtures to partial loads is not allowed (partial loads of concrete are defined as loads that have been partially discharged). Admixtures shall be added in accordance with the manufacturer's recommendations. When additional water, cement, or admixture is added, the batch shall be mixed an additional 30 revolutions at mixing speed. The Contractor shall provide means to accurately measure the amount of additional materials added.

- 3. Water/Cementitious Material Ratio:** The water/cementitious material ratio of the concrete placed shall not exceed the maximum water/cementitious ratio established for the mix design.
- F. Limitations of Mixing:** Concrete shall be mixed in the quantities required for immediate use and shall be placed before initial set has occurred. Concrete in which initial set has begun prior to beginning placement shall be wasted at the Contractor's expense. Retempering of concrete after initial set has occurred will not be allowed.

Concrete shall not be mixed and placed unless the natural light is sufficient for finishing operations, or an adequate artificial lighting system is provided.

Mixing water shall not be heated above 160°F. Aggregates shall not be heated above 100°F and shall be free of frozen lumps, ice, and snow.

- G. Delivery Requirements:** When concrete is continuously agitated in the hauling unit, the concrete shall be discharged within 90 minutes after the cement has been placed in contact with the aggregates and discharged and screeded within 105 minutes after the cement has been placed in contact with the aggregates. When the concrete temperature is 80°F or above, the time limitation shall be reduced to discharged within 45 minutes and discharged and screeded within 60 minutes.

When concrete is not continuously agitated in the hauling unit, the concrete shall be discharged within 45 minutes after the cement has been placed in contact with the aggregates and discharged and screeded within 60 minutes. When the concrete temperature is 80°F or above, the time limitation shall be reduced to discharged within 30 minutes and discharged and screeded within 45 minutes.

The rate of delivery of concrete shall be uniform. The interval between batches shall not exceed 30 minutes.

For delivery of concrete in remote locations where the preceding concrete delivery requirements will be difficult to meet, the Contractor may be allowed to use a set retarding admixture to control initial set when approved by the Engineer. When set retarding admixtures are allowed, the concrete delivery requirements may be adjusted with approval from the Engineer.

- H. Construction Tolerances:** Construction tolerances shall be in accordance with the latest edition of ACI 117, Standard Tolerances for Concrete Construction and Materials.
- I. Placing Concrete:** The Contractor shall give sufficient notice before starting to place concrete to permit inspection of forms, reinforcing steel, and preparation for placing. Concrete shall not be placed without approval of the Engineer.

Placement of concrete on a frozen foundation will not be permitted. The surface temperature of forms, steel, and adjacent concrete which will come in contact with the concrete being placed shall be raised to a temperature above freezing prior to placement.

The temperature of concrete immediately after placing shall not be less than 50°F or more than 90°F. The top limit for bridge deck concrete shall be 80°F except as indicated below.

The slope of chutes for concrete placement shall allow the concrete to flow slowly without segregation. The delivery point of the chute shall be as close as possible to the point of deposit. Chutes and spouts shall be kept clean and shall be thoroughly flushed with water before and after each run. The flush water shall be discharged outside the forms.

Free fall of concrete shall not exceed five (5) feet. In thin walls or columns where the reinforcement prohibits the use of chutes the method of placement shall prevent objectionable separation of coarse aggregate.

The sequence of placing concrete, including the location of construction joints, shall be as specified. Concrete shall be placed in continuous horizontal layers. Each subsequent layer shall be placed before the preceding layer has attained its initial set.

The concrete shall be consolidated by vibrating internally, externally, or both without displacement of reinforcing or forms. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete without causing segregation; localized areas of grout; or damage to concrete, forms, and reinforcement.

Vibration shall not be applied directly to reinforcement which extends into sections or layers of concrete which are not plastic under vibration. Vibrators shall not be used to move concrete over distances or to transport concrete in the forms.

Accumulations of mortar splashed upon the reinforcing steel and the surfaces of forms shall be satisfactorily removed. Care shall be exercised not to injure or break the concrete to steel bond at and near the surface of the concrete while cleaning the reinforcing steel.

- J. Surface Finish:** The surfaces of all structural concrete shall be worked during placing. The working shall force all coarse aggregate from the surface and thoroughly work the

mortar against the forms to produce a smooth finish relatively free of water, air pockets, and honeycombing.

As soon as the concrete has set in accordance with Section this section the forms on all exposed surfaces shall be carefully removed and all depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the same proportions as the concrete being treated. All fins and rough corners on the surfaces shall be removed to present a neat and uniform appearance.

Concrete flatwork shall be finished per appropriate section of these Standard Specifications.

Additional finishing will be required as follows:

Rubbed, Brushed, and Commercial Texture Finishes: One of these three finishes will be required for all railing, curbs, parapets, wing walls, Type "C" walls, and other surfaces not subject to wear which are visible to the traveling public unless otherwise designated in the plans. The selected finish shall be used throughout the entire structure, except the finish for the top and inside of the curb may be different than that used for the other parts of the structure. These finishes will not be required on surfaces which are not visible to the traveling public such as box culvert wing walls, box culvert parapets, bridge wing walls, and backsides of curbs on bridges, provided the forms result in a smooth unblemished surface.

Begin finishing as soon as the forms are removed. Remove fins and irregular projections from surfaces that are exposed or will be waterproofed. Remove bulges and offsets with carborundum stones or discs. Remove localized, poorly bonded rock pockets or honeycombed concrete, and replace with sound concrete or packed mortar in an approved manner.

Clean and point form tie cavities, holes, broken comers and edges, and other defects. Saturate the area with water. Finish the area with mortar that is less than 1-hour old. After the mortar is set, rub it (if required) and continue curing. Match exposed surfaces to surrounding concrete.

Carefully tool and remove free mortar and concrete from construction and expansion joints. Leave joint filler exposed for its full length with clean, true edges.

1. Rubbed Finish: As soon as the pointing has set sufficiently, the surfaces to receive a rubbed finish shall be thoroughly wetted with a brush and rubbed with a medium coarse carborundum stone or an abrasive of equal quality using a small amount of mortar on stone face. The rubbing shall be continued until all form marks and projections are removed, producing a relatively smooth clean surface free from pits or irregularities.

The final finish shall be obtained by rubbing with a fine carborundum stone or an abrasive of equal quality. This rubbing shall continue until the entire surface has a smooth texture and a uniform color.

Unless otherwise specified in plans, Type "C" walls shall receive a rubbed finish.

2. **Brushed Finish:** This finish will be permitted only if it is accomplished within 12 hours of concrete placement. The forms shall be removed as soon as the concrete is able to stand firm without slumping. The surface shall be worked with a rubber float which may be dipped in a very wet three parts sand to one part cement grout mixture. Immediately after the surface is worked into a lather, a soft bristle brush shall be used to smooth the surface, leaving a fine grained, smooth but sanded texture. A "plastering" job resulting from the use of an excess of grout on the surface will not be permitted. Linseed oil cure shall be added immediately after the brushed finish operation, and shall be maintained for the remainder of the curing period.
3. **Commercial Texture Finish:** The objective is to obtain a surface that is reasonably smooth and uniform in texture and appearance. Repairing surface blemishes (bug holes, form lines, etc.) to prevent "show through" prior to application of the commercial texture finish is required. The commercial texture finish shall be performed using an approved system listed in the detailed plans and specifications and approved by the Engineer. The Contractor is required to provide a copy of the manufacturer's recommendations to the Engineer prior to performing any commercial texture finish work.

Unless otherwise noted in the manufacturer's recommendations, commercial texture finish shall not be applied to any surface until the concrete is a minimum of 28 days old. The surfaces to receive commercial texture finish shall be abrasive blast cleaned to break the surface film, to remove all laitance and other foreign material, and to provide an absorptive surface. When allowed in the manufacturer's recommendations, pressure washing may be used to prepare the surface in lieu of abrasive blast cleaning.

The commercial texture finish mixture shall be mixed in accordance with the method specified in the approved list for the system being used. The same materials and application method shall be used for all surfaces on any one structure.

Commercial texture finish mixtures may be applied by a brushing, rolling, or by spraying, as per the manufacturer's recommendations. The mixture shall cover the original surface with a one coat application. The one coat application shall not be too thick to cause runs, sags, or a plastered effect. After drying, the final surface shall be uniform in color and texture with no laps or breaks in continuity. The color of the system shall closely simulate the color of the original concrete, unless otherwise specified on the plans.

The application of the commercial texture finish shall not be started until all other work that could damage the finish has been completed. The finishing operations shall be continuous until completion of the finish application on any one surface. Corrective work, at the Contractors expense, will be required on any surfaces

which have not been satisfactorily finished or on finished surfaces that have been damaged during subsequent work. The repair work will include as much adjacent surface area as necessary to achieve a uniform appearance.

K. Curing Concrete: Begin curing immediately after the free surface water has evaporated and the finishing is complete. If the surface of the concrete begins to dry before the selected cure method can be implemented, keep concrete surface moist using a fog spray without damaging the surface.

1. **Forms In-Place Method:** Forms remaining in place shall be considered as adequate cover for curing for the number of days such forms remain in place, providing all exposed concrete surfaces are so covered. Curing shall continue for a period of not less than seven (7) days after placing the concrete. Other precautions to insure development of strength shall be taken as the Engineer may direct.
2. **Liquid Membrane Curing Compound Method (Linseed Oil Cure):** White pigmented linseed oil-based emulsion compound shall be used. The compound shall be uniformly applied after the final finishing operations are completed and immediately after the free water has left the surface.

The curing compound may be applied in either one or two applications in accordance with the direction of the manufacturer. If applied in two coatings, the second shall not be applied later than 30 minutes after the first.

Equipment, workmen, and materials will not be allowed on the surface for a minimum of seven days after application of the curing compound, unless the surface is adequately protected with an approved material. This protection shall not be applied for at least eight hours after application of the curing compound. If the membrane film is broken or damaged within the seven (7) day curing period, the areas affected shall be given a duplicate treatment of the curing material, at the same application rate as the first treatment.

Application of linseed oil base emulsion curing compound shall conform to the following requirements:

- a) Prior to application, the material shall be mixed to a uniform consistency without the use of air, violent agitation, or thinning.
- b) The material shall be maintained above 50°F during application.
- c) The material shall be spray applied with an applicator of sufficient capacity and spray nozzles of proper size and design to provide a uniform application at the specified rate immediately after the concrete has received the final finish.
- d) Unless otherwise provided on the plans or ordered by the Engineer, minimum application rate shall be as follows:

- 1) Carpet drag or broom finish - one gallon/150 square feet
- 2) Steel tine finish - one gallon/125 square feet

- 3. Curing for Special Surface Finish:** For surfaces that are not to be cured with linseed oil curing compound, such as Type "C" walls, forms shall remain in place for minimum 72 hours. Keep surfaces to be rubbed moist after forms are removed. Cure immediately with linseed oil curing compound following the first rub. For formed surfaces, leave the forms in-place without loosening. If forms are removed during the curing period to facilitate rubbing, only strip forms from those areas able to be rubbed during the same shift.

Surfaces, which are to receive a rubbed finish or a brush finish, shall be cured by a method other than linseed oil cure until the rubbing or brushing has been completed, after which the linseed oil cure shall be used as directed above, and maintained for the duration of the cure period.

Surfaces which are to receive a commercial texture finish, or colored concrete, shall be cured by a method other than linseed oil cure. Linseed oil curing compound will not be allowed on any surface to which concrete is to be bonded.

- L. Protection of Concrete:** The following provisions apply to all type of concrete except PCC concrete pavement.

Vibrations caused by any work activities that may be detrimental to the freshly placed concrete will not be allowed for at least 72 hours after placement or until the concrete has attained a minimum compressive strength of 1600 psi. If the Engineer suspects that construction activities may be causing excessive vibration, a 2 inch x 4 inch stake shall be driven solidly into the ground adjacent to the freshly placed concrete. A small container of water shall then be placed on top of the stake. If the water surface remains calm, the construction activity will be allowed to continue. When the water surface shows any movement, vibrations are reaching the freshly placed concrete and the construction activities shall be either stopped or altered such that vibrations at the freshly placed concrete are eliminated.

Enclosures for protection of concrete shall be capable of maintaining the temperature specified and permit free circulation of artificial heat. Open flame type heating units are prohibited.

Form insulation shall be bats of fiberglass, rockwool, balsam wool, or similar commercial insulation material. Insulation shall remain in place for the full protection period. The forms may be loosened slightly to control the temperature of the concrete below the maximum value specified.

The Contractor shall install a min-max (a.k.a. high-low) thermometer at locations determined by the Engineer, to determine the concrete temperature when the forecasted air temperature will drop below 40°F.

1. Concrete for sidewalks, curb and gutter, fillets, drop inlets, manholes, pipe headwalls, driveway pavement, etc. shall be maintained above 35°F until it has attained 1500 psi compressive strength.
2. Concrete for box culverts, retaining walls, anchor blocks, median barriers, light and signal footings, and other structures shall be maintained at a temperature of 50°F or above for the first 72 hours after the concrete has been placed. The concrete shall be maintained at a temperature of 40°F or above for the next 48 hour period. If low temperatures are recorded during this protection period, one extra day of protection time above 40°F shall be added to the original five days of protection for each day that the minimum concrete temperature falls below the specified temperature.

If an additional bag of cement per cubic yard is used, or if high early strength cement is permitted, the concrete shall be maintained at a temperature of 60°F or above for 72 hours. If temperatures less than 60°F are recorded during this protection period, the protection time required shall revert back to that in the preceding paragraph with its provision for low temperatures also being applicable.

Until one of the protection periods have been satisfied, cold weather protection shall continue, falsework shall remain in place, live loads shall not be applied, and the concrete temperature shall be maintained above 35°F.

At the end of the protection period, the concrete temperature shall not be permitted to fall more than 40°F in each subsequent 24 hour period.

The surface temperature of concrete protected by housing and heating or insulated forms shall not exceed 100°F during the protection period.

It will be permissible to flood concrete with water to a minimum depth of 1 foot for 10 calendar days after the concrete is placed maintaining a water temperature which prevents freezing of the water in contact with the concrete.

- M. Removal of Formwork and Construction of Superimposed Elements:** In the determination of the time for the removal of false work and forms, consideration shall be given to the location and character of the structure, the weather, and any other conditions influencing the setting of the concrete.

Methods of removal of temporary works likely to cause overstressing of the concrete shall not be used. Temporary works shall be removed such that the concrete gradually and uniformly takes stresses due to its own weight.

Falsework, forms and other temporary works shall not be removed and superimposed elements shall not be placed without the approval of the Engineer. Falsework and forms may be removed from the affected concrete and placement of superimposed elements may proceed when the concrete reaches the strength specified in Table 1. Concrete compressive strength shall be used as the basis for falsework removal, form removal, and placement of superimposed elements whenever possible. Falsework

removal, form removal, and superimposed element placement may be allowed on the basis of time only when concrete compressive strength is not able to be determined and shall not include periods of time when the temperature is below 40°F.

Table 2

Structural Elements	Formwork/Form Removal		Placement of Superimposed Elements	
	Concrete Strength psi	Time	Concrete Strength psi	Time
Footings/Sleeper Slabs	800	24 hrs.	1600	72 hrs.
Box Culvert:				
Floor, Wing Wall Footings	800	24 hrs.	1600	72 hrs.
Walls	800	24 hrs.	3000	20 days
Top Slab	2000	12 days	1200	48 hrs.
Other Vertical Surfaces not Carrying Load	800	24 hrs.		

For removal of formwork associated with structures not listed in Table 1 refer to SDDOT Standard Specifications.

- N. Backfilling and Application of Liveload:** All concrete shall attain full design strength and all falsework shall be removed prior to backfilling and applying highway live loads to the structure. Construction vehicles, materials, and equipment weighing less than 4,000 pounds in total will be allowed on any span, provided the most recently placed concrete has attained a compressive strength of 2,400 psi. Loads over 4,000 pounds will not be allowed until the concrete has attained design strength and all falsework has been removed.

The only exceptions are that footings, curb and gutter, and sidewalks shall not be backfilled until permission has been given by the Engineer.

Backfill material shall be placed in accordance with the associated specification section.

Luminaires, sign poles, and signals shall not be installed on their footings until the concrete has reached full design strength.

- O. Joints:** Shall be constructed at the locations and of the dimensions shown on the plans or as directed by the Engineer. In joining fresh concrete to that which has already set at a construction joint, the concrete in place shall have all loose material removed.
- P. Concrete Quality Tests:** The Contractor is to be responsible for slump, air content, seven (7) and twenty-eight (28) day compressive strength test sets unless otherwise indicated in detailed plans and specifications. All sampling and testing shall be done by certified testing laboratory and American Concrete Institute (ACI) certified personnel.

Testing shall be done at the rate of one test set per maximum 30 cubic yards of concrete placed. All test results shall be submitted to the Engineer prior to final payment. The Engineer or his representative shall be present for all field sampling.

55.4 METHOD OF MEASUREMENT

Measurement of concrete structures shall be per the associated specification section.

55.5 BASIS OF PAYMENT

Payment for concrete structures shall be per the associated specification section.

Payment will be full compensation for materials, labor, equipment and tools necessary, concrete, reinforcing steel, joint sealer, plastic sheeting, preformed expansion joint material, sawing, testing, curing, finishing, and incidentals.

END OF SECTION

SECTION 56

CLASS M6 CONCRETE FOR CURB & GUTTER AND FLATWORK

56.1 DESCRIPTION

A. General: This work consists of site preparation, form construction, and the furnishing, handling, placing, curing, and finishing of Class M6 concrete for minor structures and incidental construction.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 55	Cast in Place Concrete Structures
Section 57	Reinforcing Steel
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 103	Fly Ash
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 106	Masonry Mortar Sand
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Prefomed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 123	Concrete Reinforcement
Section 203	Submittals

56.2 MATERIALS

A. Cement: Shall conform to the requirements of Section 100. Unless otherwise specified, Type II cement shall be used.

B. Fine Aggregate: Shall conform to the requirements of Section 105.

C. Coarse Aggregate: Shall conform to the requirements of Section 107.

D. Water: Shall conform to the requirements of Section 104.

E. Admixtures: Shall conform to the requirements of Sections 101 and 102.

F. Reinforcing Steel: Shall conform to the requirements of Sections 57 and 123.

G. Curing Materials: Shall conform to the requirements of Section 108.

H. Joint Filler: Shall conform to the requirements of Section 113.

I. Joint Sealer: Shall conform to the requirements of Section 114.

J. Fly Ash: Section 103.

56.3 CONSTRUCTION REQUIREMENTS

The supplier of Class M6 Concrete will be required to furnish a written statement certifying that the concrete furnished meets the applicable requirements of Section 56 for Class M-6 concrete.

A. Concrete Quality and Proportion: Class M6 concrete shall be used for curb & gutter, sidewalk, approach pavement, driveways, fillets, and drain pans. For mainline Portland Cement Concrete Pavement refer to Section 40.

Class M-6 concrete shall meet the following requirements:

1. The concrete aggregate mixture shall contain a minimum of fifty percent (50%) coarse aggregate by weight.
2. The mixture shall contain at least six hundred (600) pounds of Cementous material per cubic yard.
3. The minimum twenty-eight (28) day compressive strength shall be four thousand (4000) psi.
4. The slump at time of placement shall be maintained between 1 inch and 4½ inches.
5. The entrained air content for cast in place concrete shall be 6.5% plus 1.0% minus 1.5%.

B. Equipment, forms, mixing and hauling concrete, delivery, placement, joints, curing, protection of concrete, testing, form removal, and surface finish shall be in conformance with Section 55.

56.4 METHOD OF MEASUREMENT

Measurement of Class M6 concrete shall be per the associated specification section.

When called for in detailed plans and specifications concrete test sets shall be measured per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental various bid items.

56.5 BASIS OF PAYMENT

Measurement of Class M6 concrete shall be per the associated specification section.

When called for in detailed plans and specifications concrete test sets shall be paid for per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental various bid items.

Payment will be full compensation for materials, labor, equipment and tools necessary, including concrete, reinforcing steel, joint sealer, plastic sheeting, preformed expansion joint material, sawing, testing, and incidentals required to furnish Class M6 concrete in place.

END OF SECTION

SECTION 57

REINFORCING STEEL

57.1 DESCRIPTION

A. General: This work consists of furnishing and placing steel of the specified size and type, as reinforcement in concrete.

B. Related Work:

Section 55	Cast in Place Concrete Structures
Section 100	Portland Cement
Section 123	Concrete Reinforcement
Section 203	Submittals

57.2 MATERIAL

Reinforcement shall conform to Section 123. Reinforcement shall be furnished in the full lengths indicated on the plans.

57.3 CONSTRUCTION MATERIALS

A. Protection of Material: Reinforcing steel shall be protected from damage and when placed in the work it shall be free from dirt, detrimental scale, paint, oil, and other foreign substance. Steel reinforcement shall be stored above ground on platforms, skids, or other supports.

When epoxy coated steel reinforcement is specified, the following requirements also apply:

1. In order to protect the coated reinforcement from damage, the Contractor shall use padded or non-metallic slings or straps to load, unload, or move epoxy coated reinforcement.
2. Bundled bars shall be handled in a manner as to prevent excessive sagging of the bars so as not to damage the epoxy coating.
3. To prevent damage to the epoxy coating, care shall be taken during placement of epoxy coated reinforcement to ensure the bars are not dropped or dragged.
4. Damaged areas shall be repaired by removing all rust and contaminants from the damaged area and applying an epoxy coating to the damaged area. The touch up epoxy coating material shall be inert in concrete and compatible with the original epoxy coating and the reinforcing steel. This coating material shall be epoxy coating touch up material supplied by an epoxy coating manufacturer who supplies

coating material for new epoxy coated reinforcing steel. Touch up epoxy coatings from spray cans will not be permitted. The touch up epoxy coating shall be allowed to cure for a minimum of 24 hours or as per the manufacturer's recommendations, whichever is more stringent, before concrete is placed.

5. Epoxy coated reinforcing steel shall be covered with a heavy duty waterproof opaque covering to protect the epoxy coating from dirt and debris and from the effects of ultraviolet rays if the reinforcing steel will be stored for more than 30 calendar days.

B. Bending: Reinforcement shall be bent to the shapes specified. Bending and bundling shall conform to the standard practice currently specified by the Concrete Reinforcing Steel Institute.

C. Placing and Fastening: Reinforcing steel shall be accurately placed in accordance with the tolerances of ACI 117 and firmly held in the positions specified using steel chairs or other approved methods. Bars shall be tied at all intersections (100%) when spacing is 1 foot or more in any direction (longitudinal, vertical, or horizontal), otherwise a minimum of every other intersection (50%) shall be tied.

All lap splices shown are contact lap splices unless specifically noted otherwise.

1. **General:** Distances from the forms shall be maintained by stays, blocks, ties, chairs, or hangers. Devices for holding reinforcement from contact with the forms shall be of approved shape and dimensions. Layers of bars shall be separated by approved metal devices. The use of pebbles, stone, brick, metal pipe, and wooden blocks will not be permitted.

Wire bar supports, such as ferrous metal chairs and bolsters, shall conform to industry practice as described in the manual of Standard Practice of the Concrete Reinforcing Steel Institute. Chairs or bolsters which bear against the forms for exposed surfaces shall be either Class 1 - Maximum Protection (plastic protected) or Class 2 - Moderate Protection, Type B (stainless steel tipped) for which the stainless steel conforms to ASTM A493, Type 430. Chairs or bolsters which are earth bearing shall be Class 3 - No Protection (bright basic bar supports). For epoxy coated reinforcement, all wire bar supports and bar clips shall be plastic or epoxy coated.

Chair spacing will not exceed 3 feet 6 inches in either direction. If plastic chairs are used, chair spacing will not exceed 2 feet 6 inches in either direction. The Engineer may require a closer chair spacing for mat rigidity.

Tie wires shall be black-annealed 16 1/2 gauge or heavier. Ties shall be plastic coated when used in conjunction with epoxy coated reinforcing steel.

Welding of reinforcing steel shall not be allowed without written approval of the Engineer. The request for approval shall list the bars to be welded, welding

procedure, type of electrode, joint detail, and mill certificate of the reinforcing steel to be welded.

Reinforcement shall be inspected and approved, before the placing of concrete begins. The placing of any reinforcement except mesh during the process of placing the concrete will not be permitted. Concrete placed in violation of this provision may be rejected and ordered removed.

- 2. Structures:** When placing bridge deck and box culvert reinforcement either slab bolster (SB) or beam bolster (BB) bar supports shall be used between the mats or reinforcement and the form work. Either slab bolster upper (SBU) or beam bolster upper (BBU) bar supports shall be used between mats of reinforcing steel. Individual high chair (HC) bar supports shall not be used.

On girder bridges either slab bolster upper (SBU) or beam bolster upper (BBU) bar supports shall be used between mats of reinforcement and placed transverse to the girders. Slab bolsters (SB) or beam bolsters (BB) shall be used under the bottom mat placed parallel to the girders.

The top mat of bridge slab and box culvert reinforcement shall be tied down with 16 1/2 gauge diameter (minimum) tie wires or other approved devices. It will not be permissible to tack weld reinforcement.

On girder bridges, ties shall be used along each line of beams at longitudinal intervals not to exceed 8 feet. The ties shall be secured to the shear transfer devices protruding from the top of the beam. Where shear transfer devices are not available, the ties may be secured to the bottom mat of slab reinforcing steel.

Other types of bridges and box culverts the top mat of reinforcement shall be tied down at a maximum of 12 foot longitudinal and transverse intervals with the ties secured to either the forms or bottom mat of slab reinforcing steel.

- D. Mechanical Bar Splices:** Shall only be used when specified in the plans or approved by the Engineer. The model of mechanical bar splice to be used shall be submitted to the Engineer through the proper channels for approval.

The mechanical connection shall develop 125% of the specified yield strength of a Grade 60 bar. The Contractor shall obtain from the manufacturer and submit to the Engineer certification indicating the mechanical bar splice is capable of developing 125% of the specified yield strength of a Grade 60 bar.

The bar lengths shown in the plans are the lengths of the bars neglecting the mechanical bar splice.

When mechanical bar splices are used to splice epoxy coated bars, the mechanical bar splices shall be epoxy coated by the manufacturer or made of an approved corrosion resistant material. Coating the mechanical bar splice with epoxy touch-up is not an approved method for this situation.

57.4 METHOD OF MEASUREMENT

Reinforcing steel will be measured as specified in plans. If reinforcing steel measurement is not specified in the plans, it shall be incidental to the associated concrete bid item.

57.5 BASIS OF PAYMENT

Reinforcing steel will be paid for as specified in plans. If reinforcing steel payment is not specified in plans, it shall be incidental to the associated concrete bid item.

END OF SECTION

SECTION 58

CONCRETE BOX CULVERT

58.1 DESCRIPTION

A. General: This work consists of furnishing and installing Concrete Box Culverts.

B. Related Work:

Section 12	Roadway and Drainage Excavation and Embankment
Section 50	Precast Concrete
Section 51	Structure Excavation
Section 54	Drainage Pipe Installation
Section 55	Cast in Place Concrete Structures
Section 108	Concrete Curing Materials
Section 200	Controlled Low Strength Material
Section 202	Geosynthetics for Roadways
Section 203	Submittals

58.2 MATERIALS

A. Precast Concrete Box Culvert and End Sections: Shall conform to the requirements of Section 50.

B. Cast in Place Box Culvert and End Sections: Shall conform to the requirements of Section 55.

C. Box Culvert Undercut:

- 1. Backfill Material:** Material for backfilling the undercut areas shall be installed at the thickness specified in plans and consist of stable material free of organic matter. Material shall conform to the following:

Sieve	% Passing
1 1/2 inch	100
1 inch	95 - 100
#4	0 - 75
#200	0 - 18.0

If undercut depth exceeds 3 feet below the bottom of the box culvert and stable material is not encountered, oversized rock or foundation material may be used up to the bottom of the undercut limits shown on the plans.

- 2. Bedding Material for Precast Concrete Box Culverts:** Shall be installed at the

thickness specified in plans and shall be sand or selected sandy soil conforming to the following:

Sieve	% Passing
3/8 inch	100
#200	0 - 10.0

- D. **Joint Wrap:** Shall be MarMac SealWrap, or approved equal.
- E. **Polyethylene Sheeting:** Shall conform to the requirements of Section 108.
- F. **Steel Wire Bar Supports:** In contact with the casting forms, shall be stainless steel, hot dipped galvanized, or plastic tipped extending at least one-half (1/2) inch from the form surface.

58.3 CONSTRUCTION REQUIREMENTS

- A. **Design:** Shall conform to the AASHTO design requirements for the depth of fill, including surfacing, etc., as well as live load or loading indicated on the plans. The specified live load shall apply to all barrel sections.
- B. **Excavation, Box Culvert:** Excavation for box culverts shall be per Section 51.
- C. **Box Culvert Undercut:** Undercut dimensions shall be to the minimum dimensions shown on the plans, unless otherwise directed by the Engineer. If the Engineer determines field conditions warrant change, the plan limits of the undercutting may be increased, decreased, or eliminated. The excavated material shall be used for backfill and embankment or disposed of as directed by the Engineer.

Backfill shall be compacted in accordance with Section 12 in horizontal layers not to exceed 6 inches loose depth.

- D. **Installation:** Box culvert installation will conform to the shop drawings and the following:
 1. **Foundation:** Foundation preparation shall be in accordance with Section 51. The foundation shall be shaped to provide a satisfactory template section and density.
 2. **Transverse Joints:** All joints in the box culvert shall be sealed. MarMac SealWrap shall be installed on the outside surface of the joint along the top and side walls of the box, to provide a minimum of 12 inches of material centered on the joint. Inside the box culvert, floor joints shall have flexible butyl joint sealant installed along the floor to the top of the floor haunches. The maximum allowable gap at any point between adjacent sections of box culvert shall be 1 inch.
 3. **Lift Holes:** Shall be covered with MarMac SealPlugs, or approved equal.

4. **Joint Ties:** Each section will be tied to adjacent sections with joint ties as shown on the shop plans.
5. **Backfilling:** Backfill shall be compacted in accordance with Section 12. Backfill placed around box culverts shall be deposited equally on both sides of the structure. Backfill shall be satisfactorily compacted in horizontal layers not to exceed six (6) inches. Hand compaction methods or use of flowable fill may be required for satisfactory compaction under and adjacent to corners with radius and between culverts on multiple installations.

E. Inspection:

1. **General:** All new box culverts shall pass a visual inspection and/or a television inspection a condition of acceptance by the City. The Engineer shall determine if the inspection is visual, television, or both. All inspections shall be performed after backfill is complete but prior to any surface restoration.

The visual and/or television inspection shall consist of viewing the inside of all box culverts installed to determine proper alignment, grade, joining, etc. The Contractor shall correct, at his own expense, any defects discovered from the visual and/or televising inspection. The inspection will be conducted by the Engineer unless otherwise specified.

The expense of the initial visual and/or television inspection and one additional reinspection will be borne entirely by the City. If defective workmanship of material or construction is noted, the Contractor at no expense to the City, shall correct the deficiency. The City will perform additional visual and/or television inspections to review if the repairs were made properly and in accordance with the specifications. The expense of any additional visual and/or television inspections beyond the initial inspection and one additional reinspection will be borne entirely by the Contractor. The Contractor shall be responsible for all related costs, including concrete or asphalt resurfacing if the street has been surfaced. The Contractor shall be required to repair all deficiencies. The City may cause to take any actions necessary for any items not completed or repaired in a timely manner and may charge the contractor one and a half (1½) times the costs incurred.

It is the Contractors responsibilities to notify the Engineer that the box culvert is ready for inspection. From the time initial notification that the box culvert is ready to be inspected the Contractor shall allow the City at least two (2) weeks to perform the visual and/or television inspections. Any surfacing started prior to visual and/or televising the box culvert and said box culvert being accepted is at the Contractors own risk.

2. **Pre-Cleaning:** Prior to inspection of newly installed box culverts the Contractor shall remove all accumulated construction debris, rock, gravel, sand, silt, and other foreign matter from the box culvert.

The Contractor shall be responsible for all work necessary to make the precast concrete box culvert acceptable for usage including removal of all mud, silt, rocks, or blockages.

In the event that the box culvert is not acceptable for visual inspection or televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to arrange to clean the box culvert and make it acceptable for the visual inspection or television work. If not cleaned in a timely manner, the City may cause to take any actions necessary and charge the Contractor one and a half (1½) times the cost incurred.

58.4 METHOD OF MEASUREMENT

- A. Box Culvert Undercut:** Measurement for box culvert undercut will not be made. Plans quantity shall be used for payment. Quantity shall be to the nearest cubic yard. When additional or less depth of undercut is directed by the Engineer, adjustment to the plans quantity shall be made to reflect the addition or reduction in work.
- B. Precast Box Culvert:** Measurement for precast box culverts will not be made. Plans quantity shall be used for payment. Quantity shall be to the nearest linear foot along centerline of the box culvert.
- C. Cast in Place Box Culvert:** Measurement for cast in place box culverts will not be made. Plans quantity shall be used for payment. Quantity shall be measured along centerline of the box culvert.
- D. Precast Box Culvert End Sections:** Precast box culvert end sections will be measured per each. One end section will be considered to be all of the individual pieces required to construct one end of the box culvert.
- E. Cast in Place Box Culvert End Sections:** Cast in place box culvert end sections will be measured per each. One end section will be considered to be all of the individual pieces required to construct one end of the box culvert.

58.5 BASIS OF PAYMENT

- A. Box Culvert Undercut:** Payment for box culvert undercut will be at the contract unit price per cubic yard. Payment will be full compensation for equipment, labor, tools and incidentals required for undercutting and for furnishing, placing, watering and compacting backfill material, including bedding material when specified on the plans.
- B. Precast Box Culvert:** Precast box culvert will be paid for at the contract unit price per foot. Payment will be full compensation for the foundation preparation, fabricating, installation, joint seal mastic, drainage fabric, joint ties, backfilling, and all other incidentals.
- C. Cast in Place Box Culvert:** Cast in place box culvert will be paid for at the contract unit price per foot. Payment will be full compensation for the foundation preparation,

reinforcement, forming, pouring, finishing, joint seal mastic, drainage fabric, joint ties, backfilling, and all other incidentals.

- D. Precast Box Culvert End Sections:** Precast box culvert end sections will be paid for at the contract unit price per each. Payment will be full compensation for the foundation preparation, fabricating, installation, joint seal mastic, drainage fabric, joint ties, backfilling, and all other incidentals.
- E. Cast in Place Box Culvert End Sections:** Payment for box culvert end sections will be at the contract unit price per each. Payment will be full compensation for the foundation preparation, reinforcement, forming, pouring, finishing, joint seal mastic, drainage fabric, joint ties, backfilling, and all other incidentals.

END OF SECTION

SECTION 59

STEEL BEAM GUARD RAIL

59.1 DESCRIPTION

A. General: This work consists of furnishing and installing steel beam guardrail.

B. Related Work:

Section 19	Incidental Work
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 203	Submittals

59.2 MATERIALS

A. Wood Posts and Offset Blocks: Shall be made of a timber with a stress grade of at least 1200 psi. Stress grading shall be in accordance with the rules of the West Coast Lumber Inspection Bureau, Southern Pine Inspection Bureau, or other appropriate timber association. Timber for posts shall either be rough sawn or sawn 4 sides (S4S) with nominal dimensions indicated. The size tolerance of the posts in the direction parallel to the axis of the bolt holes shall not be more than $\pm 1/4$ inch. Posts and blocks with checks or cracks more than 1/4 inch wide and deeper than 3 inches will not be acceptable.

Preservative treatment for Wood post and blocks shall comply with EPA, AASHTO M 133, and the AWPA Standard U1 referenced in AASHTO M 133. The posts and blocks shall be treated with retention specifications from commodity specification B, use category 4B. lumber in contact with the ground shall be treated with creosote, ammoniacal copper zinc arsenate, copper naphthenate, pentachlorophenol, or chromated copper arsenate.

B. Steel Beam Guard Rail: Shall be type conforming to the requirements of AASHTO M 180 Type 1, Unless the plans specify another type.

C. Bolts, Nuts and Washers: Shall be as specified in AASHTO M 180.

D. Concrete: Shall conform to Class M6 as specified in Section 56.

59.3 CONSTRUCTION REQUIREMENTS

A. Guardrail Alignment: Posts and rail shall be set to the plans shown alignment using a string line or other approved methods.

B. Posts: Posts shall be set plumb. When posts are installed in augured or dug holes, the holes shall be backfilled with material approved by the Engineer. The backfill shall

be placed and compacted in 4 inch lifts, using a mechanical tamper with an appropriate sized tamping head without displacing the post alignment. Surplus excavated material will be disposed of at locations approved by the Engineer.

In lieu of the above requirements, post may be set by driving. Driving shall be accomplished by mechanical means, which will give the necessary accuracy of placement without any damage. Damaged posts shall be replaced at the Contractor's expense.

Regardless of the method of setting posts, the posts shall be firm, and at the locations, spacing, and height shown on the plans.

When guardrail posts are installed through asphalt concrete shoulders, the Contractor shall take care to minimize damage to the asphalt concrete. If during post installation the asphalt concrete shoulder is raised more than 2 inches, lowered more than 1 inch, or otherwise damaged, the Contractor shall repair the damaged shoulders.

The method of repair may require patching, recompaction, or removal and replacement of the affected asphalt concrete. The method of repair is subject to the approval of the Engineer, depending on the type and extent of the shoulder damage. All repair costs shall be at the Contractor's expense.

Drilling postholes in pavement shall be done without damage to the surrounding pavement. The Engineer must approve the proposed drilling method and equipment before the work begins.

Upon completion of the installation of the guardrail posts, the Contractor shall place and compact asphalt concrete or asphalt concrete cold mix material around the posts to fill and level any voids created by the driving of the posts through the asphalt concrete. The material shall be placed 1/2 inch to 1 inch high around the posts to force water to flow away from the post-hole. Cost for this work shall be incidental to the contract unit prices for the various guardrail items.

Field cuts in treated wood shall be given two applications of a compatible preservative material meeting AWPA Standard M4, with a minimum time lapse of 2 hours between applications. Field bored holes may be left untreated.

- C. Rails:** The rail elements shall be ready for assembly when delivered to the project site. Welding of rail elements will not be allowed. Field cutting of rail elements shall be accomplished with a plasma cutter or other method approved by the Engineer. All field made cuts or holes shall be a neat line. Rail elements that have been altered in the field or have been damaged in transporting, handling, or installing shall be repaired at the Contractor's expense. The altered or damaged surface area of rail element shall be thoroughly cleaned and painted with two coats of matching zinc-rich paint.

When nested rail is specified, rail elements shall not be staggered.

- D. W Beam End Terminal:** The W beam end terminal to be used shall be the Contractor's choice selected from the SD DOT's Approved Products List unless otherwise specified on the plans. The W beam end terminal is to be installed according to the manufacturer's installation instructions. A copy of the installation instructions and drawings for the W beam end terminal being installed shall be furnished to the Engineer prior to installation. The drawings shall contain all components of the W beam end terminal. Surfacing and embankment shall be placed as detailed on the standard plates.
- E. Remove Beam Guardrail:** Beam guardrail removed, including end terminals, steel beam rail, posts, blocks, and hardware shall become the property of the Contractor unless otherwise noted on the plans.

Any holes left after removal of the guardrail shall be backfilled with material furnished by the Contractor. Wherever posts were set through asphalt, the top 3 inches of the hole shall be backfilled with bituminous mix.

- F. Completion Requirements:** On projects where existing cable or steel beam guardrail is to be removed and replaced or reinstalled and the roadway will be open to traffic during construction, the guardrail installation shall be completed within 14 calendar days from the day the controlling item of work is sufficiently complete to allow guardrail installation. A guardrail installation is defined as each individual run of guardrail (i.e., a typical bridge would have 4 guardrail installations). Controlling items for guardrail include, but are not limited to: structure, structure end block, and surfacing work. Typically, there will be a sequence of controlling items for guardrail. Prior to any guardrail removal, the Contractor shall submit and the Engineer must approve a written construction schedule for work in the guardrail area. In no case shall work cease between controlling items of work for more than 4 working days.

Once the existing guardrail is removed from a bridge end, box culvert, bridge column, etc., the Contractor shall place drums or Type II barricades at 25 foot intervals at each location where existing guardrail is removed. These devices shall extend 175 feet beyond the item of concern for each direction of traffic. Drums and barricades shall remain in place until new guardrail has been installed. Cost for furnishing, installing, and maintaining drums and barricades shall be incidental to the contract lump sum price for traffic control miscellaneous.

Post end, beam, and end terminal sections shall be installed in a continuous operation within each individual run of guardrail. Incomplete guardrail installations shall be marked by delineation as noted in the previous paragraph.

If the Contractor does not complete the required work within the time allowed, the Contractor shall install an approved safety treatment that complies with crashworthy requirements for test level 3 of National Cooperative Highway Research Program (NCHRP) Report 350 or the AASHTO Manual for Assessing Safety Hardware (MASH) to protect the site at no additional cost to the Department.

59.4 METHOD OF MEASUREMENT

- A. Steel Beam Guard Rail:** Each class and type will be measured by the linear foot along the centerline of the rail. The length in feet shall be understood to be the overall length center to center of end posts or to connections with bridges and culverts.
- B. W Beam End Terminal:** The quantity will be the actual number installed.
- C. Remove Beam Guardrail:** Remove Beam Guardrail will be measured to the nearest linear foot along the centerline of the rail.

59.5 BASIS OF PAYMENT

- A. Steel Beam Guard Rail:** Guardrail will be paid for at the contract unit price per linear foot to the nearest whole foot for each class and type installed. Payment will be full compensation for materials, labor, equipment, and incidentals required.
- B. W Beam End Terminal:** W beam end terminals will be paid for at the contract unit price per each. Payment will be full compensation for labor, materials, equipment, and incidentals required.
- C. Remove Beam Guardrail:** Remove Beam Guardrail will be paid for at the contract unit price per foot. Payment will be full compensation for the backfill of holes and the removal of the guardrail including end terminals, beam guardrail, posts, blocks, and hardware from the project limits.

END OF SECTION

SECTION 60

CONCRETE CURB AND GUTTER

60.1 DESCRIPTION

A. General: This work consists of constructing concrete curb and gutter on a prepared subgrade.

B. Related Work:

Section 12	Roadway and Drainage Excavation and Embankment
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 57	Reinforcing Steel
Section 61	Concrete Sidewalk, Curb Ramps, and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Preformed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 117	Aggregates for Granular Bases and Surfacing
Section 123	Concrete Reinforcement
Section 203	Submittals

60.2 MATERIALS

A. Concrete: Shall conform to the requirements of Class M6, Section 56.

B. Preformed Expansion Joint Filler: Shall conform to the requirements of Section 113.

C. Curing Compound: Shall conform to the requirements of Section 108, Linseed Oil Base Emulsion Compound, white pigmented.

D. Reinforcing Steel: Shall conform to the requirements of Section 123.

60.3 CONSTRUCTION REQUIREMENTS

A. General: The foundation shall be excavated, shaped, and compacted to a firm, uniform bearing surface. Unsuitable foundation material shall be removed and

replaced as directed. The foundation shall be thoroughly moistened immediately prior to placing concrete. Moisture shall be applied without forming pools of water.

Granular material, shall be furnished, placed and compacted to the required Contract depth and density. Minimum depth of granular material placed under fillets, pans, curb and gutter, type "P" gutter, and driveway approach pavement shall be four (4) inches.

Forms shall be full depth, rigid, unyielding and mortar tight. They shall be securely staked, braced and tied to the required line and grade.

In lieu of construction using fixed side forms, concrete may be placed and formed to the required shape by using an approved type of extrusion machine. When machine placement is used, the Engineer may permit modification of consistency requirements.

The exposed surfaces of the fillets and pan and curb and gutter shall be finished smooth and even.

Edges of gutter and the top face edges of the curb shall be finished with an approved finishing tool.

The top surface of the concrete shall be brushed or broomed transversely to the direction of gutter flow to slightly roughen the surface and remove the finishing tool marks.

All honeycombed surfaces shall be corrected to the satisfaction of the Engineer by using a grout composed of one part cement and two parts sand. Severely honeycombed areas shall be removed and replaced at the Contractor's expense.

Transverse contraction joints shall be constructed at 10 foot intervals in the curb and gutter except where adjacent to PCC pavement, or as otherwise specified by plans or the Engineer. When PCC pavement is adjacent to the curb and gutter, the transverse contraction joints shall match the spacing of the PCC pavement. Joint depth shall be minimum 25 percent of the total depth of concrete. Joint sealant shall be per standard detail.

The exposed surfaces of the curb and gutter shall be protected and cured in accordance with Section 55, except the minimum curing time shall be 72 hours.

After the curing period, the area behind the curb and gutter and fillets shall be filled to the required elevations with suitable material and the material shall be satisfactorily compacted.

- B. Testing:** The Contractor shall be responsible for providing a minimum of a slump, air content, seven (7) day and twenty-eight (28) day compressive strength quality test set for each days pour. Additional or fewer test sets and testing may be required by

the Engineer or as called for in the Detailed Specifications. Results from concrete testing shall be provided to the Engineer within 3 days of the test being performed.

60.4 METHOD OF MEASUREMENT

Concrete curb, gutter and combined curb and gutter will be measured to the nearest one half (0.5) linear foot. Measurement for concrete curb will be on the inside bottom face of the curb. Measurement for separate gutters and combined curb and gutter will be on the inside edge next to the pavement.

Measurement of curb and combined curb and gutter will include tapers for approaches and or entrances. Measurement for approach gutter or "P" gutter will not include tapers.

Measurement for curb and gutter shall not include the "gutter throat" of a Type "E" Inlet or the fillet curb. Refer to standard detail.

Concrete fillets, pans, approach pavement and similar items shall be measured to the nearest whole square foot or square yard consistent with the appropriate bid item in the Bidder's Proposal.

Measurement for granular materials placed under the concrete shall be in accordance with Section 117, Aggregates for Granular Bases and Surfacing.

When called for in detailed plans and specifications concrete test sets shall be measured per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental to various associated bid items.

60.5 BASIS OF PAYMENT

Concrete curb, gutter and combined curb and gutter will be paid for at the contract unit prices per linear foot for the types constructed.

Concrete fillets, pans, approach pavement and similar items will be paid for at the contract unit prices per square foot or per square yard for the types constructed.

Payment for granular materials placed under the concrete shall be in accordance with Section 117, Aggregates for Granular Bases and Surfacing.

Payment for these items will be full compensation for furnishing materials, the expansion joints, steel reinforcement, forms, bracing, excavation, backfill, labor, equipment, and incidentals necessary.

When called for in detailed plans and specifications concrete test sets shall be paid per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental to various associated bid items.

END OF SECTION

SECTION 61

CONCRETE SIDEWALK, CURB RAMPS, AND DETECTABLE WARNING SURFACES

61.1 DESCRIPTION

A. General: This work consists of constructing sidewalks, curb ramps, detectable warning surfaces, Type "C" retaining wall/sidewalk and exposed aggregate sidewalk on a prepared subgrade.

B. Related Work:

Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 57	Reinforcing Steel
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Preformed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 117	Aggregates for Granular Bases and Surfacing
Section 123	Concrete Reinforcement
Section 203	Submittals

61.2 MATERIALS

A. Concrete: For sidewalk shall conform to the requirements of Class M6 Concrete provided in Section 56.

B. Expansion Joint Filler: Shall conform to the requirements of Section 113.

C. Cushion Material: Shall meet the requirement of Section 117.

D. Curing Compound: Shall conform to the requirements of Section 108.

E. Concrete Joint Sealer: Shall conform to the requirements of Section 114.

F. Concrete Reinforcing Steel: Shall conform to the requirements of Section 57 and Section 123.

- G. Detectable Warning:** Color shall be a contrasting color to the surrounding sidewalk. Color shall be homogeneous throughout the tile. Detectable warnings may be cast iron or composite and shall be approved by the Engineer.

61.3 CONSTRUCTION REQUIREMENTS

- A. General:** The foundation shall be excavated, shaped, and compacted to a firm, uniform, bearing surface conforming to the planned section and established grade. Unsuitable foundation material shall be removed and replaced as directed. The foundation shall be thoroughly moistened immediately prior to the placing of concrete. Moisture shall be applied without forming pools of water.

Cushion material shall be placed under the sidewalk to a depth of two (2) inches and satisfactorily compacted.

Forms shall be made of wood not less than two (2) inches nominal thickness or of steel of equal rigidity. Flexible strips may be used on curves. The forms shall be securely held to line and grade and shall not deviate more than one-eighth (1/8) inch from an accurate template ten (10) feet in length. The forms shall remain in place until the concrete has hardened to the point that no damage will be done to the concrete during form removal. Damage to the concrete as the result of form removal shall be repaired by the contractor at no additional expense to the City.

Contraction joints shall be formed at intervals equal to sidewalk width by means of a grooving tool, to a depth of at least one-fourth (1/4) the thickness of the sidewalk. Joints shall be penetrated with point of a trowel or other tool at least one-half (1/2) the thickness of the concrete at minimum intervals of 8 inches to 12 inches along the joint. Joints and edges shall be finished with an approved one-fourth (1/4) inch edging tool. If plans specify saw-cutting joints, the depth shall be one-fourth (1/4) the thickness of the concrete.

Expansion joints shall be constructed of 1/2 inch preformed expansion joint filler at a maximum spacing of 100 feet, at the locations and dimensions specified on the plans, or as directed by the Engineer. When the concrete sidewalk is placed adjacent to the curb and gutter, the Contractor shall place 1/2 inch preformed expansion joint filler longitudinally along the backface of the curb and gutter. When the concrete sidewalk is placed adjacent to other solid fixtures including, but not limited to, buildings, parking lots, driveways, and retaining walls, the Contractor shall place a double thickness of preformed expansion joint filler at the back of the sidewalk. All other obstructions will require 1/2 inch preformed expansion joint filler, as directed by the Engineer. The expansion joint filler shall be placed the full depth of the sidewalk.

All expansion joints shall be sealed with hot poured elastic joint sealer, or low modulus silicon sealant.

Immediately after the water sheen has disappeared, the concrete shall be brushed or broomed in a direction perpendicular to the flow of traffic to roughen the surface and remove tool marks.

Concrete sidewalk shall be protected and cured in accordance with Section 55.

After the curing period, the area adjacent to new sidewalk shall be filled to the required elevation with suitable material and the material shall be satisfactorily compacted, seeded, or sodded.

Colored or stamped concrete or similar forms of architectural concrete finish shall not be placed with in the street right of way, except as specified by the Engineer.

Concrete type "C" retaining wall shall be per approved plans and details.

- B. Testing:** The Contractor shall be responsible for providing a minimum of one set of slump, air content, seven (7) and twenty-eight (28) day compressive strength quality tests for each day's pour. Additional test sets or testing may be required by the Engineer or as called for in the Detailed Specifications. Results from concrete testing shall be provided to the Engineer within 3 days of the test being performed.
- C. Detectable Warning:** Installation of detectable warning surfaces shall be per manufacturers installation instructions.

61.4 METHOD OF MEASUREMENT

- A. Concrete Sidewalk and Curb Ramp:** Will be measured to the nearest one-tenth (0.1) linear foot and the area computed to the nearest square foot.
- B. Concrete Type "C" Retaining Wall:** Concrete Type "C" retaining wall will be measured to the nearest one-tenth (0.1) linear foot. A separate measurement for wall will be made in 2 foot vertical increments. The sidewalk area associated with a Type "C" retaining wall will not be measured. Reinforcing steel will not be measured.
- C. Detectable Warning:** Detectable warnings will be measured to the nearest square foot.
- D. Concrete Test Set:** When called for in detailed plans and specifications concrete test sets shall be measured per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental to the various bid items.

61.5 BASIS OF PAYMENT

- A. Concrete Sidewalk and Curb Ramp:** Will be paid for at the contract unit price per square foot for concrete sidewalk or curb ramp, exclusive of sidewalk associated with Type "C" wall. Payment for this item will also be full compensation for labor, equipment, tools, backfilling, furnishing, preparing, testing, and placing materials and incidentals necessary, including disposal of excavation and discarded materials. Such payment shall include cushion material.

- B. Concrete Type “C” Retaining Wall:** Will be paid for at the contract unit price per linear foot of wall categorized within separate bid items of 2 foot vertical increments. Such payment shall include the adjacent sidewalk. Reinforcing steel shall be incidental to the Type “C” retaining wall. Payment for this item will also be full compensation for labor, equipment, tools, backfilling, furnishing, preparing, testing, and placing materials and incidentals necessary, including disposal of excavation and discarded materials. Such payment shall include cushion material.
- C. Detectable Warning:** Will be paid for at the contract unit price per square foot furnished and installed.
- D. Concrete Test Set:** When called for in detailed plans and specifications concrete test sets shall be paid per each. If concrete test sets are not called out as a bid item in the detailed plans and specifications they shall be considered incidental various bid items.

END OF SECTION

SECTION 62

DROP INLETS

62.1 DESCRIPTION

A. General: This work consists of furnishing materials and the construction of drop inlets.

B. Related Work:

Section 50	Precast Concrete
Section 54	Drainage Pipe Installation
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 57	Reinforcing Steel
Section 63	Storm Sewer Junction Boxes and Manholes
Section 100	Portland Cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 104	Water for Use in Portland Cement Concrete
Section 105	Fine Aggregate for Use in Portland Cement Concrete
Section 106	Masonry Mortar Sand
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 108	Concrete Curing Materials
Section 113	Preformed Expansion Joint Filler for Concrete
Section 114	Concrete Joint Sealer
Section 120	Drainage Pipe Materials
Section 123	Concrete Reinforcement
Section 203	Submittals

62.2 MATERIALS

A. Concrete: Class M6, Section 55. For precast drop inlets cast at a facility regularly producing other precast concrete items under Section 50, the concrete shall conform to Section 50.

B. Castings: Unless otherwise specified, frames and grates shall consist of approved gray iron castings meeting the requirements of AASHTO M 105-06/ASTM A48, Class 35B. Grates shall fit the frames with which they are to be used. Inaccuracies of bearing shall be corrected by machining before use or replaced with new assemblies. Grates or covers to be placed in the roadway surface shall also meet AASHTO M306.

C. Steel Reinforcement: Section 123. Reinforcement is not required to be epoxy coated.

D. Mortar: Mortar shall consist of one (1) part portland cement and two (2) parts mortar sand conforming to Sections 100 and 106 respectively. Alternate commercially

available grout may be used if approved by the Engineer.

E. Curing Compound: Section 108.

62.3 CONSTRUCTION REQUIREMENTS

- A. General Requirements:** Concrete for cast-in-place drop inlets shall be proportioned, mixed, hauled, and placed in accordance with Section 55. For precast drop inlets cast at a facility regularly producing other precast items under Section 50, the concrete proportions, slump, and air content shall conform to Section 50.

When the foundation for a drop inlet is in new embankment, the embankment shall be constructed to an elevation at least 1 foot above the footing before the foundation for the drop inlet is prepared. The foundation shall be compacted as specified for the adjacent embankment.

Castings shall be set in full mortar beds or secured as specified. Castings shall be set accurately to the correct elevation so subsequent adjustment will not be necessary.

Pipe sections shall be flush on the inside of the structure wall and project outside sufficiently for proper connection with the next pipe section. Masonry shall fit neatly and tightly around the pipe. Grouting of the pipe connection may be required as directed by the Engineer if voids exist after form removal.

Drop inlets shall be either cast in place or precast. Precast drop inlets shall be defined as those drop inlets cast outside of the project limits. Drop inlets cast within the project limits will be considered cast in place.

- B. Cast In Place Drop Inlets:** The foundation excavated for drop inlets shall be thoroughly moistened immediately prior to placing concrete. Moisture shall be applied without forming pools of water.

Steel reinforcement shall be placed in accordance with Section 57.

Concrete shall be protected and cured in accordance with Section 55. The minimum curing time shall be 72 hours. The finished surface of the concrete shall present a neat and smooth appearance.

Upon completion and curing of the unit, the sheeting, bracing, forms, and falsework shall be removed and the excavation backfilled. The unit shall not be backfilled until the completion of the 72 hour curing period, or until the concrete reaches a minimum compressive strength of 3,000 psi. Backfill shall be placed in loose layers not exceeding 6 inches thick and compacted to the same degree as specified for the adjacent embankment. Installations shall be completed and left in a neat appearing condition.

- C. Precast Drop Inlets:** Shall conform to the following requirements:

Notification: Inlets shall be manufactured at a precast facility that is certified by the American Concrete Pipe Association, is approved for supplying inlets to the South Dakota Department of Transportation, or has been approved by the Engineer. Upon request from the Engineer, the Contractor and/or supplier shall supply a test report from an independent testing laboratory showing compliance with this Specification.

1. **Design:** Precast drop inlets shall conform to the configurations of the standard detail. Alternate designs may be submitted to the Engineer for approval, and shall comply with AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications. Precast drop inlets shall be designed to HL-93 load conditions. The design shall be reviewed and stamped by Professional Engineer registered in the State of South Dakota. The design submittal shall include structural design calculations, and documentation that the alternate design has been accepted by the SDDOT. The Engineer reserves the right to reject alternate designs, including alternate designs that were previously approved.
2. **Shop Drawings:** If using a design that varies from the standard detail, prior to fabrication, the Contractor shall submit shop drawings in accordance with Section 203 Submittals. The shop drawings shall consist of fabrication details including reinforcing steel and spacer placement and configurations, total quantities for the complete item, structural design calculations, and all information necessary for fabrication and erection.
3. **Forms:** Shall be designed to withstand the fluid pressure of the concrete and the added forces due to vibration and impact without distortion. The forms shall be mortar tight and free from warp.

The form surface area in contact with the concrete shall be treated with an approved form oil or wax before the form is set in position. The forms shall be thoroughly cleaned of all other substances.

4. **Fabrication:** Welding of mild reinforcing steel will not be permitted.

Steel wire bar supports will be used to maintain proper reinforcement location and concrete cover. Cutting of reinforcement and bending to the form surface, for support, will not be permitted. Steel wire bar supports, in contact with the casting forms, will be stainless steel, hot dipped galvanized, or plastic tipped extending at least 1/2 inch from the form surface.

The surface temperature of the forms and reinforcing steel, which come into contact with the concrete being placed, will be raised to a temperature above freezing prior to concrete placement. All deleterious material will be removed from the forms prior to concrete placement. For cold weather placements, concrete surfaces will be protected from freezing throughout the pour and until covered for the waiting period before application of live steam or radiant heat.

The precast units will have sufficient strength to prevent damage to the units during removal of the forms and yarding. Precast units will have a minimum concrete

compressive strength of 800 psi prior to form removal. Precast units will have a minimum concrete compressive strength of 3000 psi prior to yarding. The Engineer may approve a different minimum concrete strength for form removal and yarding, based upon fabricator demonstrated results or as shown on design details submitted and approved with the shop plans.

5. **Concrete Cure:** The concrete shall be cured by low pressure steam, radiant heat, or as specified in Section 55.

Low pressure steam or radiant heat curing shall be done under an enclosure to contain the live steam or the heat and prevent heat and moisture loss. The concrete shall be allowed to attain initial set before application of the steam or heat. The initial application of the steam or heat shall be three hours after the final placement of concrete to allow the initial set to occur. When retarders are used, the waiting period before application of the steam or radiant heat shall be five hours. When the time of initial set is determined by ASTM C 403, the time limits described above may be waived.

During the waiting period, the minimum temperature within the curing chamber shall not be less than 50°F and live steam or radiant heat may be used to maintain the curing chamber between 50°F and 80°F. During the waiting period the concrete shall be kept moist.

Application of live steam shall not be directed on the concrete forms causing localized high temperatures. Radiant heat may be applied by pipes circulating steam, hot oil, hot water, or by electric heating elements. Moisture loss shall be minimized by covering exposed concrete surfaces with plastic sheeting or by applying an approved liquid membrane curing compound to exposed concrete surfaces. The top surface of concrete members for use in composite construction shall be free of membrane curing compound residue unless suitable mechanical means for full bond development are provided.

During the initial application of live steam or radiant heat, the concrete temperature shall increase at an average rate not exceeding 40°F per hour until the curing temperature is reached. The maximum concrete temperature shall not exceed 160°F. The maximum temperature shall be held until the concrete has reached the desired strength. After discontinuing the steam or radiant heat application, the temperature of the concrete shall decrease at a rate not to exceed 40°F per hour until the concrete temperature is within 20°F of the ambient air temperature.

The test cylinders shall be cured with the inlet, or in a similar manner as the inlet, until minimum compressive strength has been obtained.

6. **Surface Finish and Patching:** If a precast or prestressed item shows stone pockets, honeycomb, delamination, or other defects which may be detrimental to the structural capacity of the item, it will be subject to rejection at the discretion of the Engineer. Minor surface irregularities or cavities, which do not impair the service of the item, and which are satisfactorily repaired will not constitute cause

for rejection. Repairs shall not be made until the Engineer has inspected the extent of the irregularities and has determined whether the item can be satisfactorily repaired. If the item is deemed to be repairable, the repair method and procedures shall be agreed upon by the City and fabricator prior to the work commencing.

Depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the proportions, similar to the specific class of concrete in the unit.

7. **Fresh Concrete Testing:** The Contractor shall be responsible for ensuring the fabricator performs all fresh concrete testing. Testing shall be performed by an American Concrete Institute (ACI) certified individual.
8. **Concrete Compressive Strength:** The Contractor shall ensure that the fabricator makes a minimum of one group of test cylinders for each class of concrete for each day's production, not to exceed 150 cubic yards per group of cylinders.

At a minimum, a group of test cylinders shall consist of the following:

- a) Two test cylinders are required for the 28 day compression test.
- b) Optionally, additional cylinders will be required for determining early concrete strength, when the Contractor desires to make delivery and obtain acceptance by the City prior to the 28 day compression test.

Acceptance of the precast units shall be in accordance with Section 55 except that the Contractor shall be responsible for ensuring the fabricator has done the sampling, preparing, and properly curing of all concrete cylinders for concrete compressive strength. The precast units will be accepted when the minimum design concrete compressive strength requirements have been met. Accepted precast units represented by that test group of cylinders may be delivered to the project and will not require the 28 day cylinder test.

Breaking of all concrete cylinders for concrete compressive strength shall be done by a certified testing laboratory.

9. **Pipe Connection and Field Collar:** An M-6 concrete collar a minimum 2 foot wide by 6 inch thick shall be placed around the outside of the pipe connection. The collar shall be reinforced with 6 inch by 6 inch W2.9 by W2.9 wire mesh. All costs for the collar shall be incidental to the unit price for the corresponding bid item.

62.4 METHOD OF MEASUREMENT

- A. **Drop Inlets:** Will be measured per each type.
- B. **Cast Iron Frames with Grates:** Will not be measured.
- C. **Concrete:** Will not be measured.

D. Reinforcing Steel: Will not be measured.

62.5 BASIS OF PAYMENT

A. Drop Inlets: Shall be made per each type, payment will be full compensation for furnishing and installing cast iron frames and grates, concrete, reinforcing steel, mortar bed, and for labor, equipment, and incidentals necessary. Precast drop inlet unit price shall include the concrete collar at the pipe connection.

B. Cast Iron Frames with Grates: Shall be incidental to the inlet.

C. Concrete: Shall be incidental to the inlet.

D. Reinforcing Steel: Steel shall be incidental to the inlet.

END OF SECTION

SECTION 63

STORM SEWER JUNCTION BOXES AND MANHOLES

63.1 DESCRIPTION

A. General: This work consists of the construction or reconstruction of manholes. For the purposes of this section manholes may be round or square, precast or cast in place.

B. Related Work:

Section 9	Sanitary Sewer
Section 50	Precast Concrete
Section 54	Drainage Pipe Installation
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 57	Reinforcing Steel
Section 62	Drop Inlets
Section 100	Portland Cement
Section 106	Masonry Mortar Sand
Section 120	Drainage Pipe Material
Section 123	Concrete Reinforcement
Section 200	Controlled Low Strength Material
Section 203	Submittals

63.2 MATERIALS

A. Cast in Place Concrete: Shall conform to the requirements of Class M6, Section 56.

B. Precast Units: Shall conform to AASHTO M 199 and Section 50.

C. Castings: Unless otherwise specified on the plans, frames and covers shall consist of approved gray iron castings meeting AASHTO M 105-06/ASTM A48 Class 35B. Frame and covers to be placed in the roadway surface shall also meet AASHTO M306-10.

D. Mortar: Shall consist of one (1) part portland cement and two (2) parts mortar sand conforming to Sections 100 and 106 respectively. Alternate commercially available grout may be used if approved by the Engineer.

E. Concrete Reinforcement: Shall conform to Section 123.

63.3 CONSTRUCTION REQUIREMENTS

Concrete for cast-in-place manholes shall be proportioned, mixed, hauled, and placed in accordance with Section 55.

When the foundation for a manhole is in new embankment, the embankment shall be constructed at least one (1) foot above the footing before the foundation is prepared. The foundation shall be compacted to the satisfaction of the Engineer.

Unless otherwise permitted by the Engineer, pipe sections shall be flush on the inside of the structure wall and project outside for proper connection with the next pipe section. Masonry shall fit neatly and tightly around the pipe.

Storm sewer manhole frames and covers located within the roadway surface shall meet Sanitary Sewer Manhole Frame and Cover Specifications Section 9. The manhole lid shall be labeled "Storm" or "Storm Sewer", and is not required to be supplied with a type "t" or o-ring gasket. Castings shall be set to the correct elevation using adjusting rings as necessary. Adjusting rings and final frame and grate adjustment shall be per Section 9. Chimney seals are not required for storm sewer manholes.

If Flowable Fill is utilized to backfill, the Flowable Fill shall be placed in accordance with Section 200 – Controlled Low Strength Material.

Installations shall be finished and left in a condition satisfactory to the Engineer.

The following specific provisions shall apply to the various types of construction:

A. Cast-in-Place Concrete: The foundation for manholes shall be thoroughly moistened immediately prior to placing concrete.

Steel reinforcement shall be placed in accordance with Section 57. Epoxy coated reinforcement is not required.

Concrete shall be protected and cured in accordance with Section 55. The minimum curing time shall be seventy-two (72) hours. The finished surface of the concrete shall present a neat and smooth appearance.

Upon completion and curing of the unit, the sheeting, bracing, forms, and falsework shall be removed and the excavation backfilled. The unit shall not be backfilled until the completion of the 72 hour curing period, or until the concrete reaches a minimum compressive strength of 3000 psi. Backfill shall be placed in loose layers not exceeding 6 inches thick and compacted to the same degree as specified for the adjacent embankment. Installations shall be completed and left in a neat appearing condition.

B. Pre-Cast Sectional Reinforced Concrete Units: The fabrication of precast manholes shall conform to Section 50.

1. Placing: Pre-cast units shall be placed on a minimum of four (4) inches of Type 1 bedding material. Backfill shall be placed in layers not exceeding six (6) inches thick and compacted to the same degree as specified for adjacent embankment.

The bottom-precast section shall be set in a full mortar bed and the joints between sections and around pipes shall be filled with mortar or an approved plastic cementing compound.

- 2. Pipe Connection and Field Collar:** An M-6 concrete collar a minimum 2 foot wide by 6 inch thick shall be placed around the outside of the pipe connection. The collar shall be reinforced with 6 inch by 6 inch W2.9 by W2.9 wire mesh. All costs for the collar shall be incidental to the unit price for the corresponding bid item.
- C. Adjusting Ring and Cover:** When the manhole ring and cover are to be lowered sufficiently to require reconstruction of the structure, or raised more than one (18) inches, or when the reconstruction of existing manhole is specified without change in grade, the manhole shall be reconstructed to the extent necessary to provide the adjustment specified.

When the ring and cover on an existing manhole are to be lowered to an extent which does not require reconstruction of the structure, or when the ring and cover are to be raised up to (18) inches or less, the adjustment shall be made by adding or removing adjusting rings. Adjusting rings shall be per Section 9.

- D. Manhole Steps:** Shall not be installed.
- E. Testing:** Pipe culverts and storm sewers shall be tested in accordance with the provisions contained in Section 54 – Pipe Culverts.

63.4 METHOD OF MEASUREMENT

- A. Pre-Cast Manholes:** Manholes of pre-cast sectional reinforced units will be measured as a unit for each manhole constructed.

Manhole rings and covers shall be included in construction of the manhole. No separate measurement will be made for manhole rings and covers.

- B. Cast-in-Place Concrete Manholes:** Shall be measured as a unit for each manhole constructed.

Manhole rings and covers shall be included in construction of the manhole. No separate measurement will be made for manhole rings and covers.

- C. Reconstructing or Adjusting Manholes:** Will be measured as a unit for each manhole reconstructed or adjusted.

- D. Flowable Fill:** Shall be measured in accordance with Section 200 – Controlled Low Strength Material.

63.5 BASIS OF PAYMENT

- A. Pre-Cast Manholes:** Manholes of pre-cast sectional reinforced concrete units will be paid for at the contract unit price bid per manhole, furnished and accepted, inclusive of materials, ring and cover, labor, equipment, excavation, and incidentals necessary.
- B. Cast-in-Place Concrete Manholes:** Units will be paid for at the contract unit price bid per manhole, furnished and accepted, inclusive of materials, ring and cover, labor, equipment, excavation, and incidentals necessary.
- C. Reconstructing or Adjusting Manholes:** Will be paid for at the contract unit price bid per reconstruction or adjustment of manhole. Payment for this item will be full compensation for furnishing materials, labor, and equipment necessary.
- D. Flowable Fill:** Shall be paid in accordance with Section 200 – Controlled Low Strength Material.

END OF SECTION

SECTION 64

UNDER-DRAINS

64.1 DESCRIPTION

A. General: This work consists of subgrade drainage installations or repair of porous backfill and under-drain pipe or edge drain.

B. Related Work:

Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 112	Select Granular Backfill
Section 202	Geosynthetics for Roadways
Section 203	Submittals

64.2 MATERIALS

A. Under-Drain Pipe Trench Granular Backfill Material: Shall be clean type 1 bedding as described in Section 112.

B. Under-Drain Pipe or Tubing: Drainage tubing used as sub-drains or edge drains shall have cleanouts installed at the upper ends. In lieu of a cleanout, where directed or approved by the Engineer, a penetration into a storm sewer culvert, inlet or pipe will be acceptable. The distance between cleanouts shall not exceed 500 feet.

Unless otherwise specified in the plans, under-drain pipe shall be 4 inches in diameter.

1. Corrugated Polyethylene Drainage Tubing: Corrugated polyethylene drainage tubing, couplings, and fittings shall conform to the requirements of AASHTO M 252, except as modified below:

- a) The length of the individual slots on the 4 inch to 6 inches diameter tubing shall not exceed 12 percent of the tubing inside nominal circumference.
- b) Corrugated polyethylene drainage tubing for use as edge drain or subgrade drain shall be a prefabricated system utilizing polyethylene drainage tubing. It shall be a flexible composite capable of following an irregular trench wall.

2. Perforated PVC: Perforated PVC, if specified, shall be the requirements of ASTM D3034 DR 35. Perforations shall be circular ½ inch holes spaced 5 inches apart (+/- 0.25 inches). Perforation locations shall be 4 o'clock and 8 o'clock on the pipe.

C. Separation Fabric: Separation fabric material used to prevent soil migration into the under-drain, shall conform to Section 202 Class 2.

D. Concrete: Where required, concrete shall conform to the requirements of Class M6, Section 56.

64.3 CONSTRUCTION REQUIREMENTS

Prior to placement of the under-drain located at the edge of roadway, the subgrade shall be built and graded to final blue top elevation. The Engineer shall accept subgrade prior to under-drain installation.

The trench to receive the under-drain shall be excavated to the lines shown on the plans or as staked by the Engineer. The trench bottom shall be shaped and tamped as required by the Engineer. Disposal of surplus excavation shall be made by the Contractor and shall be incidental to the under-drain construction.

Prior to placement of under-drain trench granular material a layer of separation fabric material shall be placed in the trench. The material shall be of sufficient width to totally wrap the bottom, sides and top of the under-drain pipe trench granular backfill material and pipe or tubing. There shall be a minimum 12 inch overlap of separation fabric material over the top of the under-drain Pipe trench granular backfill material. Longitudinal sections shall have a minimum 12 inch overlap end to end.

Prior to placement of perforated or corrugated under-drain pipe or tubing, a layer of under-drain pipe trench granular backfill material shall be placed to the depth shown on the plans and shaped to receive the pipe or tubing.

Perforated under-drain pipe or tubing shall be laid with the symmetrically placed holes on the lower side. In outlet sections, the pipe or tubing shall be either non-perforated or the symmetrically placed holes shall be on the upper side. The sections shall be well bedded at all points throughout their entire length and securely bolted or banded together.

Under-drain pipe trench granular backfill material shall be placed without compaction, in one (1) foot layers. It shall be uniformly spread without segregation or contamination. Tarpaulins or other approved devices shall be used as guides to transport the granular backfill material from the hauling vehicle to the trench to prevent pulling dirt in with the granular backfill.

Satisfactory free and unobstructed outlets shall be provided for all drains. Where possible, all outlets shall have a twelve (12) inch free fall and shall be properly marked. All outlets to daylight shall be marked with a solid yellow Type II object marker, and have a precast concrete headwall with rodent screen. Outlets to underground storm sewer shall be sealed to the storm sewer with a concrete grout collar.

Drain installations and waste disposal shall be furnished and left in a neat appearing condition satisfactory to the Engineer.

64.4 METHOD OF MEASUREMENT

- A. Under-Drain Pipe Trench Granular Backfill Material:** Where a separate bid item for under-drain pipe trench granular backfill material is included in the bid proposal, under-drain pipe trench granular backfill material will be measured to the nearest one-tenth (0.1) ton utilizing certified weight tickets delivered to the Engineer within 48 hours of material delivery and placement. Excess material used to fill unauthorized or oversized trench widths or other dimensions will not be measured for payment.

Where no such item is included, weekly, or at the direction of the Engineer, the Contractor shall provide weight tickets to verify the quantity of granular backfill material used, along with the corresponding quantity of water and sewer pipe installed.

- B. Under-Drain Pipe or Tubing:** Shall be determined by measuring from centerline to centerline of all pipe and fittings. Measurements shall be to the nearest whole foot.

Separation fabric for under-drains will not be measured. It is incidental to the under-drain pipe.

- C. Under-Drain Cleanout:** Shall be measured per the each.

- D. Precast Concrete Headwall for Drains:** Shall be measured per the each. The solid yellow Type II object marker shall not be measured.

64.5 BASIS OF PAYMENT

- A. Under-Drain Pipe Trench Granular Backfill Material:** Where a separate bid item for under-drain Pipe Trench Granular Backfill Material is included in the bid proposal, under-drain Pipe Trench Granular Backfill Material will be paid for at the contract unit price per ton.

Where no such item is included, it shall be incidental to the under-drain installation.

Payment for this item will include full compensation for furnishing the material, labor, equipment, and incidentals necessary.

- B. Under-Drain Pipe or Tubing:** Will be paid for at the contract unit price per linear foot for the various types and classes of pipe or tubing and shall include pipe or tubing, necessary fittings, bands, bolts, wyes, elbows, gratings, lids, covers, guide posts, screens, breathers, excavation, backfilling, separation fabric material, and handling waste disposal.

- C. Under-Drain Cleanout:** Shall be full compensation for installation of the cleanout including casting and concrete collar if required by detailed plans and specifications.

- D. Perforated Pipe Precast Concrete Headwall:** Shall be paid by the each. The solid yellow Type II object marker shall be incidental to the headwall.

END OF SECTION

SECTION 65

RIPRAP

65.1 DESCRIPTION

A. General: This work consists of furnishing and placing approved material for the protection of piers, abutments, walls, embankments, and other plan-designated locations.

B. Related Work:

Section 202 Geosynthetics for Roadways
Section 203 Submittals

65.2 MATERIALS

Riprap shall be under-laid with Class 1 non-woven separation fabric per Section 202.

Riprap: Stone for riprap shall be hard and durable and shall have a minimum weight of 155 pounds per cubic foot. Riprap may be ledge rock or field stone. If field stone is utilized for Class B or larger, the stone shall have a minimum of 2 crushed faces as defined under SDDOT Materials Sampling and Testing SD 211. Stone shall be free from overburden, spoil, shale, and organic material. The riprap stone shall meet the following gradation requirements:

Riprap Class	Rock Size* ¹ in feet	Rock Size in pounds	Percent of Riprap Smaller Than
A	1.30	200	100
	0.95	75	50
	0.40	5	15
B	1.80	500	100
	1.30	200	50
	0.40	5	15
C	2.25	1000	100
	1.80	500	50
	0.95	75	15
D	2.85	2000	100
	2.25	1000	50
	1.80	500	15
E	3.60	4000	100
	2.85	2000	50
	2.25	1000	15
F	4.50	8000	100
	3.60	4000	50
	2.85	2000	15

*¹ Based on a specific gravity of 2.65 and spherical shape.

The riprap class is the median particle weight with 50% of the material smaller and 50% of the material larger.

Each load of riprap shall be well graded from the smallest to the maximum size specified.

65.3 CONSTRUCTION REQUIREMENTS

Areas to be protected by riprap shall be free of brush, trees, stumps, and other objectionable material and shall be dressed to a smooth surface. Soft or spongy material shall be removed to the specified depth and replaced with approved material. Filled areas shall be thoroughly compacted. All excavation required to construct the riprap subgrade to the configuration detailed in the plans shall be incidental to the payment for riprap. On slopes, a trench at least one (1) foot deep and one (1) foot wide shall be cut along the toe of the slope to receive the first or bearing course of large riprap stone.

The surface to be covered with separation fabric shall be smooth, free of obstructions, and shall conform to plan shown dimensions prior to placement of the separation fabric. The separation fabric shall be placed under and along all sides of the riprap that are in contact with earth, unless otherwise shown on the plans. Lapped joints in the separation fabric shall be placed transverse to the direction of flow with the overlap in the direction of flow. All lapped joints shall be lapped a minimum of one (1) foot. Vehicles and equipment shall not be operated directly on the separation fabric.

Protection for structure foundations shall be provided as early as the foundation construction permits. The area to be protected shall be cleaned of waste materials.

Riprap shall be placed in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids. Riprap shall be placed to its full course thickness in one operation without displacing the underlying material. Bridge berms, channel slopes/bottoms, and other surfaces that will be covered with riprap shall be finished to an elevation that will permit the placement of the required depth of riprap and match plan elevations or existing channels. Placing of riprap in layers, or by dumping into chutes, or similar methods likely to cause segregation will not be permitted. The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified.

In order to produce a compact riprap protection in which all sizes of material are placed in their proper proportions, hand placing or rearranging of individual stones by mechanical equipment may be required.

The riprap protection shall be placed in conjunction with the construction of the embankment. To prevent mixture of embankment and riprap, sufficient lag in construction of the riprap may be necessary. The Contractor shall maintain the riprap protection until accepted. Material displaced by any cause shall be replaced.

65.4 METHOD OF MEASUREMENT

A. Riprap: Will be measured to the nearest one-tenth (0.1) ton or one-tenth (0.1) cubic yard.

B. Separation Fabric: Will not be measured separately.

65.5 BASIS OF PAYMENT

A. Riprap: Will be paid for at the contract price per ton or cubic yard of material furnished. Payment for this item will be full compensation for furnishing, loading, hauling, placing, spreading the stone, and for labor and equipment required for shaping, excavating and performing all operations necessary.

B. Separation Fabric: Is incidental to the contract unit price for riprap.

END OF SECTION

SECTION 66

GABIONS

66.1 DESCRIPTION

A. General: This work consists of furnishing, assembling and filling woven wire gabions with stones as specified in the contract in conformance with the dimensions, lines, and grades shown on the plans or established by the Engineer.

B. Related Work:

Section 202 Geosynthetics for Roadways
Section 203 Submittals

66.2 MATERIALS

A. Gabions: Shall be supplied in various lengths and heights. The lengths shall be multiples (2, 3, or 4) of the horizontal width. The heights shall be fractions (1, 1/2, or 1/3) of the horizontal width. The horizontal width shall not be less than 36 inches. Gabions shall be of uniform width.

Gabions shall be fabricated so the sides, ends, lid, and diaphragms can be assembled at the construction site into a rectangular basket. Gabions shall be of single unit construction. Base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion so strength and flexibility at the point of connection is at least equal to that of the mesh.

The gabion shall be furnished with diaphragms the same mesh and gauge as the body of the gabions, secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. The spacing of the diaphragms shall be the same as the horizontal width.

The gabions shall be made of woven wire mesh. The woven wire mesh shall be made of galvanized steel wire having a minimum size of U.S. steel wire gauge #11. The tensile strength of the wire shall be 60,000 to 85,000 psi when tested in accordance with ASTM A392. The minimum zinc coating of the wire shall be 0.8 oz. per square foot of uncoated wire surface as determined by ASTM A90. The maximum linear dimension of the mesh opening shall not exceed 4½ inches and the area of the mesh opening shall not exceed 10 square inches.

The wire mesh shall have elasticity permitting elongation to a minimum of 10% of the length of the section of the mesh without reducing the gauge or tensile strength of individual wires to values less than those for wire one gauge smaller.

A section of the mesh 6 feet long and not less than 3 feet wide, after the elongation test shall withstand a load test of 6,000 pounds applied to an area of 1 square foot in the center of the section.

An uncut section of mesh 6 feet long, not less than 3 feet wide, including selvedge bindings, shall have the ends securely clamped for 3 feet along the width of the sample. When the width of the sample exceeds 3 feet, the clamps will be placed in the middle and the excess width will fall free on each side of the clamped section. The sample shall be subjected to sufficient tension to cause 10% elongation of the section between the clamps. After elongation and while clamped, the section shall be subjected to a load applied to an area of 1 square foot in the center of the sample section and perpendicular to the direction of the tension force. The sample shall withstand, without rupture of wire or opening of mesh fastening, an actual load of 6,000 pounds. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting of the wires.

The wire mesh shall resist pulling apart at the twists or connections forming the mesh when a single wire is cut and the section of mesh then subjected to the load test described in the elasticity test.

Each shipment of gabions shall be accompanied by a certificate, which states that the material conforms to the requirements.

GAUGE TABLE FOR ZINC COATED STEEL WIRE

Wire Gauge	Equivalent Diameter
Designation	Inches
9	0.148
10	0.135
11	0.120
11½	0.113
12	0.105
12½	0.099
13	0.0915
14	0.080

Materials shall conform to the following requirements and Sections.

- B. PVC Coating:** When specified, the wire used in the fabrication of the bank and channel protection shall be PVC coated. After zinc coating, the PVC coating shall be extrusion bonded on the wire. The PVC coating shall have a nominal thickness of 0.02165 inches and a minimum thickness of 0.015 inches. The lacing wire shall also be PVC coated.

The PVC coating shall not crack, peel, blister, split, or have any other defects. The coating material shall be resistant to the effects of weather and exposure to ultraviolet rays.

- C. Lacing and Internal Connecting Wire:** Shall be 0.0866 inch diameter steel wire ASTM A641 Class 3 soft temper measured after galvanizing and for PVC coated baskets shall be 0.0866 inch diameter steel wire measured after galvanizing but before PVC coating.

All perimeter edges of the mesh forming the baskets, including end panels and top of the diaphragms, shall be selvedged with selvedge wire. For sound structural integrity, the gabion mesh wires shall be wrapped around the selvedge wire with a number of turns necessary to interconnect each of them with the adjacent mesh wire.

For multitiered structures, the internal connecting wires shall be furnished. The internal connecting wires shall meet the same specifications as the wire used in the mesh.

Tie wire or connecting wire shall securely fasten all edges of the gabion and diaphragms to provide for four internal connecting wires in each cell one-half unit high and eight internal wires in each cell one unit high. The tie wire shall meet the same specifications as the wire used in the mesh except that the tie wire may be two gauges smaller.

- D. Interlocking Fasteners:** For galvanized gabions shall be high tensile 0.120 inch diameter galvanized steel wire measured after galvanizing. The galvanizing shall conform to ASTM A641 Class 3 coating. Fasteners shall also be in accordance with ASTM A764, Class II, Type C.

Interlocking fasteners for PVC coated gabions shall be high tensile 0.120 inch diameter stainless steel wire conforming to ASTM A313, Type 302, Class I.

The use of alternate fasteners shall be permitted in lieu of lacing wire provided the following has been demonstrated.

1. The ability of the alternate fastener to contain a minimum of four selvedge wires while remaining overlapped a minimum of 1 inch for overlapped type or in a locked and closed condition.
2. The proposed fastener system can consistently produce a four selvedge wire joint with a strength of 1400 pounds per linear foot for a galvanized joint and 1200 pounds per linear foot for PVC coated gabion joints.
3. The proper installation can be readily verified by visual inspection.

- E. Stone:** Shall be durable stone or ledge rock, free of seams, cracks, and defects. Slabby stone pieces will not be acceptable. The stone shall range in size from a minimum of 4 inches to a maximum of 8 inches in the greatest dimension. The majority of the stones shall be in the 5 to 6 inch range and cubical or rounded in shape. Stone shall not have an L.A. Abrasion of more than 40%.

F. Separation Fabric: Shall conform to Class 1 non-woven separation fabric per Section 202.

66.3 CONSTRUCTION REQUIREMENTS

Slopes to be protected by gabions shall be free of brush, trees, stumps and other objectionable material and shall be dressed to a smooth surface. Soft or spongy material shall be removed to the specified depth and replaced with suitable material. Filled areas shall be thoroughly compacted. The bank and channel protection shall be assembled individually by erecting the sides, ends and diaphragm(s) with all creases in the correct position and the top of all sides satisfactorily level. Lacing wire, fasteners, or both shall be used to assemble the units and to join the units together.

A. Lacing: The lacing procedure is as follows:

1. Cut a length of lacing wire approximately 1½ times the distance to be laced but not exceeding 5 feet.
2. Secure the wire terminal at the corner by looping and twisting.
3. Proceed lacing with alternating single and double loops at a spacing not to exceed 6 inches.
4. Securely fasten the other lacing wire terminal.

B. Interlocking Fasteners: May be used for basket assembly as final construction of gabion structures. Spacing of fasteners during all phases of assembly and construction shall not exceed 6 inches.

C. Fabric: When separation fabric is specified, the surface to be covered shall be smooth, free of obstructions, and shall conform to plan shown dimensions prior to placement of the separation fabric.

The separation fabric shall be placed under and along all sides of the bank and channel protection that is in contact with earth, unless otherwise shown on the plans. Lapped joints in the separation fabric shall be placed transverse to the direction of flow with the overlap in the direction of flow. All lapped joints shall be lapped a minimum of 12 inches. Vehicles and equipment shall not be operated directly on the separation fabric.

D. Installation: A standard fence stretcher, chain fall, or iron rod may be used to stretch the bank and channel protection and hold alignment. The units shall be filled with stone carefully placed by hand or machine to assure alignment and avoid bulges with a minimum of voids. To allow for settlement, overfilling of 2 to 3 inches is required. After each unit has been filled, the lid shall be stretched tight over the stone fill using only an approved lid closing tool, until the lid meets the perimeter edges of the front and end panels. Using crowbars or other single point leverage

bars for lid closing shall be prohibited.

After the units are filled, the lid(s) shall be folded over to meet the sides and edges and secured with lacing wires, fasteners, or both. When PVC coated bank and channel protection is specified, special care shall be taken during the filling operation to avoid damaging the coating. Bank and channel protection on which the PVC coating has been damaged shall be repaired or replaced.

Whenever a structure requires more than one tier, the upper empty cells shall also be connected to the top of the lower tier along the front and back edges of the contact surface using the same connecting procedure described above using lacing wire or fasteners or both.

Internal connecting wires shall be installed in multi-tiered structures as follows:

36 Inch High Gabions: Shall be filled in three layers, 1 foot at a time. After the placement of each layer, that is at 1 foot high and 2 feet high, connecting wires shall be placed according to the manufacturer's recommendations to connect the exposed face of a cell to the opposite side of the cell. An exposed face is any side of a cell that will be exposed or unsupported after the structure is completed.

18 Inch High Gabions: Do not require connecting wires unless the cells are used to build vertical structures. In some cases, these units shall be filled in two layers, 9 inches at a time. After the placement of the first layer, connecting wires shall be placed according to the manufacturer's recommendations to connect the exposed face of a cell to the opposite side of the cell. An exposed face is any side of a cell that will be exposed or unsupported after the structure is completed.

66.4 METHOD OF MEASUREMENT

- A. **Bank and Channel Protection Gabions:** Will be measured to the nearest 0.1 cubic yard. If a substitution is made, the dimensions of the bank and channel protection installed shall be equal to or greater than the dimensions specified. Payment will be based on plans quantity, unless changes are ordered in writing by the Engineer.
- B. **Separation Fabric:** Will not be measured.

66.5 BASIS OF PAYMENT

- A. **Bank and Channel Protection Gabions:** Will be paid for at the contract unit price per cubic yard. Payment will be full compensation for materials, equipment, labor, excavating, shaping and incidentals required.
- B. **Separation Fabric:** Will be incidental to the unit price bid for gabions.

END OF SECTION

SECTION 70

SEEDING

70.1 DESCRIPTION

A. General: This work consists of preparing a seedbed and furnishing and planting seed on disturbed areas identified within the limits of the work.

B. Related Work:

Section 18	Erosion, Sediment, and Water Pollution Control
Section 71	Fertilizing
Section 72	Mulching
Section 76	Compost
Section 203	Submittals

70.2 MATERIALS

A. General: The seed shall comply with the requirements of the South Dakota Seed Law.

B. Origin Limitations: Grass seed furnished shall be the grass species listed in the plans or these specifications. The Contractor may use one of the grass varieties listed in the plans for the specified grass species or the Contractor may use a different grass variety of the same grass species specified. If the Contractor uses a grass variety listed in the plans for the specified grass species, the grass seed origin limitations will not apply. If the Contractor uses a grass variety not listed in the plans for the specified grass species, the grass seed furnished must originate in South Dakota, North Dakota, Montana, Wyoming, Nebraska, Iowa, Minnesota, Kansas, Colorado, or Wisconsin. Grass seed grown outside this area may be approved after the Contractor has furnished written certification from three seed suppliers confirming seed grown within this area is not readily available.

Forb, sedge, rush, shrub, and wildflower seed must originate in the United States or Canada. Forb, sedge, rush, shrub, and wildflower seed grown outside the United States and Canada may be approved after the Contractor has furnished written certification from three seed suppliers confirming seed grown within the two countries is not readily available.

C. Seed Testing: Seed shall be tested within 9 months prior to planting, exclusive of the calendar month in which the test was completed. Testing shall be performed by a State Seed Lab, Commercial Seed Testing Lab, or a registered member of the Society of Commercial Seed Analysts (Registered Seed Technologist). A certified test report shall be furnished prior to the start of seeding operations. If the seed is not planted within the 9 month period, the Contractor shall have the seed retested for germination, as described above, and a current germination report with the certified

test report shall be furnished prior to starting seeding operations. The retest will be based on a sample obtained from the seed out of compliance.

D. Labeling: Each bag of seed delivered to the project shall bear a tag which shows the following information:

1. Name and address of supplier.
2. County and project number for which seed is to be used.
3. Suppliers lot number for each kind of seed in the mixture.
4. Origin (where grown) for each kind of seed.
5. Purity, germination, and other information required by South Dakota Seed Law, for each kind of seed.
6. Pounds of bulk seed of each kind of seed in each bag.
7. Total pounds of bulk seed mixture in each bag.
8. Pounds of pure live seed (PLS) of each kind of seed in each bag.
9. Total pounds of PLS mixture in each bag.
10. Dormant seed and hard seed.

When bulk seed is referred to, it is defined as total seed, including PLS, inert matter, crop seed, and weed seed.

E. Inoculation of Legumes: Prior to seeding, legumes (alfalfa, clovers, etc.) shall be inoculated with fresh culture of the appropriate nitrogen fixing bacteria in accordance with instruction accompanying the inoculant. A certification of the inoculation shall be furnished.

F. Seed Mixes: Seed mixes for seeding areas over two (2) acres shall be designed to meet site-specific requirements, such as soil type, orientation, slope, irrigation/no-irrigation, soil nutrients, and other.

Seed mixes for small applications, under two acres, may be the following:

1. Irrigated Turf Mix:

- 30% Gaelic Kentucky Bluegrass
- 25% Shannon Kentucky Bluegrass
- 25% SPF-30 Kentucky Bluegrass
- 10% Benchmark Perennial Ryegrass
- 10% Salinas II Perennial Ryegrass
- Drilled Rate: 4 lbs per 1000 square feet

2. Non-Irrigated Lawn Mix:

35% Fairmont Chewings Fescue
 30% Cardinal Creeping Red Fescue
 25% Brigade Hard Fescue
 10% Blue Heron Blue Fescue
 Drilled Rate: 4 lbs per 1000 square feet

3. Reclamation Blend (Road Ditch Mix):

40% Ephraim Crested Wheatgrass
 30% Perennial Ryegrass
 20% Hard Fescue
 10% Annual Ryegrass
 Drilled Rate: 2 lbs per 1000 square feet

4. Alkali Turf Mix:

The Contractor shall submit a seed mix listing the specific varieties of seed in the mix intended for use for each project.

70.3 CONSTRUCTION REQUIREMENTS

- A. General Requirements:** Within seasonal limitations, seeding shall be done as soon as finish grading and placing topsoil on each section have been completed.

Seeding or related work shall not be done when the ground is frozen or the condition of the soil is such that a satisfactory seedbed or uniform seed placement cannot be obtained. Seed shall not be sown, when the wind interferes with uniform seed application, or on areas under water.

Slopes shall be worked longitudinally, on contour, during the preparation of areas, drilling, and after seeding.

Fertilizing and mulching shall be provided as specified in Sections 71 and 72.

The Engineer may approve necessary adjustments in the requirements outlined to obtain the most satisfactory results under varying conditions.

- B. Seasonal Limitations:** Seeding shall not be done between June 15 and August 31 without written authorization from the Engineer.

Seeding may be done when the ground is not frozen and condition of the soil permits preparation of a satisfactory seedbed. Seeding shall not be done without authorization from the Engineer.

- C. Application Rate:** The seed mixture shall be applied at the plan specified rate of pounds of PLS per acre.

The primary method of application shall be by drill. Hydroseeding or broadcast seeding shall be allowed only with permission of the Engineer. The Engineer may require up to two (2) times the application rate for hydroseeding or broadcast seeding with no additional cost to the City above the cost to drill the seed.

The Contractor will be required to calibrate the drill or hydroseeder on each project. Calibration runs may be performed on areas to be seeded.

- D. Cover Crop Seeding:** When specified in the plans or directed by the Engineer, cover crop shall be seeded. Engineer may determine that specific areas may be excluded from cover crop seeding.

Cover crop seed shall consist of 56 pounds of oats, spring wheat, winter wheat, or cereal rye (minimum 75% PLS) per acre.

Cover crop seeding may be done at any time when the soil and weather conditions are suitable, as determined by the Engineer. Oats or spring wheat shall be used April through July, and winter wheat and cereal rye shall be used August through November.

E. Equipment and Methods:

- 1. Seedbed Preparation:** The Contractor shall work areas to be seeded to a depth of approximately 3 inches. The Contractor shall take every effort to obtain this depth on the first pass with tillage equipment. The Contractor shall remove and dispose of logs, stumps, brush, weeds, cobbles, and other foreign material which interferes with the proper operation of drills and other implements. After the initial seedbed preparation, the Contractor shall prepare seedbeds according to the type of grass seed mixture to be planted.

- a) Turf Grass Seed Mixtures:** The Contractor shall remove rocks larger than one (1) inch. The Contractor shall construct the surface to be seeded to the required cross section. The Contractor shall shape the surface to remove mounds and low spots to provide a smooth even surface to match grade and cross section as shown in the plans. After seeding and fertilizing, the seedbed shall be rolled or otherwise worked by a method approved by the Engineer to firm the seedbed and break up lumps and clods so they are no larger than one (1) inch in size.

- b) All Other Grass Seed Mixtures:** Lumps and clods exposed by the initial pass of tillage equipment over 3 inches in diameter shall be broken up. The implement used shall be a tool carrier with rigid shanks with sweeps or chisels, or a heavy-duty disk as appropriate to the conditions. The implement shall have positive means of controlling depth of penetration. The number of passes required to break up lumps and clods shall be kept to a minimum. Working the soil to a fine pulverized condition shall be avoided. The final prepared seedbed shall be left in a roughened condition consisting mainly of lumps 2 to 3 inches in diameter, for maximum resistance to erosion. After

seedbed preparation has been completed, the Contractor shall pick up and dispose of all loose stones and boulders having a vertical projection of 3 inches or more above the soil surface.

2. **Reseeding of Previously Seeded Areas:** Existing vegetation and cover crop shall be preserved for mulch. The seed shall be drilled directly into existing cover if possible, or by mowing and disking to permit penetration of drill openers and placement of seed to the specified depth.
3. **Drilling:** The specified seed mixture shall be uniformly drilled using a press drill equipped with individually mounted, adjustable, spring loaded, double disk furrow openers fitted with depth control bands or drums.

The depth control bands or drums shall be of a size to provide a final planting depth of 1/4 to 1/2 inch behind the press wheel.

The press drill shall be mounted on rear press wheels, which carry a major portion of the weight of the drill, and shall have no weight carrying wheels at the ends of the seedbox. The press wheels shall be mounted independently of the furrow openers. A press wheel shall follow directly behind each opener to compact the soil over the drill row.

Seeding may be done with drills other than press drills provided they are equipped with baffles, partitions, agitators, or augers which keep the seed distributed throughout the seed box. They must also have packer wheels which follow directly behind double disk furrow openers and provide compaction of the seeded drill rows similar to the compaction obtained by a press drill. No-till drills will be allowed for seeding into cover crop or existing vegetation as long as the seed is planted to the required depth.

The seedbox shall be equipped with positive feed mechanisms which will accurately meter the seed, and agitators which will prevent bridging in the seedbox and keep the seed uniformly mixed during drilling. The drill shall conform to the following:

Drill Width Maximums:

- a) Single units..... 10 feet
- b) Flex coupled side by side units 16 feet (maximum two 8 foot members)
- c) Max. drill row (openers) spacing 8 inches

Each drill shall be equipped with a metering device which will measure the area covered by the drill.

Each drill shall be equipped with fabricated baffles or partitions mounted a maximum of 2 foot on centers and flush with the top of the seedbox and extending

downward to within 4 inches of the bottom of the seedbox.

On areas where a press drill cannot be operated satisfactorily, hydraulic, cyclone or knapsack hand operated, or other broadcast type seeders may be used.

4. **Hydroseeding:** The equipment shall be designed specifically for hydroseeding. The nozzle shall be adaptable to hydraulic seeding requirements. Storage tanks shall have a means of estimating the volume used or remaining in the tank. Hydroseeding shall be allowed only with permission of the Engineer.
5. **Broadcast Seeding:** The Contractor shall rake or drag (incorporate) all seed broadcast within the top 1/4 to 1/2 inch of topsoil. The Engineer may waive this requirement when raking or dragging is deemed, in the Engineer's sole discretion, not feasible by conventional methods. Broadcast seeding shall be allowed only with permission of the Engineer.

- F. Care During Construction and Final Inspection:** Dirt ridges which result from seeding operations or from traffic shall be smoothed so they will not interfere with future mowing operations.

Following completion of seeding operations, foot, vehicular, or equipment traffic over the seeded area shall be avoided. Areas damaged from such traffic shall be reworked and reseeded.

Before the acceptance of the project, any area on which the original seed has been lost or displaced shall be reseeded.

Engineer may determine that specific areas may be excluded from seeding.

- G. Watering:** After seed, fertilizer and mulch have been placed, it shall be watered to provide a moist condition through the mulch as well as into the underlying soil bed. For a period of three (3) weeks after seeding and initial watering, the Contractor shall apply adequate water to insure proper germination of the seed and growth of the grass. The Engineer may waive watering requirements if adequate natural moisture has been present. At the end of the three (3) week watering period, the Engineer will inspect to determine if the grass is alive and growing. If seed has not satisfactorily rooted into the soil and is not alive and growing, the Engineer will determine if new seed and/or additional watering, at the Contractors expense, are required. Replaced seed shall be watered as required for the original.

After the Engineer acceptance of the newly seeded areas, the Contractor shall notify all affected property owners, with notification of watering requirements provided by the Owner, that they will be responsible for watering the newly seeded areas. The Contractor shall provide written verification that affected property owners have both been notified and have accepted the condition of the newly seeded areas.

The growing season is defined as May through September.

70.4 METHOD OF MEASUREMENT

- A.** Permanent seed will be measured to the nearest pound of PLS furnished and planted. Unauthorized increases in the specified rate of seeding will not be measured for payment. Seed required for calibration of the drill will be measured. Reseeding of areas damaged from causes beyond the control of the Contractor will be measured and added to the original quantities used.
- B.** The weight of PLS is computed by multiplying the purity, times the sum of the germination and dormant seed value, times the weight of bulk seed applied. The purity, dormant seed, and germination values will be as shown on the bag tag. If the seed has been retested, the retested value will be used in determining PLS. Seed bag tickets shall be submitted to the Engineer no later than 48 hours after seeding.
- C.** Cover crop seeding shall be measured per bushel. For purposes of measurement, one bushel of cover crop seed shall be considered to be 56 pounds of bulk seed regardless of whether oats, spring wheat, or winter wheat is used.

70.5 BASIS OF PAYMENT

- A.** PLS will be paid for at the contract unit price per pound of permanent seed. Payment will be full compensation for the preparation of the seedbed, labor, tools, equipment, inoculant and its application, and incidentals necessary.
- B.** Cover crop seeding shall be paid for at the contract unit price per bushel. Payment will be full compensation for the preparation of the seedbed, labor, tools, equipment, inoculant and its application, and incidentals necessary.
- C.** Water for seeding shall be considered incidental and shall be included in the unit price bid for seeding.

END OF SECTION

SECTION 71

FERTILIZING

71.1 DESCRIPTION

A. General: This work consists of furnishing and applying fertilizer material on areas to be seeded or sodded.

B. Related Work:

Section 18	Erosion, Sediment, and Water Pollution Control
Section 70	Seeding
Section 72	Mulching
Section 76	Compost

71.2 MATERIALS

A. Requirements: Fertilizer shall be a dry standard commercial product conforming to the South Dakota Fertilizer Law and subsequent amendments or revisions. Each brand and grade of fertilizer must be registered with the State Department of Agriculture. Contractor shall submit information demonstrating that the proposed fertilizer meets these specifications. Each bag or container shall clearly show the net weight of the contents, the name and address of the manufacturer, the brand and grade, the guaranteed analysis of the contents showing the minimum percentages of total nitrogen, phosphoric acid, and water-soluble potash available, in that order.

B. Condition: Fertilizer shall be in a condition which permits proper distribution.

C. Testing: Testing of fertilizer will not be required.

D. Fertilizer:

1. For small projects, under two acres of seeding area:

a) Reclamation blend (road ditch mix) or pasture blend: 11-52-0 (low salt)
Rate: 200 pounds per acre

b) Sod, non-irrigated, irrigated, or alkali turf mix: 15-25-10 (slow release, low salt)
Rate: 400 pounds per acre

2. Fertilizer type and quantity for projects with seeding areas larger than two acres shall be based upon testing of topsoil for horticultural properties. Test results and fertilizer type shall be submitted to the Engineer for approval.

71.3 CONSTRUCTION REQUIREMENTS

A. Application: Fertilizer shall be applied not more than twenty-four (24) hours prior to seeding. Fertilizer shall be applied by one of the following methods:

1. With a fertilizer attachment on the drill, which will place the fertilizer in a band on or near the drill row behind the openers during the drilling operations (preferred method).
2. By drilling in with an approved drill prior to seeding.
3. By spreading the fertilizer uniformly over the areas to be seeded prior to or during seedbed preparation (before final pass). This method will not be acceptable when seedbed preparation is not required.
4. Where the seed is sown by a hydraulic seeder, the required amount of fertilizer may be placed in the tank, mixed together with the water and the seed, and applied in the seeding operation.
5. By hand operated broadcaster following sod installation.
6. By equipment mounted broadcast spreaders on slopes flatter than 6:1.
7. On slopes steeper than 3:1, where fertilizer cannot be incorporated into the soil effectively by mechanized equipment, fertilizer may be applied by any approved method and raked in to a depth of approximately one (1) inch.

B. Cleanup: The Contractor shall sweep all fertilizer misplaced on adjacent pavement onto the seedbed. The Contractor shall remove and dispose of all logs, stumps, brush and other foreign material exposed during fertilizer application including rocks larger than one (1) inch in areas to be seeded with turf grass mixtures and clods having a vertical projection of 3 inches or more above the soil surface.

71.4 METHOD OF MEASUREMENT

Fertilizing will be measured to the nearest 0.01 ton or to the nearest whole (1) pound or as specified in the plans. Weigh tickets shall be submitted to the Engineer no later than 48 hours after fertilizing.

71.5 BASIS OF PAYMENT

Fertilizing will be paid for at the contract unit price or as specified in the plans. Payment will be full compensation for furnishing, hauling, placing, labor, equipment, materials, tools, and incidentals necessary.

END OF SECTION

SECTION 72

MULCHING

72.1 DESCRIPTION

A. General: This work consists of placing a mulch cover on slopes or other designated areas following seeding and fertilizing operations.

B. Related Work:

Section 18	Erosion, Sediment, and Water Pollution Control
Section 70	Seeding
Section 71	Fertilizing
Section 203	Submittals

72.2 MATERIALS

A. Grass Hay or Straw Mulch: Shall be free of noxious weed seeds and objectionable foreign matter. The mulch shall have been baled dry, in bales of approximately equal weight and shall be relatively dry when applied. Materials with noxious weed contamination or materials with characteristics unsuitable for the purpose intended will be rejected and the Contractor shall remove the contaminated material from the project.

Bromegrass is not an acceptable mulch.

B. Fiber Mulch: Shall contain no germination or growth inhibiting factors and shall have the property of becoming evenly dispersed and suspended when agitated in water. Fiber mulch that is blended with recycled paper is not allowed. When sprayed uniformly with hydraulic seeding equipment on the surface of the soil, the fibers shall form a blotter like ground cover, which will readily absorb water and allow infiltration to the underlying soil without restricting emergence of seedlings. Weight specification from suppliers, and for all applications, shall refer only to air dry weight of the fiber, considered to be 10% moisture.

The fiber mulch material shall be supplied in packages marked by the manufacturer to show the air dry weight content. Suppliers shall certify that laboratory and field testing of their product has been accomplished, and that it meets all of the foregoing requirements.

C. Bonded Fiber Matrix: Shall consist of a continuous layer of elongated fiber strands held together by a water resistant bonding agent. The bonded fiber matrix shall be uniformly applied and shall have no gaps between the product and the seeded soil. The product shall be 100% biodegradable and composed of 90% wood fiber, 9% natural binder, and 1% organic and mineral activators (all by weight). The treatment

shall be installed with hydraulic seeding equipment.

- D. Fiber Reinforced Matrix:** Shall consist of thermally processed fiber, crimped interlocking fibers, cross-linked hydrocolloidal polymer tackifiers, and activators. Fiber reinforced matrix shall form an intimate bond with the soil surface. The fiber reinforced matrix shall form a continuous, flexible, and lofty interlocking matrix that creates air spaces and water absorbing cavities to improve seed germination, reduce the impact of raindrop energy, and minimize soil loss. The treatment shall be installed with hydraulic seeding equipment.

72.3 CONSTRUCTION REQUIREMENTS

- A. General:** Reapplication in areas damaged from causes beyond the control of the Contractor will be measured and added to the original quantities used.

B. Grass Hay or Straw Mulch:

- 1. Placing:** The mulch shall be placed within 48 hours after the seeding has been completed. Mulching operations shall not be performed during periods of high winds, which preclude the proper placing of the mulch. The placing of mulch shall begin on the windward side of the areas to be covered.

The mulch shall be machine blown to uniformly distribute mulch over the seeded areas. The machine shall blow or eject mulch, by a constant air stream, that controls the amount of mulch. The machine shall cause a minimum of cutting or breakage of the mulch.

Mulch containing excessive moisture, which prevents uniform feeding through the machine, shall not be used.

Mulch shall be placed uniformly over the seeded areas at a rate of 2 tons per acre. Approximately 10% of the soil surface shall be visible through the mulch blanket prior to mulch tiller (punching) operation.

Excessive cover, which will smother seedlings, shall be avoided. The Engineer may order the placement of mulch on any area where protection is necessary to forestall erosion or encourage turf establishment.

- 2. Punching:** Immediately following application, the mulch, shall be punched into the soil by a mulch tiller consisting of a series of dull, flat disks with notched or cutout edges. The disks shall be approximately 20 inches in diameter, 1/4 inch thick, spaced approximately 8 inches apart and fitted with scrapers.

Working width of the tiller shall not exceed 6 feet per member, but may be operated in gangs of not over three members. The tiller shall be operated on contour, except those on slopes 3:1 or steeper diagonal operation will be permitted.

Tiller members shall be ballasted; to push mulch into the soil approximately 3

inches with ends exposed above the soil surface. If punch depth cannot be achieved, the Engineer may require a tackifier or soil stabilizing product be applied.

The mulch tiller shall follow as closely as possible behind the mulcher. Mulch shall not be blown when wind velocity causes appreciable displacement before it can be anchored by the mulch tiller. More than one pass of the mulch tiller may be required to ensure adequate anchoring.

- C. Fiber Mulch:** Rate of application shall be 2,000 pounds per acre unless otherwise specified in the plans or by the Engineer. Excessive thickness of mulch, which will smother grass seedlings, shall be avoided.

Mulch shall be placed on a given area as soon as possible or within 48 hours after seeding as a separate operation. The Contractor shall allow the fiber mulch to cure a minimum of 18 hours prior to watering.

- D. Bonded Fiber Matrix:** Rate of application shall be 3,900 pounds per acre and the mix shall consist of 50 pounds bonded fiber matrix to 125 gallons water unless otherwise specified in the plans or by the Engineer. Bonded fiber matrix shall be placed on a given area as soon as possible, or within 48 hours after seeding as a separate operation.
- E. Fiber Reinforced Matrix:** Shall not be placed in channels. Fiber reinforced matrix shall be placed on a given area as soon as possible and within 48 hours after seeding as a separate operation. Fiber reinforced matrix is effective upon application therefore does not require a curing time.
- F. Care during Construction:** Traffic, either foot, equipment, or vehicle shall be avoided over the seeded and mulched areas.

Before acceptance of the project, any area on which the original mulch has been displaced shall be remulched.

72.4 METHOD OF MEASUREMENT

Material weight tickets shall be submitted to the Engineer no later than 48 hours after application.

- A. Grass Hay or Straw Mulch:** Will be measured to the nearest 0.1 ton of mulch applied.
- B. Fiber Mulch:** Shall be measured to the nearest whole pound or 0.1 ton, as specified in the plans, of mulch applied.
- C. Bonded Fiber Matrix:** Shall be measured to the nearest whole pound or 0.1 ton, as specified in the plans, of matrix applied.
- D. Fiber Reinforced Matrix:** Shall be measured to the nearest whole pound or 0.1 ton,

as specified in the plans, of matrix applied.

72.5 BASIS OF PAYMENT

- A. **Grass Hay or Straw Mulch:** Will be paid for at the contract unit price per ton. Payment will be full compensation for furnishing, hauling, placing, punching, and for materials, equipment, labor, tools, and incidentals necessary.
- B. **Fiber Mulch:** Will be paid for at the contract unit price per pound or ton, as specified in the plans. Payment will be full compensation for furnishing, hauling, and placing and for materials, equipment, labor, tools, and incidentals necessary.
- C. **Bonded Fiber Matrix:** Will be paid for at the contract unit price per pound or ton, as specified in the plans. Payment will be full compensation for furnishing, hauling, and placing and for materials, equipment, labor, tools, and incidentals necessary.
- D. **Fiber Reinforced Matrix:** Will be paid for at the contract unit price per pound or ton as specified in the plans. Payment will be full compensation for furnishing, hauling, and placing and for materials, equipment, labor, tools, and incidentals necessary.

END OF SECTION

SECTION 73

SODDING

73.1 DESCRIPTION

A. General: This work consists of preparing the ground surface and furnishing, transporting, and placing live sod.

B. Related Work:

Section 17	Salvaging, Stockpiling, and Placing Topsoil
Section 18	Erosion, Sediment, and Water Pollution Control
Section 71	Fertilizing
Section 76	Compost
Section 203	Submittals

73.2 MATERIALS

The sod shall consist of a dense, well-rooted growth of Kentucky Blue Grass, fescue, or sod as approved by the Engineer. The sod shall be free from noxious weeds and substantially free from other objectionable grasses, weeds, or foreign materials detrimental to the development and future maintenance of the sod.

At the time the sod is cut, the grass shall have a length of approximately two (2) inches. If longer than three (3) inches, the grass shall be cut to approximately two inches in length, and the sod shall have been raked free of debris. Sod shall be delivered to the jobsite in live, moist condition without undue crumbling or breaking.

If the sod is in a dry condition so that it cannot be cut, rolled, loaded, and hauled to the jobsite, without crumbling or breaking, the Contractor shall apply water to the sod in sufficient quantities to provide a well-moistened condition of the sod to the depth to which it is to be cut. This watering shall be at no additional cost to the City.

Water used on sod shall be from municipal, domestic, or other sources known to be suitable for irrigation.

Fertilizer shall be provided as indicated in Section 71.

73.3 CONSTRUCTION REQUIREMENTS

A. Cutting and Salvaging Sod: Shall be machine cut into rectangular sections. The sections shall be of uniform width of not less than ten (10) inches or more than twenty-four (24) inches. The sections may vary in length, up to nine (9) feet maximum. The sod shall be cut to a depth of three-fourths ($\frac{3}{4}$) inch or more so the dense root system will be retained and exposed in the bottom side of sod, and the sod can be handled

without undue tearing or breaking. Sod shall be rolled with the top growth inside. Sod strips, which indicate crumbling, tearing, breaking, or loss of soil during the operations of cutting, transporting, or handling will not be acceptable. Sod shall be laid in its final position within 36 hours after being cut. During the period between cutting and laying, the sod shall be protected from damage.

- B. Preparing Surface for Sodding:** The surfaces to be sodded shall be constructed to the required cross-section and contour and shall be smooth, uniform, and free from stones, roots, or other undesirable foreign material. These surfaces shall be undercut to sufficient depth below adjacent areas so the top of newly-laid sod will be flush with any adjacent seeded or turfed areas and between one inch below to flush with top of sidewalks, curbs, or other structures. Some trenching-in of the areas to be sodded and some building up of the adjacent areas may be necessary. The adjacent areas shall smoothly blend with each other, without sharp breaks in the contours.

The prepared soil bed shall be inspected and approved prior to sodding. If the soil bed is dry and/or hot, the Engineer may require the Contractor to pre-water to a depth of one (1) inch prior to sodding. The earth planting bed shall be allowed to dry sufficiently after watering to permit sod placement without tracking.

Immediately prior to placing the sod, the soil shall be loosened and brought to a fine granular texture, to a depth of not less than one (1) inch. Clods, lumps, weeds, rocks larger than one (1) inch, or other unsatisfactory materials shall be removed.

- C. Laying Sod:** Sod shall be placed as soon as practicable following the winter season. When sod is available in the spring, the Engineer may issue written notice requiring the Contractor to begin placing sod within 10 working days of receipt of the notice. Failure to begin placement of the sod within the specified time shall result in issuance of a stop-work order. However, contract time will continue to be counted.

The sod on berm slopes shall be laid by hand in horizontal strips, beginning at the bottom of the slope and working upwards. In waterways, strips shall be laid parallel to the flow. Each section of sod shall be laid parallel to the flow. Each section of sod shall join the adjacent sections without overlapping but shall abut snugly against the section previously laid. End joints shall be staggered and open joints or gaps shall be filled with sod cut to the proper size and shape.

The top and bottom ends of sodded areas shall extend at least two (2) inches into the ground or ditch bottom. Other edges of sodded areas shall be turned into the ground two (2) inches and covered with a layer of topsoil which shall be compacted to conduct the surface water over the edge of the sod and blend the sodded areas into the adjacent finished grades.

Fertilizer shall be spread by hand operated broadcaster following sod installation as per Section 71.

- D. Anchoring:** On slopes steeper than 6:1, the sod shall be anchored with one (1) inch wide by six (6) inch long U-shaped staples made from No. 11 or heavier ungalvanized steel wire. A minimum of four (4) staples per sod strip in every other row shall be used.

In waterways, two (2) staples shall be placed in the upper end of each sod strip in the end facing flow.

Staples shall be driven flush with the top of the sod. Additional staples as required, to obtain adequate anchoring shall be placed as determined by the Engineer.

- E. Watering:** After sod has been laid, it shall be watered to provide a moist condition through the thickness of the sod and six (6) inches into the underlying soil bed.

For a period of three (3) weeks after sodding and initial watering, the Contractor shall apply adequate water to insure proper growth of the grass. The Engineer may waive watering requirements if adequate natural moisture has been present. At the end of the three (3) week watering period, the Engineer will inspect to determine if the sod is rooted into the underlying soil and is alive and growing. If sod has not satisfactorily rooted into the soil and is not alive and growing, the Engineer will determine if new sod and / or additional watering, at the Contractors expense, are required. Replaced sod shall be watered as required for the original.

After the Engineer acceptance of the newly sodded areas, the Contractor shall notify all affected property owners, with notification of watering requirements provided by the Owner, that they will be responsible for watering the newly sodded areas. The Contractor shall provide written verification that affected property owners have both been notified and accepted the condition of the newly sodded areas.

The growing season for sod is April through September.

- F. Rolling:** While not generally required, rolling may be specifically ordered for any areas where an especially smooth and level surface is desired.
- G. Seasonal Limitations:** Sod may be installed any time during the growing season. Dormant sodding shall be approved by the Engineer.

73.4 METHOD OF MEASUREMENT

Sodding will be measured to the nearest whole square yard. Necessary resodding of areas damaged from causes beyond the control of the Contractor will be measured and added to the original quantity used.

73.5 BASIS OF PAYMENT

Sodding will be paid for at the contract unit price per square yard. Payment will be full compensation for cutting, preparing the earth planting bed, for furnishing, hauling, placing, anchoring, rolling, tamping, and maintaining the sod, and for labor, equipment, tools, and incidentals, which may be necessary.

Payment for fertilizing sod will be included under a separate bid item. Water for sodding shall be considered incidental and shall be included in the unit price bid for sodding.

END OF SECTION

SECTION 74

PLANTING TREES, SHRUBS, AND VINES

74.1 DESCRIPTION

A. General: This work consists of furnishing and planting or transplanting trees, shrubs, vines, or other plants of the species, grade, and size specified. Included is the preparation of the ground, storage, staking, furnishing and placing topsoil, peat moss, mulch, water, and other incidentals.

B. Related Work:

Section 7	General Conditions
Section 17	Salvaging, Stockpiling and Placing Topsoil
Section 70	Seeding
Section 71	Fertilizing
Section 72	Mulching
Section 73	Sodding
Section 76	Compost
Section 203	Submittals

74.2 MATERIALS

A. Plant Materials (Nursery Stock):

- 1. Limitations on Source of Material:** Plants furnished shall have a hardiness rating compatible to Zones 2, 3, or 4, or 5, if given authorization from Urban Forester or his/her designee as established by the United States Department of Agriculture.
- 2. Notification of Source of Supply and Verification of Origin:** As soon as possible and before any planting, the Contractor shall furnish written notification as a submittal of the location of the proposed source for each item of plant materials. The Urban Forester may require the Contractor to furnish written verification from the supplier and grower to establish the origin of plant materials, seed, or vegetative material. The source of supply and origin of plant materials will be subject to approval.
- 3. Names of Plants:** Plant materials furnished shall be of the genus, species, and variety specified and shall follow standard names of plant materials as adopted by the Integrated Taxonomic Information System (ITIS). Substitutions will not be permitted without the written consent of the Urban Forester or his/her designee.
- 4. Form, Shape, and Condition of Plants:** Trees and shrubs furnished shall be of standard nursery stock (i.e. balled and burlapped, potted, bare root), shall be well branched according to species or variety, and uniformly straight-trunked or heavily

caned, respectively. Trees, shrubs, and vines shall be number one (1), heavy-grade, nursery-grown stock, strong, healthy, clean, well-grown, free from insects, disease, rodents, mechanical injuries, disfiguring knots, sunscald, frost cracks, broken bark, broken or dead branches, broken roots, stubs, or any other objectionable features and shall possess a healthy, normal root system of sufficient size to permit successful establishment and good growth and shall be typical of the species or variety specified. Evergreen plants delivered to the project with new growth in an advanced stage of candling out will be rejected.

- 5. Size of Plants:** Plants shall be of uniform height and diameter. The figures shown on the plans indicate the minimum height of the plants called for. When such figures are used in connection with spread, they indicate the minimum and maximum spread of the plant to be furnished.

The height of each species or variety of plant shall be the vertical measurement of the plant from the ground upward as it stands in its natural position in the nursery without straightening branches or leaders. The measurements shall not include the fine or slender terminal leader, twig or branch growth, but shall stop where the main part of the plant ends. The spread of each species or variety shall be the horizontal measurement of the plant as it stands in its natural position in the nursery without straightening its branches. The measurements shall not include the fine or slender terminal shoots. Each plant shall be measured both in its smallest and greatest dimension and averaged. Caliper of trees shall be taken six (6) inches above the ground level, up to and including four (4) inches caliper size, and 12 inches above ground level for larger sizes.

- 6. Nursery Stock:** Plant materials shall be nursery grown unless otherwise specified, shall have been subjected to proper transplanting during growth in the nursery, shall bear evidence of proper top and root pruning, and shall be thrifty, well-grown, and hardy northern stock, grown under the same climatic conditions as exist at the location to be planted. Plants shall meet the standards as set forth in South Dakota Nursery Laws and in the edition of the American Standard for Nursery Stock. In all cases where grades are indicated in these standards, No. 1 or top grade will be required.
- 7. Labeling:** Legible labels must be attached to all specimens, boxes, bundles, bales, or other containers indicating the genus, species, size, grade, or age of each species or variety and the quantity contained.

B. Incidental Materials:

1. The topsoil shall conform to the requirements of Section 17.
2. Organic soil conditioners shall be sphagnum peat moss or other material as specified. The approved amended soil mix shall be furnished in an air-dry condition and shall be free from woody substances and mineral matter such as sulfur or iron.
3. Mulching material shall be shredded wood mulch, unless otherwise specified.

4. Staking materials shall be six-foot (6 ft.) T type studded steel posts. Guy material shall be three-quarter (3/4) inch or greater tree tie webbing or one-quarter (1/4) inch or greater nylon rope.
5. Tree straps shall be minimum one (1) inch wide heavy-duty canvas with a steel grommet in each end to secure webbing or rope. Webbing or rope shall not be wrapped around tree, but shall be tied through the steel grommets in the canvas strap. Lengths of garden hose shall not be used.
6. Tree trunk guards shall be rigid plastic mesh at least twice the diameter of the trunk and forty-eight (48) inches high or six (6) inches below bottom branch, whichever is less.
7. In certain locations as designated by the Urban Forester extra protection may be required from deer damage. This may be in the form of wire cages around the newly planted material

74.3 CONSTRUCTION REQUIREMENTS

- A. **General:** The digging, transporting, storing, layout, planting, pruning, watering, mulching, staking, maintenance, and replacement of plants shall be performed by a qualified nurseryman, landscape specialist or by experienced crews under the direct supervision of a qualified nurseryman or landscape specialist.
- B. **Digging and Transporting Nursery Stock:** Plants shall be dug with care and skill immediately before shipping. Possible injury to the roots, particularly to the fibrous roots, shall be avoided. Balled and burlapped plants shall be dug to retain as many fibrous roots as possible and shall come from soil which will form a firm ball. The soil in the ball shall be the original undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, packed, and transported in such a manner that, upon delivery, the soil in the ball will not have been cracked, loosened, or caused to drop away from contact with the small and fine feeding roots.

As plants are dug and during transportation to the planting site, precautions shall be taken to prevent roots from drying out, balls of earth from being broken, and to otherwise assure the arrival of plants at their destination in good condition.

- C. **Temporary Storage:** Plant materials which cannot be immediately planted upon delivery shall be heeled in by placing the plants in a trench in a shaded location and covering the roots firmly with moist soil or by storing in a cool, moist cellar or similar enclosure with roots packed in wet sphagnum moss and covered with tarpaulins (tarps). Other methods of storage must be approved by the Urban Forester or his/her designee. Roots shall be kept thoroughly moist at all times, and stored plants shall be properly maintained by the Contractor.

Balled and burlapped plants shall be protected against drying of the ball by covering with wet sawdust, soil, or peat moss in a manner appropriate to the conditions.

Risks involved in storing and transporting plant materials shall be borne by the Contractor.

D. Staking and Layout of Planting: Planting holes shall not be dug until all plant locations have been staked. Plan-shown locations, spacings, and quantities may be adjusted by the Urban Forester or his/her designee to suit field conditions.

E. Planting - General Requirements:

1. The Contractor shall notify the Engineer at least one (1) week in advance of the beginning of the planting operation.
2. Upon arrival at site, plant materials must be inspected by Urban Forester or his/her designee. Plants must be declared and certified free of diseases and insects, and necessary inspection certificates to this effect must accompany each shipment, invoice, or order of plants. Plants not approved by the Urban Forester or his/her designee or otherwise not meeting these specifications will be rejected. Rejected plants shall immediately be removed and disposed of by the Contractor and replaced with approved nursery stock of like variety, size, and age at no additional cost.
3. During planting operations, suitable warning signs shall be provided in accordance with Section 7.

F. The Planting Operation: As specified in this Section and Section 74 Standard Details.

1. Digging of Planting Holes:

- a) The Contractor shall provide necessary safeguards to prevent accidents during the time the plant holes are open.
 - b) Planting holes shall have tapered sides and flat bottoms. Planting hole should be three times the width of root ball at the soil surface, sloping down to one and one half (1.5) times width of root ball at the base. The hole shall be no deeper than the distance from the trunk flare to bottom of root ball Set the root ball on firm soil so that the top of the root ball will sit at the final grade.
2. **Mixing Backfill Soil:** Backfill around tree using the same soil that was removed from the planting hole, if possible. If amendment is needed, original soil can be mixed with approved amended soil mix.
 3. **Care of Plants Prior to Planting:** When plants are taken from storage to the planting site, roots of plants shall be immersed in water immediately upon opening the bundle and kept in water until planted. The Contractor shall have sufficient tanks and pails to keep roots of plants from opened bundles in water until planted.

In transferring plants from the site of temporary storage to the planting site, only

plants that can be planted in that day shall be transferred. Material not planted the day it is taken from storage shall be rewrapped in the approved manner or the roots kept immersed in water at the storage site until planted.

Bare roots shall not lie exposed to the sun or air.

4. Method of Planting:

- a) **Bare-Rooted Plants:** Plants shall be set in the bottom of the planting holes on a compact cone of soil constructed by backfilling the planting hole with topsoil. Trees and shrubs shall be placed at the same depth as they grew in the nursery.

Roots shall be carefully spread over and around this cone of topsoil in their natural position.

Roots, which are broken or damaged, shall be cut back to firm tissue. After placing the plant in the hole and spreading the roots, topsoil shall be tamped in place carefully but firmly to insure that topsoil is around all of the roots and air pockets are not present. Care shall be taken to avoid bruising or breaking the roots when firming the soil around them.

- b) **Balled and Burlapped Plants:** Plants shall not be handled by the plant stem. After the planting hole is dug as described in this section, the bottom portion of the wire basket and burlap shall be cut away prior to setting the plant in the hole. After setting plant in planting hole, the remaining portion of the wire basket and burlap shall be removed from the root ball. All twine and shipping tree wraps shall be removed from the trunk.

Holes shall be backfilled in not less than two (2) lifts, the first lift shall not exceed one-half (1/2) total hole depth. Each lift shall be heel tamped and watered to remove air pockets.

- c) **Potted Plants:** Potted plant holes shall be dug as described in this section. All plants shall be removed from containers in a manner which does not damage the root ball.

Holes shall be backfilled in not less than two (2) lifts, the first lift shall not exceed one-half (1/2) total hole depth. Each lift shall be heel tamped and watered to remove air pockets.

5. **Watering:** All plants shall be thoroughly watered during planting operation, within four (4) hours of planting and every two (2) days thereafter for a minimum of three (3) weeks. Each plant shall receive a rate of ten (10) gallons per diameter inch of the tree's trunk at each watering.
6. **Mulching:** Shall be placed between and around the plants during planting and shall be applied uniformly to cover the cultivated areas to a depth of four to six (4-

6) inches. Mulch shall be pulled back a minimum of six (6) inches from trunks and canes.

7. **Staking:** Each newly-planted deciduous tree under three (3) inches in caliper or conifer tree under eight (8) feet in height shall be staked with two (2) standard "T" type studded posts. The posts shall be driven an adequate distance away from the trunk of the tree so they are not driven into the root ball of the newly planted tree. Webbing shall be used for each post. Canvas tree straps shall secure the webbing to the tree as specified in this section. Two (2) straps per tree are required.

Three (3) posts and straps are required for deciduous trees over three (3) inches in diameter or conifers over eight (8) feet in height.

8. **Cleanup:** When planting has been completed, debris and waste materials shall be removed from the area, excess earth materials graded or otherwise removed, damaged turf reseeded, and the area left in a neat, orderly, and finished condition.
9. **Property Owner Notification:** After completion of the minimum three (3) weeks of watering, the contractor shall notify the property owner of their responsibility for care of the planted tree, shrub, or vine. This notification shall be in writing and verification shall be provided to the Engineer.
10. **Establishment Period:** An establishment period shall begin immediately after completion of that phase(s) planting, and shall continue for one (1) year. The plants shall be guaranteed during this period against defects, including death and unsatisfactory growth, except for defects resulting from neglect by owner, abuse, or damage by others, or unusual phenomena or incidents, which are beyond the landscape installer's control.
11. **Replacement of Plants:** The Contractor shall remove and replace trees, shrubs, or other plants found to be dead or in unhealthy condition during establishment period. The Contractor shall also plant missing trees, shrubs, and plants, make replacements during growing season following end of establishment period, and furnish and plant replacements which comply with requirements shown and specified. The Contractor shall also replace trees and shrubs, which are in doubtful condition at end of the establishment period, unless, in the opinion of the Urban Forester, it is advisable to extend the establishment period for another full growing season. Some maintenance of the tree or shrub may be required if the plant is allowed to remain past the establishment period. The Urban Forester will make another inspection at the end of the extended establishment period to determine acceptance or rejection. Only one (1) replacement will be required at the end of the establishment period, except for losses or replacements due to failure to comply with specified requirements.

74.4 METHOD OF MEASUREMENT

Quantities of each species or variety of trees, shrubs, and vines will be determined from count of each.

74.5 BASIS OF PAYMENT

Upon satisfactory completion of planting, payment will be made at the contract unit price per tree, shrub, or vine. Payment will constitute full compensation for furnishing, transporting, handling, storing, planting, pruning, watering, necessary excavation, disposal of surplus materials, furnishing and placing topsoil, amended soil mix, staking, mulching material, and labor, equipment, tools, and necessary incidentals.

END OF SECTION

SECTION 75

TRANSPLANTING TREES AND SHRUBS

75.1 DESCRIPTION

A. General: This work consists of furnishing and transplanting large trees or shrubs. This item shall include digging, transplanting, guying, mulching, and other incidentals necessary. Transplanting of trees and shrubs require prior written approval of the Engineer or the Urban Forester.

B. Related Work:

Section 17	Salvaging, Stockpiling and Placing Topsoil
Section 70	Seeding
Section 71	Fertilizing
Section 72	Mulching
Section 73	Sodding
Section 74	Planting Trees, Shrubs, and Vines
Section 76	Compost

75.2 MATERIALS

A. Plant Materials:

1. Substitutions will not be permitted other than specified by the plans or by written consent of the Engineer.
2. Removal and installation shall be subject to the approval of the Urban Forester.

B. Equipment and Incidental Materials:

1. Transplanting shall be done with a multiple cutting cup or spade-type digger designed for the purpose. Suitability of the machine and method of digging and transporting plant material shall be subject to the approval of the Engineer.
2. The topsoil used in planting shall conform to the requirements of Section 17.
3. Mulching materials shall conform to the requirements of Section 72.
4. Staking materials shall conform to the requirements of Section 74.

75.3 CONSTRUCTION REQUIREMENTS

- A. General:** The digging, transporting, planting, pruning, watering, mulching, guying, maintenance, and replacement of plants shall be performed by experienced crews under the direct supervision of a qualified nurseryman or landscape specialist.
- B.** Planting general requirements shall be as specified in Section 74.
- C.** Staking and layout of planting shall be as specified in Section 74 and Standard Details.
- D. Digging, Transporting, and Planting:** Plants machinery moved shall be dug with care, avoiding mechanical injury to trunks and branches.
 - 1.** A planting hole shall be dug at the project site for each plant before the plant intended for that hole is removed from its original position. When a plant is dug from its original position, it shall be transported directly to the project site in the digging machine, with earth ball intact and carefully placed in its planting hole directly from the machine. Care shall be taken during digging, transporting, and resetting to assure earth ball is kept intact throughout the operation to avoid root breakage.
 - 2.** After plant is set straight in its hole and the spades removed, any voids between hole and earth ball shall be filled with good topsoil and tamped.
 - 3.** Watering shall be provided as specified in Section 74.
- E.** Plants shall be guyed as specified in Section 74.
- F.** Mulching shall be applied as specified in Section 74.
- G.** Trees shall not be pruned except to remove damaged or broken ends.
- H.** Cleanup shall be as specified in Section 74.
- I.** Establishment period shall be as specified in Section 74.
- J.** Replacement planting shall be as specified in Section 74.

75.4 METHOD OF MEASUREMENT

Quantities of each species or variety of trees and shrubs planted will be determined from actual count.

75.5 BASIS OF PAYMENT

Basis of payment will be as specified in Section 74.

END OF SECTION

SECTION 76

COMPOST

76.1 DESCRIPTION

A. General: This work shall consist of incorporating compost within the root zone to improve soil quality and plant growth. This specification applies to all types of turf establishment methods (including seeding, sodding, and hydroseeding) and plantings (including trees, shrubs, vines, ground covers, and herbaceous plants). Compost use as a soil amendment shall only be required as directed by the Engineer.

B. Related Work:

Section 70	Seeding
Section 71	Fertilizing
Section 73	Sodding
Section 74	Planting Trees, Shrubs, and Vines
Section 75	Transplanting Trees and Shrubs
Section 203	Submittals

76.2 MATERIALS

Compost shall be well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants. For acid loving plants, provide only compost that has not received the addition of liming agents or ash by-products. Composts containing available nutrients, primarily nitrogen, are preferred, while the use of unstable or immature compost is not approved. Care should be given when using composts possessing a basic pH (>7) near acid loving plants.

A. Product Parameters

Table 1
Model Compost Specification for General Landscape Applications(soil amending)

Parameters	Reported as (units of measure)	General Range
pH	pH units	5.0-8.5
Soluble Salt Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	30 - 60
Organic Matter Content	%, dry weight basis	30-65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through ¾" screen or smaller
Stability Carbon Dioxide Evolution Rate	Mg CO ₂ -C per g OM per day	< 8

Maturity (Bioassay) Seed Emergence and Seeding Vigor	%,relative to positive control %, relative to positive control	Minimum 80% Minimum 80%
Physical Contaminants	%, dry weight basis	< 1
Chemical Contaminants	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR 503.13, Tables 1 and 3 levels
Biological Contaminants Select Pathogens	MPN per gram per dry weight	Meet or exceed US EPA Class A standard, 40 CFR 503.32(a) levels
Fecal Coliform Bacteria, or Salmonella	MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR 503.32(a) levels

76.3 CONSTRUCTION REQUIREMENTS

- A. Soil Analysis:** Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the turf species to be established. A copy of the results of the soil analysis shall be provided to the Engineer.
- B. Turf Establishment and Planting Bed Preparation:** Compost shall be uniformly applied over the entire area at an average depth of one (1) to two (2) inches and uniformly incorporated to a minimum depth of six (6) inches (for a 20% to 30% inclusion rate) using a rotary tiller or other appropriate equipment. The Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations. Pre-plant fertilizer and pH adjusting agents (e.g., lime and sulfur) may be applied before incorporation, as necessary. The use of stable, nutrient rich composts may reduce initial fertilizer requirements by the amount of available nutrients in the compost. Rake the soil surface smooth prior to seeding, sodding, or hydroseeding. The soil surface shall be reasonably free of large clods, roots, and other material which will interfere with planting and subsequent site maintenance. Water thoroughly after seeding, or sodding.

76.4 METHOD OF MEASUREMENT

- A. Compost:** Will be measured to the nearest 0.1 ton.
- B. Soil Amendments:** Shall be measured to the nearest 0.1 ton or whole pound.

76.5 BASIS OF PAYMENT

- A. Compost:** Application will be paid for at the contract unit price per ton, which will be full compensation for furnishing, hauling, placing, mixing, and for materials, equipment, labor, tools, and incidentals necessary.

- B. Soil Amendments:** Application will be paid for at the contract unit price per ton or pound, which will be full compensation for furnishing, hauling, placing, mixing, and for materials, equipment, labor, tools, and incidentals necessary.

END OF SECTION

SECTION 90

ROADWAY SIGNS AND DELINEATORS

90.1 DESCRIPTION

- A. General:** This work consists of furnishing materials, making and preparing signs and delineators, erection and installation of signs and delineators, and performing incidental work. The specific combination of Contractor furnished and installed material or City furnished and Contractor installed material will be as called for in the Bidder's Proposal or as directed by the Engineer.

All traffic control remaining on the site following project acceptance shall become the property of the City. All existing traffic control devices shall remain the property of the City. All signs, signals, or delineators removed by the Contractor shall be delivered in the condition prior to removal to the City of Rapid City, Traffic Operations, unless directed otherwise by the Engineer. All returned traffic control devices shall be delivered disassembled. A delivery list shall accompany all returned traffic control devices.

B. Related Work:

Section 91	Pavement Marking
Section 92	Temporary Traffic Control
Section 93	Traffic Signals and Roadway Lighting
Section 203	Submittals

90.2 MATERIALS

General: If requested by the Engineer, a Certificate of Compliance shall be furnished for each material item and shall state that the item conforms to the required specification, with reference being made to the appropriate specification number.

- A. Shop Drawings:** Prior to fabrication of project or location specific signs (example: street name signs), the Contractor shall submit shop drawings showing the sign layout with correct spelling and suffixes to the City for review and approval. Submittals shall be made in accordance with Section 203 Submittals. The Contractor shall not begin fabrication prior to the City's review and final approval of shop drawings. The Contractor shall not begin fabrication or construction of the work contained in the shop drawings until the City has completed the review. Contractor shall not deviate from materials reviewed without additional review and approval.

- B. Anchor Bolts, High Strength Bolts and Anchor Rods:** SDDOT Section 972.

C. Signs:

1. **Sheet Aluminum:** Shall meet the requirements of ASTM B209 for alloy 5052-H38 or alloy 6061-T6. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating. All signs shall be fabricated using an aluminum backing and have a thickness of 0.080 inches for signs with a horizontal dimension of 30 inches or less and a thickness of 0.100 inches for signs with a horizontal dimension greater than 30 inches.
2. **Bolts, Nuts, and Washers:** Shall be galvanized in accordance with ASTM F2329 or zinc plated per ASTM F1941.

D. Perforated Tube Posts: Post material shall meet impact performance (change in momentum) requirements for small sign supports contained in the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic signals."

Perforated tube posts shall conform to ASTM A1011 Grade 50 structural steel.

Posts shall be a 2 inch square tube formed of 12 gauge steel, 0.105 inch thick, rolled to size. The tubing shall be molded so the weld or flash does not interfere with telescoping. The posts shall be hot dipped galvanized with a 1.25 ounce per square foot coating conforming to ASTM A123. As an alternate, the post shall be given a triple coated protection by application of hot dip galvanized zinc conforming to ASTM A53, followed by a chromate conversion coating and a polyurethane exterior coating, with inside surfaces given corrosion protection by in-line application of zinc base organic coating after fabrication.

The posts shall be punched, bored, or have knockouts with 7/16 inch diameter holes on 1 inch centers of all four sides for the entire length of the posts. The post sections shall be straight, with a smooth uniform finish and a minimum amount of play between telescoping sections. Holes and cutoff ends shall be free of burrs and ragged edges.

Wind anchors as specified and shown on the plans shall be installed as part of the perforated sign posts.

Bolts, nuts, and washers shall conform to ASTM A307, ASTM A563, and ASTM F436, respectively, and shall be galvanized in accordance with ASTM B695.

E. Slip Base Assemblies:

1. **Base Plates and Friction Fuse Plates:** Shall conform to ASTM A36. The plates shall be galvanized in accordance with ASTM A123. Welding, punching, and boring of the plates shall be done before galvanizing.
2. **Bolts, Nuts and Washers:** Bolts, hex nuts, and washers used in conjunction with base plates or friction fuse plates shall conform to ASTM A325, except 1/2 inch

and 5/8 inch bolts conforming to ASTM A449 are permissible instead of ASTM A325. Bolts, hex nuts, and washers shall be covered with zinc coating (hot dip galvanized) per ASTM F2329.

3. **Shims:** Shims used in conjunction with base plates or friction fuse plates shall be covered with a zinc plating (electro-deposited zinc) as per ASTM B633.

F. Reflective Sheeting:

1. **Grade:** Reflective Sheeting shall be Type IV or higher for all signs except street name signs, which shall be Type IX or higher. All reflective sheeting shall be prismatic.
2. **General Characteristics:** The reflective sheeting shall be free from ragged edges, cracks, and extraneous materials. There shall be no more than four splices per 50 yard length. Splices shall be made by overlapping the sheeting a minimum of 3/16 inch.
3. **Fabrication:** The background for signs shall be sheet reflective material applied to aluminum backing. The preparation of the aluminum surface and the sheeting application shall be in complete compliance with the recommendations of the manufacturer.

All legend and border utilizing the color black shall be vinyl or screen printed black, non-reflectorized material. All other legend and border shall be of the same type of sheeting as the background of the same sign.

4. **Application:** Reflective sheeting shall be applied to properly prepared aluminum (degreased and etched or treated with a light, tight, amorphous chromate coating) with mechanical equipment in a manner prescribed by the sheeting manufacturer.

Sign faces comprising two or more pieces or panels of reflective sheeting must be carefully matched for color during sign fabrication to provide uniform appearance and brilliance, day and night. Alternate, successive width sections of either sheeting or panels must be reversed and consecutive to insure that corresponding edges of reflective sheeting lie adjacent on the finished sign.

Reflective sheeting for sheet aluminum signs shall be of the pressure sensitive or heat activated type. Splicing of the sheeting will not be allowed except those splices permitted by the sheeting manufacturer. Splices will not be permitted on signs which are screen processed with transparent color.

5. **Legend:** Message and borders shall be type, reflective material, and color specified.
 - a) **Screen Process:** Message and borders shall be processed on reflective sheeting using mechanical equipment, materials, and operational methods

and procedures as prescribed by the sheeting manufacturer. Processing shall be accomplished by the direct or reverse screen method using opaque or transparent processing material as required. Screening may be accomplished either before or after application of the sheeting to the base panels, conditional upon the method recommended by the sheeting manufacturer. Freehand painting will not be permitted on any part of the finished sign face.

- b) Direct Applied:** Cut-out message and borders shall be reflective sheeting or opaque lettering film applied directly to clean, dust free, reflective sheeting background. Message and borders shall be applied in accordance with the operational methods and procedure prescribed by the sheeting manufacturer. The finished letters, numerals, symbols, and borders shall be cut with smooth regular outline, free from ragged or torn edges.

Mounting holes will not be drilled or punched in any part of the nonremovable copy.

- 6. Color:** The reflective sheeting shall meet the color specification limits and luminance factors listed in Tables 1-4 when tested in accordance with ASTM E1347 or ASTM E1349. Fluorescent retroreflective materials shall be tested in accordance with ASTM E991. The reflective sheeting shall maintain the colors and luminance factors provided in the appropriate tables throughout its service life. Warning signs, except those for bicycle and shared use path facilities, shall be fluorescent yellow. Warning signs for bicycle and shared use path facilities shall be fluorescent yellow-green. All pedestrian and school signs shall be fluorescent yellow-green.

Table 1

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.430	0.390	0.518	0.434	0.570	0.382
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Blue	0.078	0.171	0.150	0.220	0.210	0.160	0.137	0.038

Table 1: Daytime Color Specification Limits for Retroreflective Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.475	0.452	0.360	0.415	0.392	0.370	0.515	0.409
Red	0.650	0.348	0.620	0.348	0.712	0.255	0.735	0.265
Orange	0.595	0.405	0.565	0.405	0.613	0.355	0.643	0.355
Brown	0.595	0.405	0.540	0.405	0.570	0.365	0.643	0.355
Yellow	0.513	0.487	0.500	0.470	0.545	0.425	0.572	0.425
Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782
Blue	0.033	0.370	0.180	0.370	0.230	0.240	0.091	0.133

Table 2: Nighttime Color Specification Limits for Retroreflective Material with CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

Table 3

Color	Chromaticity Coordinates (corner points)								Luminance Factor (Y %)	
	1		2		3		4		Min	Max
	X	Y	X	Y	X	Y	X	Y		
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	None
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	None
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	None
Fluorescent Green	0.210	0.770	0.232	0.656	0.320	0.590	0.320	0.675	20	30

Table 3: Daytime Color Specification Limits and Luminance Factors for Fluorescent Retroreflective Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 4

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
Fluorescent Orange	0.625	0.375	0.589	0.376	0.636	0.330	0.669	0.331
Fluorescent Yellow	0.554	0.445	0.526	0.437	0.569	0.394	0.610	0.390
Fluorescent Yellow-Green	0.480	0.520	0.473	0.490	0.523	0.440	0.550	0.449
Fluorescent Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782

Table 4: Nighttime Color Specification Limits for Fluorescent Retroreflective Material With CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

G. Object Markers:

1. **Description:** Object markers shall be adhesive coated reflective sheeting permanently bonded to sheet aluminum backing.

Object markers shall be of the size and color specified. Type 1, 2, 3, and 4 object markers shall conform to the following requirements:

- a) Type 1 object markers shall consist of a yellow 18 inch x 18 inch reflector unit.
 - b) Type 2 object markers shall consist of a yellow 6 inch x 12 inch or size specified reflector unit.
 - c) Type 3 object markers shall consist of a yellow and black 12 inch x 36 inch reflector unit. The yellow and black stripe pattern shall be 6 inch black and 4 inch yellow.
 - d) Type 4 object markers shall consist of a red 18 inch x 18 inch reflector unit.
2. **Reflective Sheeting:** Shall be Type XI or higher conforming to ASTM D4956.

In addition to the requirements stated above, the reflective sheeting shall maintain the colors provided in the appropriate tables contained in this section throughout its service life.

3. **Fabrication:** The aluminum shall be a 0.080 inch thick sheet conforming to the requirements of ASTM B 209 for alloy 6061-T6 or 5052-H38. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating.

The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

4. **Shape and Holes:** Object markers shall be punched or sheared to size with 1½ inch radius corners. Mounting holes shall be as follow:
 - a) Type 1 object markers shall have 2 holes 1/4 inch in diameter 20 inches center to center.
 - b) Type 2 object markers shall have 2 holes 1/4 inch in diameter 8 inches center to center.
 - c) Type 3 object markers shall have 2 holes 1/4 inch in diameter 30 inches center to center.
 - d) Type 4 object markers shall have 2 holes 1/4 inch in diameter 20 inches center to center.

5. **General Requirements:** The finished object markers shall be free of burrs, scratches, and damaged reflective sheeting and shall have essentially a plane surface.
6. **Object Marker Posts:** Shall be the same as sign posts.

90.3 CONSTRUCTION REQUIREMENTS

Roadway signs, delineators, and object markers shall comply with the current edition of the MUTCD and Standard Highway Signs, issued by the U.S. Department of Transportation, FHWA.

A. Signs:

1. **Location and Position:** The location of each sign shall be established by a stake bearing the sign number as determined from the plans.

Posts shall be in a plumb position and the flanges of structural shape posts or other supports shall lie in the same plane. The post shall not extend above the top of the sign.

2. **Post Size:** Shall be 2 inch square, extensions for street name signs shall be 1 ¾ inch square. The Contractor shall field verify the post length prior to ordering.

- B. **Object Markers:** Object markers of the type specified shall be erected at the locations shown in the plans or as directed by the Engineer.

- C. **Perforated Tube Posts:** Shall be installed in accordance with the contract or as directed by the Engineer. Sign post locations in concrete shall be installed in a cored hole or preformed sleeved hole opening.

- D. **Slip Base Assemblies:** The use of surface mount slip base breakaway bases shall require prior approval by the Engineer. Slip base assemblies shall be assembled per manufacturer's instructions.

The top of the concrete footing/grout pad shall be placed flush with the finished grade. The mounding of soil around the footing will not be permitted.

- E. **Reflective Sheeting:** Shall be of the type specified.

- F. **Remove, Salvage, Relocate, and Reset Sign:** The Contractor shall remove signs, post, and bases for reset as shown in the plans. The Contractor shall reuse existing extruded aluminum panels, posts, footings, and hardware where specified. All existing posts, bases, and signs listed in the plans that are scheduled for removal shall be dismantled. All bolts, nuts, and washers shall be placed in containers to keep the hardware separated. Backing materials shall be separated from the signs and may be reused at the Contractor's discretion. Wooden posts shall be carefully removed to avoid damage and cleaned of excess

dirt and neatly stockpiled separate from the steel posts. The resultant holes in the ground from removal of wooded posts shall be backfilled to the satisfaction of the Engineer.

90.4 METHOD OF MEASUREMENT

- A. **Signs:** Sheet aluminum and extruded aluminum signs will be paid for at the contract unit price per each sign. Payment will be full compensation for furnishing and installing materials, including post, base assemblies, hardware, borders, legend, and edge trim.
- B. **Object Markers:** Object marker quantities will be determined by count of each type regardless of size.
- C. **Delineators:** Delineator quantities will be determined by count of each type.
- D. **Perforated Tube Posts:** Field measurement will not be made.
- E. **Fixed Base Assemblies:** Field measurement will not be made.
- F. **Slip Base Assemblies:** Field measurement will not be made.
- G. **Reflective Sheeting:** Field measurement will not be made.
- H. **Remove, Salvage, Relocate, and Reset Sign:** Measurement will be the actual count of signs on a per each assembly basis regardless of the number of signs or posts at each assembly.

90.5 BASIS OF PAYMENT

- A. **Signs:** Sheet aluminum and extruded aluminum signs will be paid for at the contract unit price per each sign, regardless of size. Payment will be full compensation for furnishing and installing materials, post, base assemblies, hardware, borders, legend, and edge trim.
- B. **Object Markers:** Object markers will be paid for at the contract unit price per each, regardless of size. Payment will be full compensation for furnishing and installing materials, including posts, reflective panels, and hardware.
- C. **Delineators:** Delineators will be paid for at the contract unit price per each, regardless of size. Payment will be full compensation for furnishing and installing materials, including posts, reflectors, and hardware.
- D. **Perforated Tube Posts:** Separate payment will not be made for tube posts. They are incidental to the sign being furnished.
- E. **Fixed Base Assemblies:** Separate payment will not be made for fixed base assemblies. The base assemblies will be considered incidental to the sign furnished.

- F. Slip Base Assemblies:** Separate payment will not be made for slip base assemblies. The slip base assemblies will be considered incidental to the sign furnished.
- G. Reflective Sheeting:** Separate payment will not be made for reflective sheeting. The reflective sheeting will be considered incidental to the sign furnished.
- H. Remove, Salvage, Relocate, and Reset Sign:** Payment shall be full compensation to remove and reset existing signs and shall include all costs for labor and equipment necessary to remove, dismantle, backfill holes, and deliver salvaged material to the City Traffic Operations shop at the contract unit price per each assembly.

END OF SECTION

SECTION 91

PAVEMENT MARKING

91.1 DESCRIPTION

A. General: This work consists of furnishing and applying pavement marking materials and surface grooving of portland cement concrete pavement or asphalt concrete pavement.

B. Related Work:

Section 90	Roadway Signs and Delineators
Section 92	Temporary Traffic Control
Section 93	Traffic Signals and Roadway Lighting
Section 203	Submittals

91.2 MATERIALS

A. Cold Applied Plastic Pavement Markings and Legends (Tape): This material shall consist of a homogeneous mixture of resins, plasticizers, fillers, pigments, and glass beads. The marking material shall be designed to adhere to portland cement concrete pavement or asphalt concrete pavement.

Reflectorized plastic pavement marking shall consist of a homogeneous, extruded, prefabricated, pliant polymer material of specified thickness and width, which shall contain abrasion resistant ceramic or ceramic coated beads bonded in a highly durable polyurethane topcoat. The material shall be fabricated with a patterned surface that presents a near vertical face to traffic to maximize retroreflectance. The pavement marking material shall be capable of being affixed to the pavement surface by means of a pre-coated, pressure sensitive adhesive.

An adhesive activator supplied by the manufacturer shall be utilized on applications of this material, except on newly installed asphalt when the surface temperature is 80°F or above, or when the material is inlaid at the time asphalt is being installed.

Reseal Test: The plastic marking material shall reseal to itself when tested. Cut two 1 inch x 3 inch pieces of plastic. Overlap these pieces face to face for an area of 1 square inch on a flat steel plate with the adhesive backing material remaining in place. Center a 2.2 pound weight over the 1 square inch overlap area and place in an oven at 190°F for one hour. After cooling to 77°F, the pieces shall be inseparable without tearing.

Pull Test: The plastic shall require a pull of 8 to 20 pounds to break. The elongation shall be no greater than 50%. The specimens for this test shall be Type 1 prepared in accordance with ASTM D638. 1 square inch pieces of carborundum extra coarse

emery cloth or its equivalent may be applied at each end of the test specimens to prevent the plastic adhesive from adhering to the test equipment. The break resistance shall be based on an average of at least 3 samples, and the rate of pull shall be 1/4 inch per minute. This test shall be conducted at a temperature of 70°F to 80°F.

Support Test: A test specimen cut to dimension of 1 inch by 6 inch shall support a dead load of 6 pounds for 30 minutes. This test shall be conducted at a temperature of 70 to 80°F.

Color: The plastic marking material shall meet the color specification limits and luminance factors listed in Tables 1 and 2 when tested in accordance with ASTM E1347 or ASTM E1349. The plastic marking material shall maintain the color and luminance factors provided in the following tables throughout its service life.

Table 1

	Chromaticity Coordinates (corner points)								Luminance Factor (Y %)	
	1		2		3		4		Min.	Max.
Color	X	Y	X	Y	X	Y	X	Y		
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35	
Yellow	0.56	0.44	0.49	0.51	0.42	0.44	0.46	0.4	25	
Red	0.48	0.3	0.69	0.315	0.62	0.38	0.48	0.36	6	15
Blue	0.105	0.1	0.22	0.18	0.2	0.26	0.06	0.22	5	14

Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

Nighttime Color Specification Limits for Pavement Marking Retroreflective Material with CIE 2° Standard Observer and Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A

B. Traffic Paint: The finished paint shall be smooth and homogeneous, free of coarse particles, skins, or any other foreign materials detrimental to the use or appearance of the paint.

Waterborne paint applied between April 15th and October 15th shall meet the following requirements per Section 91.2.B.1 – High Build Waterborne Paint. Cold weather waterborne paint shall be used between October 15th and April 15th, and shall meet the requirements of Section 91.B.2- Cold Weather Waterborne Paint.

The manufacturer shall submit a “Certificate of Compliance” for each batch of paint produced for use under this specification. The certification shall contain the manufacturer’s code number and batch number along with the test results of each

batch for weight per gallon, viscosity, drying time, percent pigment, percent vehicle, and fineness of grind.

1. **High Build Waterborne Paint:** The vehicle shall be composed of a 100% acrylic polymer such as Dow FASTRACK™ HD-21A or an approved equal.

- a) **Quantitative Requirements:** The finished paint shall meet the following quantitative requirements:

	<u>WHITE</u>	<u>YELLOW</u>
<u>Lead</u> , parts per million ASTM D3335 or X-ray fluorescence	100 max.	100 max.
<u>Pigment</u> , percent by weight Tested in accordance with ASTM D3723 The residual extracted pigment upon analysis shall conform to the following quantitative compositional requirements when tested in accordance with ASTM D1394 or ASTM D4764.	60.0 - 62.0	58.0-62.0
<u>Titanium Dioxide</u> , pounds/gallon ASTM D 476 Type II Rutile 92% min. TiO ₂ tested in accordance with ASTM D1394 or ASTM D4764	1.00 min.	0.20 min.
<u>Total Solids</u> , percent by weight Tested in accordance with ASTM D3723	77.0 min.	76.0 min.
<u>Non-volatile Vehicle</u> , percent by weight Tested in accordance with ASTM D3723 and then calculating the % total solids minus the % pigment	42.5 min.	42.5 min.
Consistency (Viscosity), KUKrebs-Stormer, equivalent units, shearing rate 200 rpm. When tested in accordance with ASTM D562, the consistency of the paint will be within the stated specification when determined a minimum 48 hours after packaging the material.	190 to 300	190 to 300
<u>Weight per Gallon</u> , pounds, min Tested in accordance with ASTM D1475* ²	13.50	13.00
* ² In addition to compliance with the minimum, the weight per gallon shall not vary more than ± 0.3 pounds/gallon between batches.		
<u>Fineness of Dispersion</u> , Hegman Scale Tested in accordance with ASTM D1210 "B" Cleanliness	2 min.	2 min.
<u>Drying Time</u> , No Pick-Up, minutes, max Tested in accordance with ASTM D711, except the wet film thickness shall be 12.5 ± 0.5 mils.	12 max.	12 max.

Drying Time, Dry-through, minutes, max 120 max. 120 max.
 Tested in accordance with ASTM D1640, except the wet film thickness shall be 12.5 ± 0.5 mils. A reference control paint will be run in conjunction with the candidate paint. Dow FASTRACK™ HD-21A formulation will be referenced-control paint.

*³ If either the candidate or reference-control paint exceeds the 120 minute maximum, then the candidate paint shall not exceed the dry time of the reference-control paint by more than 15 minutes.

Directional Reflectance, min 85 50
 When applied at a wet film thickness of 15 mils and when tested in accordance with ASTM E1347 using the 45/0 illumination.

pH, min 9.6 9.6
 Tested in accordance with ASTM E70

Dry Opacity, Contrast ratio, min. 0.95 0.88
 When applied at a wet film thickness of 6 to 7 mils and when tested in accordance with ASTM D2805

Volatile Organic Content (VOC), grams/liter 115 max. 115 max.
 Tested in accordance with ASTM D3960

Flash Point, closed cup, °F 115 min. 115 min.

Color: The paint shall meet the color specification limits and luminance factors listed in Tables 1 & 2 when tested in accordance with ASTM E1347 or ASTM E1349. The paint shall not discolor in sunlight and shall maintain the colors and luminance factors throughout the life of the paint. No Bayferrox 3950, iron oxides or other color enhancers will be permitted to achieve the color chromaticity coordinates.

Table 1*¹

Color	Chromaticity Coordinates (corner points)								Min. Luminance Factor (Y %)
	X	Y	X	Y	X	Y	X	Y	
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25

*¹ Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2*²

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

*² Nighttime Color Specification Limits for Pavement Marking Retroreflective Material with CIE 2° Standard Observer, Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A.

b) Qualitative Requirements: The finished paint shall meet the following qualitative requirements:

Condition in Container - Storage Stability. Within a period of 12 months from the time of delivery and when examined in accordance with Federal Specification TT-P-1952F 4.3.2, the paint shall not show excessive settling in a freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no undesirable characteristics to include curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. The consistency shall not change more than 5 Krebs Units from that of the original sample, the degree of settling shall have a rating of 6 or better per ASTM D869, and the drying time shall be as specified.

Skinning: The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container when examined in accordance with Federal Specification TT-P-1952F 4.3.14.

Flexibility and Adhesion: The paint shall show no cracking, flaking, or chipping when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 inch x 5 inch tin panel weighing 0.39 to 0.51 pounds per square foot, previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 to 80°F in a horizontal position for 18 hours, then bake in an oven at $122 \pm 4^\circ\text{F}$ for two hours, and cool to room temperature for at least 1/2 hour. Bend over a 1/2 inch diameter rod and examine, without magnification, in accordance with ASTM D522 Test Method B.

Water Resistance: The paint shall show no softening, blistering, loss of adhesion or other evidence of deterioration, other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Dry the paint film at 70 to 80°F in a horizontal position for 72 hours. Immerse one-half of the painted plate in distilled water in a vertical position at room temperature (70 to 80°F) for 18 hours in accordance with ASTM D870. Remove the painted plate from the immersion liquid, allow to air dry for 2 hours, and then examine.

Dilution Stability: The paint shall be capable of dilution with water with no separation, curdling or precipitation observed when examined in accordance with NIST 141D (Method 4203.2), such that the wet paint can be readily cleanable with only water.

Spraying Properties: The paint as received shall have satisfactory spraying and hiding properties when applied by either airless or air-assisted type traffic strippers to glass or metal plates at a wet film thickness of 0.015 inches.

Bleeding: The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with ASTM D868. The asphalt saturated felt shall conform to ASTM D 226 (Type I).

Freeze-Thaw Stability: The paint shall show no coagulation or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.8.

Heat-Shear Stability: The paint shall show no gelling, signs of instability, or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.13.

Abrasion Resistance: No less than 190 Liters of sand shall be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952 F 4.3.7.

2. **Cold Weather Waterborne Paint**: The vehicle shall be Dow FASTRACK™ 5408, Dow FASTRACK™ XSR™ resin binder, or an approved equal.

- a) **Quantitative Requirements**: The finished paint shall meet the following quantitative requirements:

	WHITE	
<u>Lead</u> , parts per million ASTM D3335 or X-ray fluorescence	100 max.	100 max.
<u>Pigment</u> , percent by weight; Tested in accordance with ASTM D3723	58.0 - 62.5	56.1 – 62.5
<u>Titanium Dioxide</u> , pounds/gallon ASTM D 476 Type II Rutile 92% min. TiO2 tested in accordance with ASTM D1394 or ASTM D4764	1.00 min.	0.20 min.
<u>Total Solids</u> , percent by weight Tested in accordance with ASTM D3723	75.0 min.	75.0 min.
<u>Non-volatile Vehicle</u> , percent by weight Tested in accordance with ASTM D3723 and then calculating the % total solids minus the % pigment		41.5 min.
<u>Consistency</u> , grams Krebs-Stormer Shearing rate 200 rpm.	165 to 300	165 to 300
<u>Equivalent K.U.</u> Tested in accordance with ASTM D562*1 *1The consistency of the paint shall be within the stated specification when determined a minimum 48 hours after packaging the material.	75 to 95	75 to 95
<u>Weight per Gallon</u> , pounds Tested in accordance with ASTM D1475*2		
Dow FASTRACK™ XSR	13.00 min.	13.00 min.
Dow FASTRACK™ 5408	13.00 min.	13.00 min.

*2 In addition to compliance with the minimum, the weight per gallon shall not vary more than ± 0.3 pounds/gallon between batches.

<u>Fineness of Dispersion</u> , Hegman Scale	2 min.	2 min.
Tested in accordance with ASTM D1210	"B" Cleanliness	"B" Cleanliness
<u>Drying Time</u> , No Pick-Up, minutes	12 max.	12 max.
Tested in accordance with ASTM D711, except the wet film thickness shall be 12.5 ± 0.5 mils. The applied film shall be immediately placed in a laboratory drying chamber maintaining the relative humidity of $65 \pm 3\%$, the temperature $73.5 \pm 3.5^\circ\text{F}$, and air flow less than 1 foot per minute.		
<u>Field Drying Time</u> , Track-Free, minutes.	5 max.	5 max.
When applied under the following conditions, the line shall show no visual tracking when viewed from 50 feet after driving a passenger vehicle over the line at a speed of 25-35 mph:		
15 mils wet film thickness		
8 pounds of glass beads per gallon of paint		
Paint temperature at nozzle between 70 to 120°F		
Pavement dry, pavement temperature 50 to 120°F		
Relative humidity of 85% maximum		
<u>Directional Reflectance</u>	85 min.	N/A
When applied at a wet film thickness of 15 mils and when tested in accordance with ASTM E1347 using the 45/0 illumination.		
<u>pH</u>	9.80 min.	9.80 min.
Tested in accordance with ASTM E70		
<u>Dry Opacity</u> , Contrast ratio.	0.955 min.	0.880 min.
When applied at a wet film thickness of 6 to 7 mils and when tested in accordance with ASTM D2805		
<u>Volatile Organic Content (VOC)</u> , grams/liter	150 max.	150 max.
Tested in accordance with ASTM D3960		
<u>Flash Point</u> , closed cup, °F	115 max.	115 max.

Color: The paint shall meet the color specification limits and luminance factors listed in Tables 1 & 2 when tested in accordance with ASTM E1347 or ASTM E1349. The paint shall not discolor in sunlight and shall maintain the colors and luminance factors throughout the life of the paint. No Bayferrox 3950, iron oxides or other color enhancers will be permitted to achieve the color chromaticity coordinates.

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Table 1*1

Color	Chromaticity Coordinates (corner points)								Min. Luminance Factor (Y %)
	X	Y	X	Y	X	Y	X	Y	
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25

*1 Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2*2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

*2 Nighttime Color Specification Limits for Pavement Marking Retroreflective Material with CIE 2° Standard Observer, Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A.

- b) Qualitative Requirements:** The finished paint shall meet the following qualitative requirements:

Condition in Container - Storage Stability. Within a period of 12 months from the time of delivery and when examined in accordance with Federal Specification TT-P-1952F 4.3.2, the paint shall not show excessive settling in a freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no undesirable characteristics to include curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. The consistency shall not change more than 5 Krieb Units from that of the original sample, the degree of settling shall have a rating of 6 or better per ASTM D869, and the drying time shall be as specified.

Skinning. The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container when examined in accordance with Federal Specification TT-P-1952F 4.3.14.

Flexibility and Adhesion. The paint shall show no cracking, flaking, or chipping when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 inch x 5 inch tin panel weighing 0.39 to 0.51 pounds per square foot, previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 to 80°F in a horizontal position for 18 hours, then bake in an oven at 122 ± 4°F for two hours, and cool to room temperature for at least 1/2 hour. Bend over a 1/2 inch diameter rod and examine, without magnification, in accordance with ASTM D522 Test Method B.

Water Resistance. The paint shall show no softening, blistering, loss of adhesion or other evidence of deterioration, other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Dry the paint film at 70 to 80°F in a horizontal

position for 72 hours. Immerse one-half of the painted plate in distilled water in a vertical position at room temperature (70 to 80°F) for 18 hours in accordance with ASTM D870. Remove the painted plate from the immersion liquid, allow to air dry for 2 hours, and then examine.

Dilution Stability, The paint shall be capable of dilution with water with no separation, curdling or precipitation observed when examined in accordance with NIST 141D (Method 4203.2), such that the wet paint can be readily cleanable with only water.

Spraying Properties, The paint as received shall have satisfactory spraying and hiding properties when applied by either airless or air-assisted type traffic strippers to glass or metal plates at a wet film thickness of 0.015 inches.

Bleeding, The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with ASTM D868. The asphalt saturated felt shall conform to ASTM D226 (Type I).

Freeze-Thaw Stability, The paint shall show no coagulation or change in consistency greater than 5 Krieb Units when tested in accordance with Federal Specification TT-P- 1952F 4.3.8.

Heat-Shear Stability, The paint shall show no gelling, signs of instability, or change in consistency greater than 5 Krieb Units when tested in accordance with Federal Specification TT-P-1952F 4.3.13.

Abrasion Resistance, No less than 190 Liters of sand shall be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952F 4.3.7.

- C. Glass Beads:** Glass beads for use with pavement marking paint shall be moisture resistant and without floatation properties. The glass beads shall have dual surface treatment consisting of a moisture resistant silicone treatment, and silane adherence surface treatment. Roundness shall be tested in accordance with SDDOT test SD510. The beads shall conform to AASHTO M247, except they shall have a minimum roundness of 80% and the following gradation:

Sieve Size	Accumulated Percent Passing
No. 18	65-80
No. 30	30-50
No. 50	0-5

91.3 CONSTRUCTION REQUIREMENTS

A. Cold Applied Plastic Pavement Marking and Legends (Tape):

- 1. Prefabrication:** Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the current edition of the MUTCD.

2. **Width Tolerance:** Shall be as specified with a tolerance of $\pm 1/8$ inch.
 3. **Surface and Air Temperature:** Surface and air temperature, and humidity shall be per manufactures specifications.
 4. **Pavement Condition:** Pavement must be dry and free of dirt, dust, and oily substances.
 5. **Application Instructions:** The manufacturer shall supply proper application instructions, and shall identify activators and adhesives which are to be used. An adhesive activator supplied by the manufacturer shall be utilized on applications of this material. On newly installed asphalt when the surface temperature is 80°F or above, adhesive may be eliminated if allowed by manufacturer. A copy of the application instructions shall be provided to the Engineer prior to use. The plastic markings shall be manufactured and packaged in a manner, which will permit storage at normal temperatures for up to one year after purchase.
 6. **Lane Lines:** Shall not deviate more than 1 inch per 200 feet nor shall any deviations be abrupt.
 7. **Bonding:** To insure a uniform bond of material to asphalt or concrete surfaces after initial laydown, rolling of the material with a truck wheel, car wheel, or heavy hand roller in accordance with the manufacturer's recommendations is required.
 8. **Molding and Sealing:** The material shall mold to the pavement contours, breaks, and faults by the action of traffic. When old markings are not required to be removed, the new material shall have resealing characteristics, which enable the material to fuse with itself and with previously applied marking materials of the same composition without externally applied tackifiers or adhesives. In most cases previous pavement markings shall be required to be properly removed.
 9. **Waste Disposal:** It shall be the responsibility of the Contractor to provide for disposal of empty material cartons, liner papers, and other waste.
- B. Pavement Marking Paint and Beads:** Pavement marking paint shall be applied by machine. On special areas and markings that are not adaptable to machine application, hand application will be permitted.

The paint shall be used as furnished by the manufacturer. Thinner or diluent shall not be added. The paint shall be thoroughly mixed in the original container before it is transferred to the tank of the spraying equipment. Filling tanks, pouring paint, or cleaning of equipment shall not be allowed on the pavement.

The pavement marking shall be applied during daylight hours when the ambient air temperature is above 45°F and the road surface is dry. Nighttime application shall be approved by the Engineer. Waterborne paint applied before April 15th or after October 15th shall be formulated as cold weather waterborne paint. Cold weather waterborne paint shall be applied in accordance with this section except where the manufacturer's

recommendations, including minimum temperature requirements, vary from this section. The pavement shall be cleaned of dirt, loose stones, and other foreign material before the paint is applied.

The paint applicator shall be a self-propelled or push-propelled spraying machine. Paint applicator shall be airless type. The left carriage shall simultaneously place a dashed marking, a solid marking and a dashed marking, or two solid markings as detailed in the plans. The paint shall be applied at a maximum speed as recommended by the paint applicator manufacturer. The paint applicator shall be capable of applying glass beads in a pressurized system, synchronized with the spray guns, uniformly across the entire painted line. All guns on the spray carriages shall be in full view of the operator during operation.

During pavement marking operations on sections of roadway open to traffic, the Contractor shall protect the markings from tracking either by placing suitable traffic control devices or by utilizing a shadow vehicle.

The Contractor shall take the steps necessary to ensure that the permanent pavement markings will match the markings on the existing surface.

Tolerances:

1. The length of the painted line shall not vary more than plus or minus 3 inches from the plans requirement.
2. The width of the painted line shall not vary more than plus or minus 1/2 inch from the plans requirement.
3. The length of a 40 foot cycle length consisting of a 10 foot dashed line and a 30 foot gap shall not vary more than 3 inches.
4. The alignment from the plans requirement or existing markings shall not vary more than plus or minus 2 inches.
5. The maximum longitudinal deviation from the existing markings at either end of the painted roadway segment shall not vary more than plus or minus 6 inches.
6. Lane lines shall not deviate more than 1 inch per 200 feet, nor shall any deviations be abrupt.

The Contractor may be required to remove and replace pavement markings not meeting the specifications and tolerances at no additional expense to the City. Removal methods shall minimize damage to the surface and shall be approved by the Engineer.

High build pavement marking paint shall be applied at the manufacturer's wet thickness to achieve an equivalent dry thickness of 15-16 mils for asphalt and portland concrete pavement. Cold weather pavement marking paint shall be applied at the

manufacturer's wet thickness to achieve an equivalent dry thickness of 10 mils. Glass beads shall be applied uniformly across the wet paint line at a minimum of 8 pounds of glass beads per gallon of paint. Restriping of pavement markings to meet this requirement and to provide a quality retroreflective line shall be at the expense of the Contractor with no additional cost to the City. Sections to be restriped shall be determined by the Engineer.

The paint shall be capable of being applied at a paint temperature up to 160°F. When applied with glass beads at pavement temperatures above 45°F and at a relative humidity of up to 75%, the paint shall dry to a no-track condition within 3 minutes.

- C. Grooving for Cold Applied Plastic Pavement Marking:** The equipment shall be capable of performing uniform grinding for alignment and depth.

The grooving shall be performed by a self-propelled machine equipped with gang mounted specially prepared circular diamond blades on a turning head. The equipment shall be capable of grooving the total width of the groove in one pass or be capable of grooving uniform depths with multiple passes. The equipment shall be capable of grooving double lines simultaneously or parallel lines to a uniform depth with two passes.

If damage to joints, joint sealant material, backer rod, etc. occurs, the grooving operation shall be stopped and modifications shall be made to the grooving operation to prevent further damage. Damage caused to joints, the joint sealant material, backer rod, etc. shall be repaired or replaced by the Contractor, as directed by the Engineer. No additional payment will be made for the repair work or any reapplication of the pavement marking in the area of the repair.

The bottom of the groove shall be uniform and free of loose material. The groove shall be flat and of uniform depth for the entire width of the groove.

The grooving shall be performed within the following specifications and tolerances:

Description	Specification	Tolerance
Depth of Groove	120 mils	± 10 mils
Width of 4 inch Groove	4½ inches	± 1/8 inch
Width of 6 inch Groove	6½ inches	± 1/8 inch
Width of 8 inch Groove	8½ inches	± 1/8 inch
Width of 12 inch Groove	12½ inches	± 1/8 inch
Width of 24 inch Groove	24½ inches	± 1/8 inch
Length of Skip Lines	10 foot 6 inches	± 3 inch
Tapers at ends of lines	6 to 9 inches	
Between Double Lines	4 inches	± 1/2 inch

The grooving alignment and straightness tolerances shall be the same as required for the cold applied plastic pavement marking as specified in Section 91.3 A.6.

If the groove is exposed to traffic or adverse weather conditions overnight, the Contractor shall sand blast the groove prior to priming and applying tape.

Existing grooves not meeting the required depth shall be re-grooved to the required depth. In areas where the existing groove meets the required depth and existing markings are still in place, the Contractor shall remove the existing marking by light grinding or sand blasting or both. The grooving, light grinding, and sand blasting operations shall provide the surface preparation required for the application of the new cold applied plastic pavement markings.

91.4 METHOD OF MEASUREMENT

- A. **Cold Applied Plastic Pavement Marking:** Of the width and color specified, will be measured by the linear foot.
- B. **Cold Applied Plastic Pavement Marking Arrow:** Will be measured by count of each type specified.
- C. **Cold Applied Plastic Pavement Marking Message:** Will be measured by count of each complete word specified.
- D. **Cold Applied Plastic Pavement Marking Area:** Of the color specified, will be measured to the nearest square foot.
- E. **Pavement Marking Paint and Beads:** Will be measured to the nearest linear foot for the width and color specified, or by gallon of paint.
- F. **Grooving:** Will not be measured.

91.5 BASIS OF PAYMENT

- A. **Cold Applied Plastic Pavement Marking:** Of each width and color specified, will be paid for at the contract unit price per foot. Payment will be full compensation for equipment, labor, grooving, materials, and all incidentals required.
- B. **Cold Applied Plastic Pavement Marking Arrow:** Of the type specified will be paid for at the contract unit price per each. Payment will be full compensation for equipment, labor, grooving, materials, and all incidentals required.
- C. **Cold Applied Plastic Pavement Marking Message:** Will be paid for at the contract unit price per each word. Payment will be full compensation for equipment, labor, grooving, materials, and all incidentals required.
- D. **Cold Applied Plastic Pavement Marking Area:** Will be paid for at the contract unit price per square foot. Payment will be full compensation for equipment, labor, grooving, materials, and all incidentals required.

- E. Pavement Marking Paint and Beads:** Will be paid for at the contract unit price per linear foot or gallon for each color of pavement marking paint. Payment will be full compensation for furnishing paint and beads and for labor, equipment, and incidentals necessary.
- F. Grooving:** Is incidental to the associated pavement marking bid item(s).

END OF SECTION

SECTION 92

TEMPORARY TRAFFIC CONTROL

92.1 DESCRIPTION

A. General: This work consists of furnishing, installing, and maintaining required temporary traffic control devices in accordance with the current edition of the Federal Manual on Uniform Traffic Control Devices (MUTCD).

B. Related Work:

Section 90	Roadway Signs and Delineators
Section 91	Pavement Marking
Section 93	Traffic Signals and Roadway Lighting
Section 203	Submittals

92.2 MATERIALS

Traffic and traffic control devices shall conform to and be maintained in accordance with the requirements of Part 6 of the MUTCD. Pavement Markings used for Temporary Traffic Control shall be per section 91.

Traffic control devices are categorized by their intended use and certification requirements.

- Category I traffic control devices are lightweight devices which may be self-certified by the manufacturer including, but not limited to; cones, drums, and delineators.
- Category II traffic control devices are other lightweight devices which must be certified by individual crash testing including, but not limited to; portable signs and barricades.
- Category III traffic control devices are fixed or other massive devices which must be certified by individual crash testing including, but not limited to; breakaway sign supports, concrete barriers, concrete barrier end protection, crash cushions, truck mounted attenuators, and longitudinal barriers.
- Category IV traffic control devices are trailer mounted devices which are not required to be individually crash tested including, but not limited to; portable changeable message signs, arrow boards, portable temporary traffic signals, and work area lighting.

Category I, II, and III traffic control devices shall meet the crashworthy requirements of AASHTO Manual for Assessing Safety Hardware (MASH). Category IV traffic control devices shall be delineated with retroreflective traffic control devices.

The Contractor shall provide documentation for all traffic control devices used when requested by the Engineer or as indicated in project documents. The documentation shall show the traffic control devices used meet the applicable MASH requirements.

Temporary traffic control devices, including signs, drums, cones, tubular markers, barricades, vertical panels, and direction indicator barricades shall be reflectorized with sheeting applied to a satisfactory backing. All fluorescent orange background material on traffic control signs, all temporary delineators, and all temporary STOP (R1-1), YIELD (R1-2), DO NOT ENTER (R5-1), and WRONG WAY (R5-1a) signs will conform to the requirements of ASTM D4956 Type IX or XI. All other traffic control signs and background colors will conform to the requirements of ASTM D4956 Type IV. For barricades, vertical panels, and direction indicator barricades; the reflective sheeting shall meet or exceed the standards of Type IV as defined by ASTM D4956. Round surfaced temporary traffic control devices including, but not limited to; drums, cones, and tubular markers shall be reflectorized with reflectorized sheeting meeting or exceeding the standards of Type IV as defined by ASTM D4956. All orange colored material shall be fluorescent.

A. Fabrication:

1. **Background Color:** Shall be as specified in Part 6 of the MUTCD.
2. **Legend:** Message and borders shall be non-removable copy of the color specified in Part 6 of the MUTCD. The non-removable copy may be screened processed or direct applied. Mounting holes will not be drilled or punched in any part of the non-removable copy.
 - a) **Screened Process:** Message borders shall be processed on reflective sheeting using mechanical equipment, materials, and operational methods and procedures as prescribed by the manufacturer. Processing shall be accomplished by the direct or reverse screen method using opaque or transparent processing material. Screening may be accomplished either before or after application of the sheeting to the base panels. Free hand painting will not be permitted on any part of the finished sign face.
 - b) **Direct Applied:** Cut out message and borders shall be reflective sheeting or opaque lettering film applied directly to clean, dust free, reflective sheeting background. Message and borders shall be in accordance with the operational methods and procedures prescribed by the sheeting manufacturer. The finished letters, numerals, symbols, and borders shall be cut with smooth, regular outline, and free from ragged or torn edges.

B. Traffic Control Device Standards:

1. **Warning Lights:** Shall be portable with lens directed enclosed lights. The lens of the unit shall not be less than seven (7) inches in diameter and shall be amber in color. They may be used in either the steady burn or flashing mode. Warning lights shall be in accordance with the requirements of Equipment and Materials Standards of the Institute of Transportation Engineers (ITE) Publication No. ST 017, Purchase Specification for Flashing and Steady-Burn Warning Lights. The lights shall be certified by the manufacturer.

The use of the warning lights shall be in accordance with Part 6 of the MUTCD.

2. **Channelizing Devices:** Channelizing devices, including cones, barricades, tubular markers, vertical panels, directional indicator barricades, and drums shall conform to the requirements of Part 6 of the MUTCD. Drums shall be of a two-part construction with breakaway bases. Cones shall be a minimum of 42 inches in height.
3. **Temporary Sign Supports:** Construction sign supports shall meet the crashworthy requirements of AASHTO Manual for Assessing Safety Hardware (MASH) and shall conform to the height requirements of the MUTCD. Temporary sign support shall be allowed up to 72 hours, or as directed by the Engineer.
4. **Pilot Car:** Shall be a passenger car, multipurpose passenger vehicle, or pickup truck.
5. **Temporary Pavement Marking Tape:** Types I and II, shall conform to the requirements of ASTM D4592. The film, without adhesive, shall have a minimum thickness of 39 mils.
6. **Temporary Raised Pavement Markers:** Shall consist of a yellow or white plastic body providing a horizontal width and length of approximately four (4) inches in both dimensions and approximately 3/4 inch high.

The adhesive shall be resistant to the effects of weather and capable of retaining the marker in position during the time it is required to function.

The markers shall consist of a methyl methacrylate, polycarbonate, polystyrene, or suitably compounded acrylonitrile butadiene (ABS) shell fitted with retroreflective lenses. The exterior surface shall be smooth.

The marker reflector shall have a minimum coefficient of (retroreflected) luminous intensity conforming to Table 1.

7. **Flexible Vertical Markers (Tabs):** Shall consist of a yellow or white plastic body providing a horizontal width of approximately four (4) inches and approximately two (2) inches high.

A strip of retroreflective tape 1/4 inch minimum width shall be bonded horizontally along the top of the vertical area.

The adhesive shall be resistant to the effects of weather and capable of retaining the marker in position during the time it is required to function.

The marker reflector shall have a minimum coefficient of (retroreflected) luminous intensity conforming to Table 1.

Table 1
Minimum Coefficient of (Retroreflected) Luminous Intensity in
Millicandelas per lux or (Candelas per footcandle)

Observation Angle in Radians (Degrees)	Entrance Angle in Radians (Degrees)	Luminous Intensity for Each Color in Millicandelas per lux (Candelas per footcandle)		
		White	Yellow	Red
0.0035 (0.2°)	0.0 (0°)	279 (3.0)	167 (1.8)	70 (0.75)
0.0035 (0.2°)	0.349 (20°)	112 (1.2)	67 (0.72)	28 (0.3)

Note: The retroreflective tape shall be acrylic backed metalized polycarbonate microprism film, molded methyl methacrylate, or approved equal.

92.2 CONSTRUCTION REQUIREMENTS

A. General: The Contractor shall furnish, install, and maintain required traffic control devices and pavement marking material.

1. All traffic control devices shall be kept in proper position, clean, and legible at all times. Damaged devices shall be replaced within 24 hours, or as directed by the Engineer.
2. Non-applicable traffic control devices shall be completely covered or removed during periods of inactivity.
3. Traffic control devices shall be immediately removed or covered when the need for such devices no longer exists. When devices are no longer needed, they should be stored off the project or as close to the right-of-way line as possible.
4. Vehicles and equipment shall be stored outside the roadway and clear zone and as near as possible to the right-of-way line. Contractor's employees should mobilize at a location off the right-of-way and arrive at the work site in a minimum number of vehicles necessary to perform the work.
5. Traffic approaching the project from intersecting roadways, streets, and approaches must be adequately accommodated. Major intersections and large commercial entrances may require additional signing, flaggers, temporary signals, and channelizing devices on a temporary basis until work activities pass these areas.
6. Unless otherwise stated, hours of darkness are defined as 1/2 hour after sunset until 1/2 hour before sunrise.

B. Apparel: All workers within the right of way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to construction equipment

within the work area shall wear high-visibility safety apparel intended to provide conspicuity during both daytime and nighttime usage, and meeting the Performance Class 2 or 3 requirements of the ANSI/ISEA 107 publication entitled “American National Standard for High- Visibility Safety Apparel and Headwear” or equivalent revisions.

Workers shall wear a vest, shirt, or jacket as an outer garment with a background color of fluorescent yellow-green, fluorescent orange-red, or fluorescent red. The retro-reflectorized portion of the material shall be orange, yellow, white, yellow-green, or silver.

- C. Flagging:** Standards for flaggers and flagging practices shall conform to Part 6 of the MUTCD and the flagger manual.

Flagger workstations shall be illuminated during hours of darkness. Flagger workstations shall be illuminated with a minimum of 108 lux (10 foot candles) of illumination. The Contractor shall perform a drive-through after dark to check for glare from the driver’s perspective and make adjustments as necessary to eliminate or reduce the glare to the satisfaction of the Engineer.

Flaggers shall be equipped with a STOP/SLOW sign for the control of traffic. The sign should be mounted on a staff from five (5) to seven (7) feet long, from the bottom of the sign to the ground. All flagging devices and the use of such devices shall comply with Part 6 of the MUTCD, unless otherwise specified.

- D. Pilot Car:** Pilot cars and pilot car practices shall conform to Part 6 of the MUTCD.

E. Traffic Control, Miscellaneous:

- 1. Channelizing Devices:** Shall be reasonably plumb to the pavement, safely and neatly ballasted as needed, clearly visible, and legible.

Additional requirements for the use of specific channelizing devices are as follows:

- a) **Cones:** Minimum cone height shall be 28-inches and reflectorized.
- b) **Barricades:**
 - 1) **Type 1 Barricades:** Shall not be used in roadway.
 - 2) **Type 2 Barricades:** Shall not be used in roadway.
 - 3) **Type 3 Barricades:** Minimum width 72-inches.
- c) **Tubular Markers:** Shall not be used in lane closure tapers.
- d) **Vertical Panels:** No additional requirements.

- e) **Direction Indicator Barricades:** No additional requirements.
 - f) **Drums:** No additional requirements.
2. **Delineators:** Shall conform to Section 90.
 3. **Warning Lights:** When used in conjunction with signs, barriers, and channelizing devices; the warning light shall conform to Part 6 of the MUTCD.

Vehicles and equipment working in traffic or alongside traffic shall be equipped with a flashing amber light visible from all directions at a minimum distance of 1/2 mile. The amber light shall be mounted on the uppermost part of the Contractor's vehicle. Lights must flash at 75 ± 15 flashes per minute. Vehicle flasher/hazard lights are not acceptable.

4. **Shadow Vehicles:** Shall conform to Part 6 of the MUTCD. Shadow vehicles shall be used as specified in the plans and for brooming operations unless otherwise directed. Shadow vehicles shall be a four-wheel motor vehicle with a flashing amber light. No separate payment will be made for shadow vehicles and any signs, warning lights, or other items associated with the shadow vehicles.
5. **Inspection:** The Contractor shall constantly monitor and maintain all traffic control items. The Contractor is responsible for adjustments of traffic control items when traffic conditions change.

The Contractor shall make weekly inspections after dark to verify the overall traffic control system is adequate and all devices are legible at night. This includes detour route signing. The weekly inspections shall begin when the first traffic control sign or device is put into operation and end when the last traffic control sign or device is removed from operation.

The Contractor shall designate an employee whose primary responsibility is the maintenance of traffic and traffic control devices, 24 hours a day, seven (7) days a week. The person so designated must have training and experience in the field of construction traffic control and be knowledgeable about the MUTCD. The employee selected must be approved by the Engineer. The name, phone number, and location of the person(s) shall be provided to the City.

If directed to by the Engineer, said designated person shall submit a weekly written report. The reports shall document the daytime and weekly night time inspections.

- F. **Traffic Control Signs:** Shall conform to Part 6 of the MUTCD and as specified in the plans.

G. Temporary Traffic Control Signal: Shall generally consist of all necessary materials and appurtenances needed to control road user movements at an intersection, bridge, or other site.

1. **General:** The Contractor shall furnish, operate, and maintain the temporary traffic control signal. The temporary traffic control signal shall reliably and continuously control traffic for all approaches at the specified location. The temporary traffic control signal system shall meet the requirements of the MUTCD, national and local electrical codes, and these specifications.

Existing signal equipment at the site may be salvaged for use in the temporary traffic control signal. Existing traffic signal equipment used on the project shall be salvaged or returned to original use as indicated in the plans. All materials furnished by the Contractor shall remain the property of the Contractor upon completion of the project.

Signal timing shall be per plans and specifications or as directed by the Engineer. Prior to operating a temporary signal contact City Traffic Operations for inspection and coordination.

The temporary traffic control signal shall display pedestrian indications if the pedestrian indications previously existed, or if it is anticipated pedestrians will utilize the temporary traffic control signalized intersection.

In the event of system failure, the Contractor shall furnish necessary flaggers to safely control traffic until the temporary traffic control signal is operable. The cost of flaggers, signing, and lighting shall be incidental to the contract price for temporary traffic control signal.

The Contractor shall have a qualified individual responsible for setup and maintenance of the temporary traffic control signal. This person shall have received training on installation, setup, and maintenance of the system.

Traffic signal operation or maintenance work is required to be performed by the Contractor when project conditions dictate, lane closures change, traffic flow is impeded, a potential risk to the public exists, or when equipment breaks down or malfunctions. Equipment break downs or malfunctions require a high priority response and are to be reacted to within one hour of notification of the event.

2. **Temporary Traffic Control Signal Equipment:** Except as required in this section, all traffic signal equipment and materials will meet the requirements of Section 93.

a) **Short Term Temporary Traffic Control Signal:** Shall consist of signal heads mounted on span wire supports.

- b) Portable Temporary Traffic Control Signal:** Shall consist of signal heads, controller, and power supply, all mounted on a heavy duty trailer.

One of the signal heads shall be mounted a minimum of 17 feet and a maximum of 19 feet above the roadway surface on the mast arm. The other signal head shall be mounted at least eight (8) feet but not more than 15 feet above the roadway surface.

The signal heads shall have the ability to be rotated 180 degrees to face in either direction. The signal heads shall also have the ability to be rotated in the vertical or horizontal plane so as to have the optimum visibility to the motorist. Signals shall be located so as to meet the visibility requirements of the MUTCD.

The portable temporary traffic control signal shall be equipped with work zone safety lights located on the back side of the signal heads to alert construction workers of the status of the traffic signal.

- 3. Temporary Traffic Control Signal Support:** The support system, with traffic signal heads, shall be designed in accordance with the current edition of the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals. The design wind velocity shall be 90 mph. The Contractor shall complete tree trimming, as necessary.

- a) Short Term Temporary Traffic Control Signal:** The Contractor shall furnish and install span wire supports. Guy wire anchors shall be used as design requires. The Contractor shall determine the size of span support wire, span tether wire, pole type, and guy wire required.

Design and check design calculations for the span wire and support system (span wire, tether wire, poles, arms, connections, guy wires, and anchors, footings, anchor bolts, etc.) shall be signed and sealed by a Professional Engineer registered in the state of South Dakota and shall be submitted with shop drawings.

- b) Portable Temporary Traffic Control Signal:** Shall be designed to support the signal heads required.

Signal supports should be located as far as practical from the edge of the traveled way without adversely affecting the visibility of signal indications. Temporary signal trailers are not to be parked in areas or lanes open to traffic.

The Contractor shall adjust the traffic signals as necessary for the various phases of the work and traffic conditions to meet MUTCD criteria for sight distances, sight triangles, and lateral distances. This includes the relocation or realignment of traffic signal indications as project conditions require.

4. Power:

- a) **Short Term Temporary Traffic Control Signal:** The Contractor shall provide power to the temporary traffic control signal system. The monthly fee for power used by the short term temporary traffic control signal system shall be paid for by the Contractor.
- b) **Portable Temporary Traffic Control Signal:** The power source for the unit shall be one of the following: an engine generator unit, a solar powered unit, or a 110 volt AC power source. Solar powered units shall have a solar array charging system capable of operating without external charge for a minimum of 20 days during all seasons. The system shall monitor alternator or charging system and battery voltage. The master trailer (controller) shall monitor all functions of remote trailers and display all conditions. The remote trailers shall also provide the status of all functions for that particular remote trailer. If a low power condition occurs, the controller software shall automatically switch the trailer to a minimum power mode to preserve battery power. The Contractor shall be responsible for providing backup power if the main power source fails. The backup power supply shall be able to operate the traffic signals for a minimum of 48 hours.

5. Controller: Shall be capable of operating pre-timed, actuated, and by manual control.

- a) **Short Term Temporary Traffic Control Signal:** Shall operate from a controller at the site. The controller and the controller cabinet shall meet the requirements of Section 93 with the following deviations:
 - 1) Battery backup is not required.
 - 2) The controller cabinet shall be a NEMA Type M enclosure capable of pole mounting with cable conduit opening(s) in the center bottom.
- b) **Portable Temporary Traffic Control Signal:** Shall operate from one master controller at a given site. The second controller or additional slave units shall be controlled by the master unit.

The controller shall have an operating temperature range from -40 to +120°F.

- 6. **Vehicle Detection:** The system shall be capable of video, loop, microwave, or radar detection. Contractor may use existing detectors per plans and shall provide temporary detectors in the event existing detectors are unusable.
- 7. **Traffic Signal Programming:** The Contractor shall program the controllers with the traffic signal programming that is provided in the project plans. Should the project plans not specify a traffic signal program, the City shall provide the traffic signal programming in writing. As project conditions and traffic needs change, the

Contractor will adjust the traffic signal splits and offsets as directed by the Engineer.

- H. Arrow Boards:** On roads with normal posted speeds of 45 mph and above, Type C units shall be used for all operations 24 hours or more in duration and Type B units may be used for operations less than 24 hours in duration. On roads with normal posted speeds less than 45 mph, Type A, B, or C, units may be used for all operations.

Type A: 48 inches x 24 inches, visible for a minimum of $\frac{1}{2}$ mile

Type B: 60 inches x 30 inches, visible for a minimum of $\frac{3}{4}$ mile

Type C: 98 inches x 48 inches, visible for a minimum of 1 mile

- I. Portable Changeable Message Signs:** Shall conform to Part 6 of the MUTCD except the minimum mounting height may be lowered, as approved by the Engineer. The Contractor shall furnish, place, operate, and maintain the Portable Changeable Message Signs (PCMS) at the locations shown on the plans.

J. Temporary Pavement Marking:

1. **General:** Temporary pavement markings shall be maintained in good condition until the permanent pavement marking is in place, or until approved by the Engineer.
2. All roadways open to traffic (including, but not limited to, newly paved surfaces, cold milled surfaces, asphalt surface treatments, flush seals, fog seals, and tack coats) shall have temporary centerline markings, lane lines, and lane use markings placed according to plans and MUTCD part 6 prior to nightfall.

Unless otherwise shown on the plans, centerline and the applicable lane lines may be temporarily marked by temporary pavement marking tape, temporary raised pavement markers, temporary flexible vertical markers (tabs), or temporary pavement marking paint.

The Contractor shall take the steps necessary to ensure the temporary markings on the final surface will match the markings on the existing surface.

3. **Materials for Temporary Pavement Marking:** Temporary pavement marking tape, temporary raised pavement markers, temporary flexible vertical markers (tabs), and temporary pavement marking paint shall be of the type specified and shall meet the following requirements.
 - a) **Temporary Pavement Marking Tape:** Shall be applied according to the manufacturer's recommendations.
 - b) **Temporary Raised Pavement Markers:** Shall be applied according to the manufacturer's recommendations. Four (4) inch wide reflectorized markers may be used in place of tape or paint.

- c) **Temporary Flexible Vertical Markers (Tabs):** Shall be applied according to the manufacturer's recommendations. Four (4) inch wide reflectorized markers may be used in place of tape or paint.
- d) **Temporary Pavement Marking Paint:** Shall be applied in accordance with Section 91.
- e) **Removal of Pavement Markings:** Shall be designated by the Engineer.

Pavement markings shall be removed from the pavement by methods that do not damage the surface or texture of the pavement. Pavement markings shall be removed before the traffic pattern is changed.

Covering the markings is not acceptable removal.

Sand or other material used for removal shall be disposed of as the work progresses. Accumulations of sand or other material, which interferes with drainage or constitutes a hazard to traffic, will not be permitted.

When sand blasting is used for removal of pavement markings or objectionable material, and the removal operation is performed within 10 feet of a lane occupied by the traveling public, the residue including dust, shall be removed immediately by a vacuum attachment operating concurrently with the sand blasting operation.

Damage to the pavement surface caused by pavement marking removal shall be repaired at the expense of the Contractor.

92.3 METHOD OF MEASUREMENT

- A. **Traffic Control, Lump Sum:** If traffic Control, Lump Sum bid item is utilized, field measurement for traffic control will not be measured.
- B. **Flagging:** Will be measured to the nearest 0.5 hour a flagger is performing flagging work. A record of the number of flagger hours used will be submitted to the Engineer.
- C. **Pilot Car:** Will be measured to the nearest 0.5 hour a pilot car is performing pilot car work. A record of the number of pilot car hours used will be submitted to the Engineer.
- D. **Traffic Control, Miscellaneous:** Will not be made.
- E. **Type 3 Barricades:** Type 3 barricades, of the type and length specified, will be measured per each used on the project. Measurement for Type 3 barricades will be made one time even if the Type 3 barricades are moved or replaced. The number of Type 3 barricades measured will be the greatest number of installations in place at

any one time, regardless of the number of setups throughout the duration of the project.

- F. Flexible Delineators:** Will be measure per each used on the project.
- G. Traffic Control Signs:** Will be measured to the nearest 0.1 foot and the area computed to the nearest 0.1 square foot of the sign face. Deduction will not be made for rounded corners. Measurement for traffic control signs will be made one time even if the traffic control signs are moved or replaced. The amount of traffic control signs measured will be the greatest number of installations in place at any one time, regardless of the number of setups throughout the duration of the project.
- H. Temporary Traffic Control Signal:**
 - 1. Short Term Temporary Traffic Control Signal:** Will be made on a per site basis. One site will be considered to be all signals, overhead span wires, support poles, and other equipment in use at an intersection.
 - 2. Portable Temporary Traffic Control Signal:** Will be made on a per each basis. One unit will be considered to be a portable traffic control signal mounted on a trailer.
- I. Arrow Board:** Will be measured on a per each basis of the total number of arrow boards used on the project. Measurement for arrow boards will be made one time even if the arrow boards are moved or replaced. The amount of arrow boards measured will be the greatest number of arrow boards on the project at any one time, regardless of the number of setups throughout the duration of the project.
- J. Portable Changeable Message Sign:** Will be measured on a per each basis of the total number of portable changeable message signs used on the project. Measurement for portable changeable message signs will be made one time even if the portable changeable message signs are moved or replaced. The amount of portable changeable message signs will be the greatest number of portable changeable message signs on the project at any one time, regardless of the number of setups throughout the duration of the project.
- K. Temporary Pavement Marking:** Measurement for tape and paint will be made the linear foot of tape or paint. Tabs, and raised pavement markers will be measured by the each.
- L. Remove Pavement Marking:** Will not be made. The plan quantity will be used for payment unless additional pavement marking removal is ordered by the Engineer.

92.4 BASIS OF PAYMENT

- A. Traffic Control, Lump Sum:** If traffic Control, Lump Sum bid item is utilized, field measurement for traffic control will not me measured. Payment will be full compensation for installation, maintenance, relocation, and removal of the traffic

control devices. Based on the lump sum contract price for Traffic Control, partial payments will be considered based on the following schedule:

<u>Milestone</u>	<u>Payment Amount</u>
Necessary signs furnished to site	50% of bid item amount
40% of original contract amount earned	75% of bid item amount
Project completion	100% of bid item amount

- B. Flagging:** Will include all costs for provided certified flagger, stop/slow paddle, flag, and any nighttime illumination required. The accepted number of flagging hours will be paid at the contract unit price.
- C. Pilot Car:** Will be paid for at the contract unit price.
- D. Traffic Control, Miscellaneous:** Will include all costs for installation, maintenance, and removal of all cones; Type 1 and Type 2 barricades; tubular markers; vertical panels; direction indicator barricades; drums; flashing warning lights; and flags on signs; temporary pedestrian access route. Payment will include all costs for removing and covering non-applicable traffic control devices, shadow vehicles, traffic control inspections, reporting for traffic control inspections, and the designated traffic control contact person.
- E. Type 3 Barricades:** Will include all cost for installation, maintenance, and removal.
- F. Flexible Delineators:** Will include all cost for installation, maintenance, and removal.
- G. Traffic Control Signs:** Will be paid for by the square foot. Payment for traffic control signs will be made following satisfactory installation. Payment will be full compensation for installing, maintaining, relocating, and removing traffic control signs and supports. Hinged signs and signs with tabs, such as right and left signs, will be paid for as one sign. Costs for posts and supports shall be included in the contract unit price of the sign.

Additional payment will not be made for any traffic control sign turned away, covered, or temporarily taken out of service and returned to service. If a fixed location traffic control sign is relocated due to an error in the plans or as directed by the Engineer, an additional 50% of the designated sign rate will be paid.

The Contractor's failure to maintain, relocate, or remove traffic control signs and supports as required will result in a price adjustment assessed to the contract.

H. Temporary Traffic Control Signal:

- 1. Short Term Temporary Traffic Control Signal:** Will be paid for at the contract unit price per each site. Payment will be full compensation for furnishing, installing, maintaining, tree trimming, and all other incidentals for the short term

- temporary traffic control signal, which may include using existing controller, signal heads, and detectors or providing new as designated in the plans.
- 2. Portable Temporary Traffic Control Signal:** Will be paid for at the contract unit price per each unit. Payment will be full compensation for furnishing, installing, maintaining, relocating, tree trimming, and all other incidentals for the portable temporary traffic control signal.
 - I. Arrow Board:** Will be paid for at the contract unit price per each. Payment will be full compensation for labor, equipment, materials, delivery, installation, maintenance, relocation, and removal.
 - J. Portable Changeable Message Sign:** Will be paid for at the contract unit price per each. Payment will be full compensation for labor, equipment, materials, delivery, installation, maintenance, relocation, and removal.
 - K. Temporary Pavement Marking:** Will be by the linear foot for paint and tape, and per each for tabs and raised pavement markings. Payment will be full compensation for all costs to furnish, install, and remove (when required) temporary pavement markings including costs to remove and properly dispose of temporary road marker covers, temporary road markers, and temporary pavement marking tape.
 - L. Remove Pavement Marking:** Will be by the foot, each, word, or square foot depending on the bid item unit description. Payment will be full compensation for all costs to remove and properly dispose of the pavement markings.

END OF SECTION

SECTION 93

TRAFFIC SIGNALS AND ROADWAY LIGHTING

93.1 DESCRIPTION

A. General: This work consists of furnishing and installing all material and equipment necessary for the operation of traffic signals and roadway lighting. Contractor shall coordinate with City Traffic Operations to determine which materials are salvaged to the City, and which material may be disposed of by the contractor. Salvaged material shall be delivered to a location as determined by City Traffic Operations.

B. Related Work:

Section 90	Roadway Signs and Delineators
Section 91	Pavement Marking
Section 92	Temporary Traffic Control
Section 203	Submittals

93.2 MATERIALS

Prior to fabrication or purchase, the Contractor shall submit shop drawings or catalog cuts for all signal equipment and luminaires to the City in accordance with Section 203 Submittals. The Contractor will not begin fabrication or construction of the work contained in the shop drawings or catalog cuts until the City has completed the review. Contractor shall not deviate from materials reviewed without additional review and approval.

A. Electrical Grounding and Bonding:

- 1. Grounding Wire:** From electrical cabinets to the ground rod shall be bare, soft drawn copper, size per National Electrical Code (NEC). Grounding wire from pole to ground rod shall be bare, soft drawn copper, minimum size #6 AWG.
- 2. Bonding Conductors:** Shall be of the same size and insulation grade as the associated circuit conductors. Equipment grounding conductors shall be sized in compliance with the NEC.
- 3. Ground Rods:** Shall be copper-coated electrodes in accordance with Underwriters Laboratory (UL). The size and length shall conform to NEC requirements.

B. Conduit:

- 1. Rigid Steel Conduit:** Conduit and fittings shall meet the requirements of UL 6 and 514 and shall be hot dip galvanized. Each section of conduit shall bear the UL label.

2. **Rigid Nonmetallic Conduit:** Conduit and fittings shall be polyvinyl chloride heavy wall meeting the requirements of UL 651 and 514. Use and installation of polyvinyl chloride (PVC) schedule 40 and 80 shall be in accordance with NEC and each section shall bear the UL label. The contractor shall use schedule 80 nonmetallic conduit under all roadways and other locations as shown in the plans.
3. **Innerduct Conduit:** Shall be SDR 13.5 HDPE. Innerduct conduit shall provide 1-inch nominal duct size, be orange in color, and be longitudinally ribbed on the inside wall.

C. Junction Boxes:

1. Shall be polymer concrete material and conform to NEC standards 314.29 and 314.30. The loading requirement for all electrical junction boxes and covers will be tier 22 of ANSI/SCTE 77 2007. The word "ELECTRIC(AL)" or "SIGNAL(S)" shall be cast into the top of the cover.
2. Surface mounted junction boxes shall comply with NEMA 4X stainless steel, shall be UL-listed, and, at a minimum, shall be sized according to the NEC. Stainless steel junction boxes shall have the cover held in place with a continuous hinge and kept closed with screws and clamps on the remaining three sides. The cover shall be removable by removing the pin with the continuous hinge. All seams shall be continuously welded. Gaskets shall be closed cell neoprene.

D. Concrete Footings: Shall meet the requirements for Class M6 concrete. Cement shall be Type II. Vertical reinforcement shall be deformed unless otherwise noted and shall conform to the requirements of ASTM A615/AASHTO M 31 Grade 60. Circular ties, stirrups, and spiral reinforcing may be fabricated from deformed bars conforming to the requirements of ASTM A615/AASHTO M 31 Grade 60. Spiral reinforcing may also be fabricated from cold drawn wire conforming to ASTM A1064 or hot rolled plain bars conforming to ASTM A615/AASHTO M 31 Grade 60.

E. Bolts: All bolts, anchor bolts, anchor rods, nuts, and washers shall conform to SDDOT Standard Specifications for Road and Bridges Section 972.

F. Electrical Power Wire: Shall be Type THW, THWN, XLPE, or XHHW rated for 600 volts AC and be clearly and durably marked with the UL label, type of insulation, number of conductors, and the AWG size.

Traffic signals with intersection lighting using the same service cabinet shall utilize stranded copper meeting the requirements of ASTM B3 and B8, Class C. Roadway lighting shall utilize stranded copper conductors for service, feeder, and branch circuits.

G. Pole and Bracket Cable: The cable from pole base to luminaire shall be two-conductor of the AWG size shown, meeting ICEA Standards.

Conductors shall be THWN/THNN meeting ASTM B3. Conductors shall be stranded bare soft copper meeting ASTM B3 and B8, Class C. Each conductor shall be insulated with high dielectric strength heat and moisture resistant PVC rated for use at 75°C, and shall meet the requirements of ICEA. One insulated conductor shall be colored white and the other black. The two insulated conductors shall be laid parallel and covered with a black polyethylene belt. The belt shall meet the requirements of ICEA.

H. Traffic Signal Control Cables:

1. **Multiple Conductor Cables:** Shall be THHN/THWN insulated conductors with fillers of nonabsorbent material, bound with polyester tape and with a PVC jacket. Two-conductor cables may either be of round or flat construction.
2. **Conductors:** Shall be Class C stranded copper meeting the requirements of ASTM B3 and B8.
3. **Insulation:** Shall have a minimum thickness of 19 mils of which 15 mils shall be PVC with the remaining thickness of nylon.
4. **Colors:** Conductor insulation shall be colored in accordance with ICEA S-73-532 Table E2.
5. **Jackets:** Shall be PVC meeting UL requirements for Class 12 jackets and ICEA standards.
6. **Markings:** The cable shall be marked with the name of the manufacturer, rated voltage, UL label, American Wire Gauge (AWG) size, and number of conductors.

I. Electrical Service Cabinet:

1. Shall be a NEMA Type 3R enclosure.
2. Size shall be as required to house required components.
3. Shall be rated for service entrance equipment.
4. Required components:
 - a) Main breaker.
 - b) A copper bus rated for the voltage, current, and phases required by the plans.
 - c) Branch circuit breakers meeting plan requirements for amps, voltage, and phases. Minimum A.I.C. shall be 10,000.
 - d) When plans require, a mechanically held contactor, NEMA rated for the load

served, shall be provided. The contactor shall be encased in a UL approved weatherproof housing with an integral test switch included. The contactor shall be complete with an interface relay for photocell control and photocell bypass switch. A photocell shall be provided.

- 5. Secondary Disconnect:** When the electrical service is not on the same corner as the traffic signal cabinet, a secondary disconnect shall be provided. The disconnect shall be a Nema Type 3R, 60 amp non-fused and shall break the power to the cabinet.

J. Traffic Signal Poles:

1. Design:

- a)** The location, number, area, and weight of the signal heads, preemption, video detection, and signing as shown on the plan detail plates shall be used for determination of adequate pole and footing structural design. The actual quantity and locations of signal heads shall be as shown on the plan sheet.
- b)** Design and fabrication shall be in accordance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, including all subsequent interims and plan details.
- c)** Wind load shall be calculated using the 50 year mean recurrent interval basic wind speed.
- d)** New poles shall be galvanized steel. Galvanizing shall be in accordance with AASHTO M 111 (ASTM A123). Steel pole material shall be in accordance with ASTM A36, A242, A570, A572, A607, A709, A1008, A1011, or A595 Grade A or B. A595 material shall be limited to a 3/8 inch maximum thickness. Steel pole material with a thickness of 1/2 inch to 2 inches, shall satisfy Charpy V-Notch toughness test requirements of 15 foot pounds at 40°F. The City's Traffic Engineer shall be contacted for Charpy impact requirements for steel pole material thickness greater than 2 inches.
- e)** The steel pole-to-base-plate connection shall be a full-penetration groove-welded connection with a backing ring as described in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- f)** The design yield strength shall be no higher than 55,000 psi. Strength of steel for fabricating poles may be higher than 55,000 psi, but not lower than 36,000 psi.
- g)** Anchor bolt or rod circle, anchor bolt or rod size, and other structural properties of the pole and base are to be designed and determined by the pole manufacturer.

- h) Connections at the base of the pole shall be 3M™ Scotchlok™314 wire connectors, or approved equal.
- i) Pole designs must provide for drainage with no laps or edges to hold moisture.
- j) Mast arm pole shafts shall have a removable cover and an opening for cable entrance to the mast arm.
- k) A "J" hook for a cable strain relief grip or other strain relief device shall be provided at the top of the pole.
- l) Luminaire extensions shall meet specifications for roadway luminaire poles.
- m) Hand holes and other openings shall be smooth, neat, and covered.
- n) All pole shall be designed with rotating arms.
- o) All poles shall have a metal identifying badge with the following information:
 - 1) Manufacturer's name
 - 2) Year of manufacture
 - 3) Pole model number
 - 4) Project name or other identifying information to determine what project the pole originated from

2. **Certification:** A statement is required, signed by a Professional Engineer registered in the state of South Dakota, certifying the pole designs meet all plan and specification requirements.
3. **Shop Drawings:** Prior to fabrication, the Contractor shall submit shop drawings or catalog cuts for the traffic signal poles to the City in accordance with Section 203 Submittals. With the shop drawings, the Contractor shall submit comprehensive design calculations for the traffic signal poles, including anchor bolts, signed and sealed by a SD registered Professional Engineer. Contractor shall not deviate from materials reviewed without additional review and approval.

K. Pedestal signal poles:

Pedestal signal poles may be aluminum. Aluminum poles will conform to the following requirements:

Aluminum will conform to ASTM B221, Alloy 6061, and Temper T6.

Poles will be round with a minimum outside pole diameter of 4 inches, and the pole assembly will have a square, cast aluminum base with aluminum access door. The base will conform to the breakaway requirements of NCHRP 350 or MASH. A

grounding lug will be provided in the base.

The pole to base connection will be a threaded connection; threads will be 8 TPI, NPT. A collar (integral or non-integral) to prevent wind-induced loosening of pole will be provided. All bolt and connection threads will be coated with a commercially available anti-seize compound intended for use in aluminum-to-aluminum and steel-to-aluminum connections.

The pole finish will either be brushed satin or spun. The top of the pole will be sealed by the traffic signal head mounting hardware or by an aluminum cap.

L. Roadway Luminaire Poles:

1. Design:

- a)** Design and fabrication shall be in accordance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, including all subsequent interims and plan details. Design shall also include provisions for mounting a 36-inch x 36-inch sign located 10 feet above the base.
- b)** Wind load shall be calculated using the 50 year mean recurrent interval basic wind speed.
- c)** New poles shall be galvanized steel. Galvanizing shall be in accordance with AASHTO M 111 (ASTM A123). Steel pole material shall be in accordance with ASTM A36, A242, A570, A572, A607, A709, A1008, A1011, or A595 Grade A or B. A595 material shall be limited to a 3/8 inch maximum thickness. Steel pole material with a thickness of 1/2 inch to 2 inches, shall satisfy Charpy V-Notch toughness test requirements of 15 foot pounds at 40°F. The City's Traffic Engineer shall be contacted for Charpy impact requirements for steel pole material thickness greater than 2 inches.
- d)** The steel pole-to-base-plate connection shall be a full-penetration groove-welded connection with a backing ring as described in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- e)** The design yield strength for steel shall be no higher than 55,000 psi. Yield strength of the steel used in fabricating poles may be higher than 55,000 psi but shall not be lower than 36,000 psi.
- f)** All poles shall have breakaway transformer bases. Hand hole latch shall be located at the top of the access panel.
- g)** Anchor bolt or rod circle, anchor bolt or rod size, and other structural properties of the pole and base are to be designed and determined by the pole

manufacturer.

- h) Connections at the pole or junction boxes shall be made with water tight connectors approved for outdoor use. Connectors shall be TE Connectivity GTAP or approved equal.
 - i) Pole designs must provide for drainage with no laps or edges to hold moisture.
 - j) A "J" hook for a cable strain relief grip or other strain relief device shall be provided at the top of the pole.
 - k) A 1/2 inch nut shall be welded inside the hand hole for grounding purposes. The weld shall not show through to the outside.
2. **Certification:** A statement is required, signed by a Professional Engineer registered in the state of South Dakota, certifying the pole designs meet all plan and specification requirements, including breakaway and structural adequacy, of the AASHTO Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The physical testing procedures outlined in the Aluminum Association's Specifications for Aluminum Structures may be used to establish service limits for structural adequacy certification of aluminum breakaway transformer bases and frangible couplings. If requested, test data of production samples to support the certification shall be provided.
 3. **Shop Drawings:** Prior to fabrication, the Contractor shall submit shop drawings or catalog cuts for the roadway luminaire poles to the City in accordance with Section 203 Submittals. With the shop drawings, the Contractor shall also submit comprehensive design calculations for the roadway luminaire poles, including anchor bolts or rods, signed and sealed by a SD registered Professional Engineer. The Contractor shall not begin fabrication prior to the City's review and final approval. Contractor shall not deviate from materials reviewed without additional review and approval.

M. Luminaires:

1. All fixtures shall be "cobra head" style with NEMA 7-pin photocontrol receptacle and 2-inch slip fitter mounting unless otherwise specified in plans.
2. All fixtures shall have multi-voltage driver covering the range from 120 volts– 277 volts AC.
3. Fixtures shall be LED with a color temperature of 4,000K, minimum color rendering index of 70, and minimum L₇₀ of 100,000 hours at 25° Celsius.
4. All fixtures shall have an upright rating as defined by IESNA TM-15-11 of zero (0).

N. Photoelectric Control Requirements: Shall be one of the photoelectric controls

listed on the SDDOT's Approved Products List.

O. Controller Cabinet: Shall be NEMA compliant.

1. Cabinet Design:

- a) The cabinet shall be made of welded sheet aluminum.
 - b) The type and size of cabinets shall be determined by the signal controller supplier. The cabinet shall be of sufficient size to accommodate the controller and associated equipment.
 - c) The cabinet shall be furnished with a hinged door that provides complete access to the cabinet interior. The controller cabinet door shall be hinged on the right side. The door shall have a gasket making a weatherproof and dust tight seal. The door shall be provided with a lock and two standard keys. Base mounted cabinets shall be furnished with doorstops to hold the door open during servicing.
 - d) The cabinet door shall contain a police panel with a lock and key. The police panel shall contain two switches. One switch shall be designated "flash/normal" and the other switch designated "signal off/on". At any switch position, power shall be maintained for all control equipment, including detector amplifier units, within the cabinet. The switch shall be labeled and rated for the current load. Switch terminals on the rear of the police panel shall be insulated so live parts are not exposed.
 - e) The controller cabinet shall be a NEMA Type 3R Enclosure.
 - f) Underside mounted LED light strips shall be installed on each shelf in the controller cabinet. An on/off switch that is turned on when the cabinet door is opened and turned off when the cabinet door is closed shall activate the lights. The switch shall be wired to place an input to the signal controller event or alarm log when the cabinet door is opened. The power supply for the LED light strips shall be separate from the standard double plug receptacle.
 - g) The controller cabinets shall be capable of placing vehicle and pedestrian calls into the controller. Placed calls shall provide for eight vehicle phases and four pedestrian phases. The placed calls for vehicle phases shall be capable of extending the associated vehicle phase by continuous or intermittent contact.
- 2. Fan Assembly:** Cabinets shall be provided with thermostatically controlled fan vent assemblies. The thermostat shall be adjustable within a range from 75°F to 150°F and shall be separately fused. A screened and filtered air intake area of at least 12 square inches shall be provided. The filters shall be removable, cleanable, reusable, and replaceable.

3. Electrical:

- a) A three wire 15 ampere NEMA standard double plug receptacle with ground contact shall be wired as a separate circuit ahead of the main breaker.
- b) A main circuit breaker shall be furnished and installed in the controller cabinet. An auxiliary circuit breaker shall be provided and connected to the load side of the main breaker. The main breaker shall be wired to protect the signal load and controller circuits. The auxiliary circuit breaker shall be properly rated and fused to protect circuits utilizing unfiltered AC power. Terminal facilities in the cabinet for incoming AC power will be protected to prevent short-circuiting when working with tools in the cabinet. The circuit breakers shall be capable of manual operation with markings to indicate ratings and whether it is in the open or closed position.
- c) A power line filter certified in accordance with UL Standard 1283 and meeting the following specifications shall be installed at the main breaker:
 - 1) 50 db minimum attenuation over a frequency range of 200 kilohertz to 75 kilohertz.
 - 2) Minimum feed through current of 30 amperes at 120 volts, 60 hertz.
- d) The cabinet shall be equipped with a surge protection device certified in accordance with UL Standard 1449 and meeting the following specifications:
 - 1) Nominal discharge current rating of 3kA.
 - 2) Voltage protection rating 330V.
- e) Bus bar terminals such as AC common (neutral), AC power, safety (chassis) ground and AC signal power shall be furnished and properly installed.
- f) Terminals and panel wiring for detector leads, interconnect, time switches, relays, load switch sockets, flash transfer relay sockets, and any other components required to provide the controller operation shall be installed.
- g) Terminals and components that make up the basic terminal facilities shall be permanently identified in accordance with the cabinet wiring diagram. Identification shall be permanently attached as close as possible to the terminal or component and shall not be affixed to any part which is easily removed.
- h) Each input or output terminated on a terminal block shall be identified on the front of the panel by a position number and functional terminology (e.g. 0/1 Red, 0/2 Hold, Channel 3 Red, etc.). The same identification shall be used consistently on the cabinet wiring diagram.
- i) Each component shall be identified on the front of the panel by a symbol and

function terminology consistent with the cabinet wiring diagram. Provisions shall be made that each load switch socket can be identified by the phase or overlap number by writing on the panel in an area established for this feature.

- j) Panel wiring shall be neat and firm with panel mounted terminals for signal lamp circuit conductors, one for each signal circuit, and one or more terminals for the common conductor. The terminals shall be located a minimum of 3 inches from the bottom of the cabinet and arranged for adequate clearance between the terminals. The controller equipment and terminals shall be arranged within the cabinet so they will not upset the entrance, training, and connection of incoming conductors.
 - k) A flasher socket and a solid state flasher meeting current NEMA standards shall be provided in the controller cabinet.
- P. Controller:** Shall be a solid state, digital, NEMA TS2 Type 1 from the SDDOT Approved Products List and as approved by the City's Traffic Engineer. The controller shall have front panel access to display cycle length, offset, and internal timing values. Access to these timing functions shall be by keyboard entry as an integral part of the controller. The controller shall meet NEMA environmental and electrical performance standards. The controller shall also have a USB port and an Ethernet port.

The controller shall be two through twelve phase controllers.

Digital timing shall be provided with a battery backup.

The controller shall be capable of programming by manual entry via the front panel keyboard, data downloading from a portable PC computer via null-modem cable, data downloading from one controller to another using a serial port on each controller, and restoring data using a data transfer module (data key). In a closed-loop system, the controller shall be capable of data downloading via telemetry. In an enterprise system, the controller shall be capable of data downloading from a central server.

The controllers shall be capable of operating coordinated by time-based, hardware, and telemetry.

The controllers shall have a copy function to copy all timing data from one phase to another. The controllers shall also permit copying all coordination pattern data from one pattern to another.

Hardware for future pedestrian signals shall be provided when shown.

The controller shall be equipped with solid state signal load switching devices meeting current NEMA requirements. Load switches shall be furnished with input and output indicator lights on the front panel.

The interface panels shall be capable of inserting up to sixteen load switches.

Each controller shall be furnished with a malfunction management unit (MMU) conforming to the requirements of NEMA Standard TS-2 Section 4. The provided MMU shall have visual displays for programming and operational purposes.

A sufficient quantity of BUS Interface Units shall be installed in the cabinet to provide communication between detectors, load switches, controller unit, etc. Each BUS Interface Unit shall conform to NEMA Standard TS-2, Section 8.

The controller shall be furnished with extra feature wiring to provide for remote flashing and each wire shall have its own terminal connection. The flash control circuit shall ensure that remote transfer to flashing from normal stop and go operations occurs during the end of the mainline green interval in the cycle. When the controller is in a flashing condition, the signal switching mechanism shall be inoperative.

The controller time of day flash shall alternate the red and yellow indication with yellow on the major route and red on the minor route. The controller malfunction flash shall be red-red.

Load switches for pedestrian indications shall be required when pedestrian indications are shown. The cabinet wiring, load switch sockets, and connection facilities shall be included for pedestrian movements permissible with phasing shown.

The controller furnished shall meet current NTCIP requirements.

Q. Detector Unit: Components and workmanship shall conform to the standards of NEMA. Detector units shall include a visual display screen in the controller cabinet.

R. Detector Loops:

1. Detector Loop Wires and Cables:

a) Lead-in (Home Run) Cables: Feeder cables from loop junction box to detector units shall be twisted shielded pairs, conforming to International Municipal Signal Association (IMSA) 50-2, #16 AWG minimum size. Splices are to be avoided in feeder wires.

b) All wire connections shall be sealed and insulated with 3M[™] Scotchcast[™] 3570G Connector Sealing Pack, or approved equal.

2. Sawed-in Loops:

a) Conductors shall conform to the following requirements:

Material	Stranded Copper
Size	#16 AWG (Minimum)
Insulation	XHHW, THHN, RHH, or RHW
Encasement	1/4 inch Polyethylene tubing

- b) Backer rod material shall be resilient, nonabsorbent material approximately 25% larger in diameter than the width of the sawed slot to be sealed.
- c) Loop Sealants: Shall be one of the products as listed on the SDDOT Approved Products List.
- d) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box.
- e) Loop wire shall be continuous throughout the loop and lead-ins to the junction box.

3. Preformed Loops:

- a) Conductors shall conform to the following requirements:

Material	Stranded Copper
Size	#16 AWG (minimum)
Insulation	600 Volt, XLP, bearing the U.L. designation for either Type RHH and RHW or Type XHHW

- b) Loop wire shall be continuous throughout the loop and lead-ins to the junction box.
- c) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box.
- d) If loop will be in direct contact with hot asphalt, it shall be rated to withstand the hot asphalt temperature.

S. Signal Heads:

1. All vehicle and pedestrian signal indications shall be light emitting diode (LED) signal modules.
2. Vehicular signal indications shall meet the requirements of the Institute of Transportation Engineers (ITE) Standard, Vehicle Traffic Control Signal Heads.
3. Pedestrian signal indications shall meet the requirements of the ITE Standard, Pedestrian Traffic Control Signal Indicators.
4. The LED signal modules shall be warranted against defects in materials and workmanship for a period of 5 years after the installation of the modules. The manufacturer shall provide this warranty in writing to the Engineer prior to installation of the LED signal modules.

5. Size: Shall be a minimum of 12 inches diameter.
 6. Color: Doors, visors, and backplates shall be dull black and housing highway yellow.
 7. Material may be polycarbonate resin.
 8. Each circular signal section shall be furnished with a tunnel type visor and shall be attached to the door front using four (4) stainless steel screws, which shall thread into a brass thread insert.
 9. Backplates for Signal Heads: All new vehicle signal heads will have backplates with retroreflective border. The vehicle signal head backplates will have a factory applied 3-inch wide yellow retroreflective border. Sheeting for the border will be Type XI or Type IX in conformance with ASTM D4956. Backplates will be polycarbonate, aluminum, or aluminum-composite. Minimum material thicknesses are:
 - Polycarbonate, 0.10-inch
 - Aluminum, 0.06-inch
 - Aluminum-Composite, 0.08-inch

Signal backplates will extend not less than 5 inches from the edge of the signal head at the top, bottom, and sides. The bottom of the backplate on vehicle signal faces mounted directly above pedestrian signal indications will be sized to permit the separate adjustment of the vehicle and pedestrian signal indication and may be less than 4 inches.
 10. Green LED displays shall have clear lenses.
- T. Pedestrian Push Button:** Shall be compliant with the Americans with Disabilities Act (ADA). Accessible pedestrian push buttons shall be one of the accessible pedestrian signals on the SDDOT's Approved Products List. Pedestrian push button pole and material shall be as specified in plans.

1. General:

- a) Shall be pressure activated with essentially no moving parts.
- b) Shall be vandal resistant.
- c) Shall activate with 3 pounds force or less.
- d) Shall have an LED that illuminates when the button is being pushed and remains illuminated until the pedestrian call is served.
- e) Shall give a toned beep verification of button being pushed.
- f) Shall have an operating life of 1 million actuations.

- g) Shall be compatible with NEMA TS2 controllers.
- h) Shall be capable of being programmed via Bluetooth®.

2. Housing:

- a) Button housing shall be unfinished, high impact cast or machined aluminum.
- b) All switch electronics shall be sealed within the high impact cast or machined aluminum housing.
- c) Shall have a gasket between the button housing and the mounting cup.

3. Electrical:

- a) Operating Voltage: 15 to 24V DC or 12 to 24V AC.
- b) On Resistance 10 Ohms (when the button is activated and placing a call).
- c) Standby Current 10 micro amps typical.
- d) Shall have built in surge protection.
- e) Shall have a solid state electronic piezo switch rated for 1 million cycles with no moving plunger or moving electrical contacts.
- f) Shall hold the call for a minimum of 5 seconds.
- g) Requires only two conductors be run from the traffic signal cabinet to the push button to operate.
- h) Six units wired in parallel on a single pedestrian isolator input shall not pull the input voltage of the pedestrian isolator down such that a false pedestrian call is placed in the controller.

U. Emergency Vehicle Preemption System: The emergency vehicle siren registers its presence by activation of the siren's "yelp" mode. The emergency vehicle preemption system provides a method that allows an emergency vehicle to have priority at the traffic signal. This specification describes the minimum operating requirements of a siren activated emergency vehicle preemption system.

1. System Equipment:

- a) **Detectors:** Directional microphones at each approach to the signal detect the arrival of an emergency vehicle.

- b) **Phase Selector:** Located in the signal controller cabinet. The phase selector shall process the input detector information and produce an appropriate output signal to the controller.
- c) **Emitters:** The existing electronic siren on each vehicle. Any electronic siren that meets current federal standards shall be compatible with the system. Sirens are not to be furnished as part of the project.

2. Equipment Requirements:

- a) **General:** The emergency vehicle preemption system shall be expandable to include sirens that generate an embedded vehicle identification code.

The signal controller shall be programmed for the special preemption sequence.

- b) **Detector Devices:** Shall be specially designed microphones that are positioned on the traffic signal poles in such a manner that each approach to the signal is adequately detected. The detectors shall be weatherproof and designed to withstand electrical transients normally encountered in the ambient outdoor environment. The detectors shall not be affected by fog, rain, ice, snow or any other adverse weather conditions. The close proximity of high profile vehicle to the emergency vehicle shall not present a shield or barrier to the acoustical energy emitted from the siren. The detectors shall be directional with an 18° cone of sensitivity and polar curve of 9:1 (from the front side).

Detectors shall be located as shown in the plans and shall be installed in accordance with the manufacturer's recommendations.

- c) **Phase Selector:** Shall be located in the controller cabinet. The phase selector is used to decode the information from each detector and produce suitable outputs to the controller. The phase selector shall meet the environmental and electrical standard specified by NEMA Standard TS1 or TS2. The phase selector shall be designed using microprocessor circuitry and shall be fully compatible with NEMA TS1, NEMA TS2, and Type 170 controller cabinet assemblies.

The phase selector shall have resident software that allows a range of sensitivity adjustments to be made using a portable computer. The phase selector shall have adequate memory to record all system activity. Each access to the system shall be recorded with the date, time, duration of access and quality of the emitter/detector input signal.

The portable computer shall not be furnished as part of this project.

- 3. **Electrical Cable:** From the detector to the controller cabinet shall be 18 AWG (minimum) 2-conductor twisted shielded pair Belden 8762 or equal. Electrical cable

from the confirmation light to the controller cabinet shall be a 16AWG (minimum) 2-conductor cable that meets 93.2.H.

4. **Confirmation Light:** Shall be installed facing the intersection that informs the driver whether the signal is under preemption or normal operation. The confirmation light should be mounted as close to the last head on the mast arm as possible.

93.3 CONSTRUCTION

- A. **General:** Installations shall comply with applicable sections of the National Electrical Code (NEC), State regulations, and local ordinances. Licenses or permits required shall be obtained by and at the expense of the Contractor.

The Contractor shall arrange for necessary electrical services at locations specified, as agreed to by the City and the utility company.

Any changes during construction shall be clearly shown on the asbuilt drawings.

After the traffic signals and the lighting system have been turned on and found to be operating satisfactorily and all installation of the system is complete, the Engineer shall notify the Contractor of acceptance. Upon acceptance, the Contractor shall be relieved of routine maintenance responsibility. The Contractor shall remain responsible for failures due to character of work, materials, or equipment that occur during a two (2) year period following the date of acceptance. The Contractor shall warrant and guarantee materials, electrical, and mechanical equipment furnished and installed to be free from defects in materials and character of work in accordance with the following:

Warranties and guarantees offered by electrical and mechanical equipment manufacturers shall be turned over to the maintaining authority at the time of acceptance of the project. The maintaining authority shall be named as the obligee on all manufacturer warranties and guarantees.

The Contractor shall warrant and guarantee satisfactory in-service operations of electrical and mechanical equipment, and related components, and shall replace or correct parts found to be defective within a two (2) year period. Compensation will not be made for replacements or corrections. The warranty and guarantee requirements shall not apply to parts of electrical and mechanical equipment which have been subjected to misuse, negligence, or accident by other parties.

- B. **Junction Boxes:**

1. Eighteen (18) inches of Type 2 Select Granular Backfill material shall be placed below the bottom of the junction box as foundation.
2. The top of the junction box shall be flush with hard-surfaced areas and approximately one inch above earth or grass areas.

3. Junction box cover labels “ELICTRIC(AL)” or “SIGNAL” shall be as specified in plans.

C. Conduit: Use and installation shall conform to NEC and the following requirements:

1. The size of the conduits installed shall not be less than the electrical trade size specified.
2. The location and direction of conduit runs is diagrammatic and may be shifted to meet field conditions.
3. Underground conduit shall be placed by trenching, jacking, or drilling methods. The use of the trenching method for placement under existing roadway pavements will be permitted only after jacking or drilling attempts have failed. The Contractor shall not use equipment requiring flowing water for installation of conduit under streets or roadways unless approved by the Engineer.

When the trenching installation method is used, electrical underground warnings tape shall be included in the construction and is incidental to the install.

Trenches shall be backfilled and compacted to the same density as the adjoining ground. Roadway surfaces, sidewalks, curb and gutters, sod, etc., which are removed by trenching operations shall be replaced. The cost of removing and replacing these materials shall be incidental to the bid price for the conduit.

4. Where trenching operations require the removal of concrete pavement or sidewalk, the concrete shall be sawed full depth along the removal lines or the concrete shall be removed to existing joints.
5. Conduit entering through junction or pull box walls shall terminate approximately 2 inches in from the inside wall and not less than 2 inches above the bottom. The diameter of the holes in the junction or pull box walls shall be no more than 1/4 inch larger than the diameter of the conduit. The area around the conduit shall be sealed with a waterproof silicone sealant.
6. Conduit entering the traffic signal cabinet shall be sealed with paraffin or other approved sealing compounds to prevent the entrance of gases. The height of the conduit shall not exceed 2 inches above the cabinet base.
7. Metal conduit open ends in junction boxes or above concrete foundations shall be provided with an approved threaded conduit grounding bushing.

Nonmetallic conduit open ends shall have an approved bell end or bushing installed to prevent damage to cable or conductors.

8. Metal conduit ends shall be reamed to remove sharp edges and burrs. Threads on threaded conduit shall be painted with a good quality lead or rust preventive paint

as the couplings are made up. Couplings shall be tightened until the ends of the conduit are brought together.

- D. Concrete Footings:** The bottom of concrete footings shall rest on firm ground. The sides of the footings shall be formed by using an auger and then placing the concrete against the natural soil. A suitable form shall be used above existing ground line and all exposed portions shall be formed to present a neat appearance. The above ground portion of the footing shall be formed of sufficient size and shape so no part of the pole base, including transformer type bases, shall overhang or protrude beyond the footing. An acceptable form shall be used if the excavation is larger than the standard footing dimensions. Backfill must be replaced to a density equal to or greater than the adjacent undisturbed natural soil. The top of the concrete footing shall be above grade with a maximum height that meets clear zone requirements. The top of the concrete footing shall be finished smooth and shall be level after anchor bolt/rod installation.

A 1/2 inch conduit for grounding wire raceway shall be installed through the footing. Ground rods shall be a minimum of 2 feet from the footing.

- E. Anchor Bolts/Rods:** Shall be installed in accordance with the following requirements:
1. **General:** Shall be provided with all hardware required for attaching and leveling in accordance with the manufacturer's recommendations.
 2. **Anchor Bolt/Rod Installation:** A steel template shall be used to accurately locate and hold the anchor bolts/rods plumb and in proper alignment. This template shall be in place during placement of the concrete base and shall remain in place a minimum of 24 hours after the concrete placement has been completed. Out of position anchor bolts/rods and anchor bolts/rods greater than 1:40 out-of-plumb are cause for rejection of the base. Bending, cutting, or welding of the anchor bolts/rods to straighten or move into position, or alterations of the pole base plate will not be permitted.
 3. **Anchor Bolt/Rod Tightening:** Breakaway transformer bases shall be tightened in accordance with the manufacturer's recommendations. All others shall be tightened in accordance with the following:
 - a) All leveling nuts (bottom nuts) shall be brought to full bearing on the bottom of the base plate. The bottom of the leveling nuts must be kept as close to the concrete base as practical, and shall not be more than one anchor bolt/rod diameter above the top of the concrete base. Leveling nuts must be threaded onto the anchor bolt to provide at least 1/4 inch projection of the anchor bolt/rod above the top nut or jam nut if required when in its tightened position.
 - b) A softened beeswax or equivalent shall be applied to the top nut bearing face and top nut internal threads prior to placement on the anchor bolt/rod. All top nuts shall be tightened to a snug tight condition. Snug tight is defined as the tightness attained by the full effort of a person using a wrench with a length

equal to 14 times the diameter of the anchor bolt/rod, except the minimum length shall be 18 inches. The use of adjustable wrenches will not be allowed. The full effort required to achieve a snug tight condition shall be applied as close to the end of the wrench as possible. Pull firmly by leaning back and using full body weight (brace feet to prevent slipping) on the end of the wrench until the nut stops rotating. This snug tightening shall be accomplished in a minimum of two separate passes of tightening. The sequence of tightening in each pass shall be such that the opposite side nut, to the extent possible, shall be subsequently tightened until all the nuts in that pass have been snugged.

Snug tightness of both the top and leveling nuts shall be checked in the presence of City personnel after the Contractor has completed nut snugging as described above, but prior to final tightening. Snug tightness of the nuts (top and leveling) shall be checked by applying a torque in a range from 20% to 30% of the verification torque. See Table 1 for verification and snug tight torque values.

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Table 1
Anchor Bolt/Rod Tightening

Anchor Bolt/Rod Diameter (in)	Anchor Bolt/Rod Stress Area (sq in)	Yield Strength (ksi)	Minimum Tensile Strength (ksi)	Verification Torque (ft-lbs)	30% Snug Tight Torque (ft-lbs)	20% Snug Tight Torque (ft-lbs)
1.00	0.61	36.0	58.0	177	53	35
1.25	0.97	36.0	58.0	351	105	70
1.50	1.41	36.0	58.0	613	184	123
1.75	1.90	36.0	58.0	964	289	193
2.00	2.50	36.0	58.0	1449	435	290
2.25	3.25	36.0	58.0	2120	636	424
2.50	4.00	36.0	58.0	2899	870	580
2.75	4.93	36.0	58.0	3930	1179	786
3.00	5.97	36.0	58.0	5192	1558	1038
1.00	0.61	55.0	75.0	274	82	55
1.25	0.97	55.0	75.0	545	163	109
1.50	1.41	55.0	75.0	951	285	190
1.75	1.90	55.0	75.0	1496	449	299
2.00	2.50	55.0	75.0	2249	675	450
2.25	3.25	55.0	75.0	3289	987	658
2.50	4.00	55.0	75.0	4498	1349	900
2.75	4.93	55.0	75.0	6098	1830	1220
3.00	5.97	55.0	75.0	8056	2417	1611
1.00	0.61	75.0	100.0	366	110	73
1.25	0.97	75.0	100.0	726	218	145
1.50	1.41	75.0	100.0	1268	381	254
1.75	1.90	75.0	100.0	1994	598	399
2.00	2.50	75.0	100.0	2999	900	600
2.25	3.25	75.0	100.0	4386	1316	877
2.50	4.00	75.0	100.0	5998	1799	1200
2.75	4.93	75.0	100.0	8131	2439	1626
3.00	5.97	75.0	100.0	10742	3223	2148
1.00	0.61	105.0	125.0	457	137	91
1.25	0.97	105.0	125.0	908	272	182
1.50	1.41	105.0	125.0	1586	476	317
1.75	1.90	105.0	125.0	2493	748	499
2.00	2.50	105.0	125.0	3749	1125	750
2.25	3.25	105.0	125.0	5482	1645	1096
2.50	4.00	105.0	125.0	7497	2249	1499
2.75	4.93	105.0	125.0	10164	3049	2033
3.00	5.97	105.0	125.0	13427	4028	2685

- c) At this point, the top nut and leveling nut must be in full bearing on the base plate. If any gap exists between either nut (top or leveling) and the base plate, a beveled washer shall be added between the nut washer and the base plate to eliminate the gap. The beveled washer shall be stainless steel Type 304 or Type 316, the same diameter as the hardened washer, and beveled as required to eliminate the gap between the nut and the base plate. All nuts shall be retightened according to steps (a) and (b) above if beveled washers are added. All costs required to remove and re-erect the structure to install beveled stainless steel washers shall be at the Contractor's expense.
- d) Using a hydraulic wrench, rotate all top nuts as indicated in Table 2. The additional turn of the nuts shall be accomplished by tightening all the nuts in two separate passes of equal incremental turns (i.e., for 1/3 turn use 1/6 turn each pass). The sequence of nut tightening in each pass shall be such that the opposite side nut, to the extent possible, shall be subsequently tightened until all the nuts in that pass have been turned. There shall be no rotation of the leveling nut during top nut tightening.

In lieu of a hydraulic wrench, torque wrenches and multipliers may be used to achieve the desired nut rotations and tightness.

- e) Tightness of the nuts shall be checked in the presence of City personnel. Tightness of the nuts shall be checked within a minimum of 48 hours and a maximum of 96 hours after the nuts have been rotated as indicated in this section. Tightness of the top nuts shall be checked by applying the verification torque to the nut. See Table 1 for verification torque.

Table 2
Nut Rotation for Turn-Of-Nut Pretensioning

Anchor Bolt/Rod Diameter (inches)	Nut Rotation from Snug-Tight Condition ^{1,2}	
	F1554 Grade 36	F1554 Grade 55 and 105
< 1½	1/6 Turn	1/3 Turn
≥ 1½	1/12 Turn	1/6 Turn

¹ Nut rotation is relative to anchor bolt/rod. The tolerance is plus 20 degrees.

² Applicable only to double-nut-movement joints.

Bottom leveling nuts shall be in contact with the base prior to applying the torque. An inability to achieve the verification torque indicates that the threads have stripped and the anchor bolt must be replaced. All costs for replacing anchor bolts/rods shall be at the Contractor's expense.

- f) Install jam nut after verification torque has been applied to top nut. Lubricate threads of jam nut with beeswax or equivalent and tighten to a torque of 100 foot pound (approximated without the use of a torque wrench).

- F. Electrical Power Cables:** Shall be installed using methods that will not damage or deform the jacket, insulation, or conductors. All cables within a single conduit shall be installed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer's recommendations and the use shall not damage or deform the cable.

Street light cables within each circuit shall have individually colored conductor wires.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

The Contractor may provide cables with conductor AWG size larger than specified where conduit fill requirements are not exceeded, subject to approval by the Engineer. When larger cables are substituted, the cables must extend from terminal to terminal for circuits used. Splicing to a conductor of a different size is not permitted. Splice connectors shall be per the materials section of this specification.

For Pole and Bracket Cable, a strain relief shall be utilized to support the weight of the cable on the "J" Hook or other strain relief device in the pole.

- G. Traffic Signal Control Cables:** Traffic signal conductors shall be continuous from the controller cabinets to the pole bases. Splicing of conductors will not be allowed in the junction boxes. Contractor shall leave no more than five (5) feet of excess cable in the cabinet, and no less than 10-feet in the junction box adjacent to the signal pole, and no less than six (6) feet in all other junction boxes.

Traffic signal control cables shall be identified in hand holes, junction boxes, pedestal bases, electrical service cabinets, and controller cabinets as indicated on the wiring diagram. Cable terminations in pole bases shall use 3M™ Scotchlok™314 wire connectors. Labels shall be wrapped around the traffic signal cable to indicate the signal pole and signal head the cable is connected to. Wires from signal heads shall be labeled with cloth type labels. Traffic signal control cables from the controller to the poles shall be marked with a legend and shall be color coded as follows: northwest (blue), northeast (red), southeast (green), and southwest (orange). All wires entering the controller cabinet shall be color coded to each corner and bundled neatly.

Cables shall be installed using methods that will not damage or deform the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer's recommendations and the use shall not damage or deform the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

- H. Electrical Service Cabinet:** Shall be installed in accordance with the plans and the manufacturer's recommendations. The City shall provide the lock. Breakers within the electrical service cabinet shall be sized according to the plans.
- I. Traffic Signal Poles:** The following shall apply to traffic signal poles:
1. Poles shall be plumb after the bracket arms, signal heads, fittings, and fixtures have been installed and connections have been made. Nuts shall be firmly tightened as per manufacturer's recommendations.
 2. Field repair of damaged galvanizing shall be done in accordance with ASTM A780.
 3. Mast arms shall be installed perpendicular to the roadway unless otherwise shown in plans, and vertical clearance shall be checked after all hardware and signing is installed.
- J. Roadway Luminaire Poles:** The following shall apply to roadway luminaire poles:
1. Poles shall be plumb when the installation is complete. Nuts shall be firmly tightened as per manufacturer's recommendations.
 2. The luminaire arm shall be set perpendicular to the project centerline, unless otherwise shown in plans.
 3. Field repair of damaged galvanizing shall be done in accordance with ASTM A780.
- K. Luminaires:** Shall be adjusted on the support so the luminaire sits level as indicated by a small bubble level. Bolts shall be firmly tightened.
- L. Photoelectric Control Units:** The photoelectric cell shall normally be positioned so the light sensor is to the north. If light sources other than sunlight interfere with normal operation of the control, the photoelectric cell shall be adjusted in an attempt to obtain proper operation
- M. Controller Cabinet:**
1. The controller cabinet shall be installed according to the directions supplied by the manufacturer.
 2. Wiring and connections in the controller cabinet shall be neat, firm, and in accordance with industry standards.
 3. Three sets of wiring diagrams and three maintenance and operation manuals shall be supplied for each controller that is required. The Contractor shall place one set in a weather resistant container in the controller cabinet, give one set to the maintaining authority, and give one set to the Engineer.
 4. A weather resistant diagram showing phase movements, detector locations, and

labels shall be affixed to the inside of the signal cabinet door. If color coding is used to identify control cables, a legend key shall be included with the above schematic.

5. Controller cabinets equipped with a thermostat shall be set to 110°F.
6. The controller cabinets shall be footing mounted. The cabinet footing shall be oriented so that the door opening faces east or south. The cabinet shall be no less than 24-inches and no more than 26-inches above finished grade. A concrete pad shall be provided in front of the cabinet doors for a minimum 36-inches depth, the full cabinet width. Cabinet doors shall be allowed to fully open without obstruction.

N. Detector Loops:

1. **Clearance between Loops and Metallic Objects:** The Contractor shall provide sufficient clearance between detector loops and metallic objects such as manhole covers, drop inlets, etc., to avoid interference with the operation of the loop.
2. **Sawed-in Loops:**
 - a) Lead-in saw cuts shall clear each other by 1 foot.
 - b) Backer rod material shall be cut into 1 inch by 2 inch lengths and spaced not farther apart than 2 feet.
 - c) Saw slots in the pavement shall be blown out with compressed air and shall be clean and free of loose grit and moisture when wires are placed and sealer is applied.
 - d) The loop wires shall be pushed into the sawed slots with a blunt wood stick (not with a screwdriver). The wires shall be laid in the slots so there are no kinks or curls and without straining or stretching the insulation.
 - e) The flexible embedding sealer shall completely surround the 1/4 inch tube, displace all the air within the sawed slot, and fill the area of the sawed slot except for that area which is taken up by the backer rod and the wires.
 - f) Loop wires or lead-ins shall be given extra protection at pavement joint locations. The extra protection shall consist of a 12-inch long piece of 3/4-inch flexible tubing that fits snugly around the wires. Allow slack in the wires to install the tubing. A longitudinal cut may be made along the bottom of the tubing for ease of placement over the wires.
 - g) Loop lead-ins shall extend to a junction box. Lead-ins shall be long enough to provide a minimum of 10-feet of cable within the junction box. Splices shall not be allowed.
3. **Preformed Loops:** Each set of loop wires shall be tagged to identify loop as

specified on plans. If installation of the loop is for future use, the loop wires in the same lane shall be taped together with the ends sealed from moisture. If installation is on a signal project, tagging shall be done and wires connected in series.

In new roadways, the preformed loops and lead-in conduits shall be placed in the base course or gravel cushion, with the top of the conduit flush with the top of the base, and then covered with hot mix asphalt or Portland cement concrete pavement. Preformed loops and lead-in conduits shall be protected from damage prior to and during pavement placement.

In new reinforced concrete structure decks, the preformed loops shall be secured to the top of the uppermost layer of reinforcing steel using nylon wire ties. The loop shall be held parallel to the structure deck by using PVC or polypropylene spacers where necessary. Conduit for lead-in conductors shall be placed below the upper mat of reinforcing steel.

In existing pavement, the preformed loops shall be placed in a saw slot, 1¼ inches minimum width, cut into the existing pavement. The top of the conduit shall be 2 inches, minimum, below the top of existing surface. Sawed slots shall be filled with an approved loop sealant.

On asphalt or concrete resurfacing projects, the preformed loops shall be placed in a saw slot, 1¼ inches minimum width, cut into the existing pavement. The top of the conduit shall be 2 inches, minimum, below the top of existing surface after any required surface removal is completed and prior to the placing of the new surface. Sawed slots shall be filled with loop sealant as specified in the materials section of this specification.

4. **Lead-ins:** Loop lead-ins shall be twisted at least three (3) turns per foot. Splices shall not be made in the loop or lead-in conductors except in the junction box. All wire connections shall be sealed and insulated with 3M™ Scotchcast™ 3570G Connector Sealing Pack, or equal.
5. **Connections in the Controller:** Terminal board screws shall be turned down tightly on the lug. The shield wire shall be cut off and taped.
6. **Loop Testing:** After installation, each loop shall be tested by the Contractor. Necessary equipment shall be furnished by the Contractor and test results recorded and furnished to the Engineer. Each detector loop shall conform to the following:

DC Continuity:	5 ohms maximum
600V (min.) Resistance, loop to ground:	10 megohms minimum
Inductance:	100-500 microhenries

7. Unless otherwise noted on the plans, the standard loop size is to be 6-feet by 6-feet.

O. Signal Heads:

1. Signal heads are to be rigidly attached to signal poles and shall appear vertical from the street approach they control. A jam nut shall be used to tighten the fitting to the pole hub.
2. Signals mounted on side of pole or top of pedestal pole shall use industry standard locking brackets made from 1 ½ inch aluminum pipe and appropriate locking fittings. Attachment to signal heads shall be with tri-stud type hardware. Exposed pipe and hardware shall not be painted.
3. Signals heads which are mounted in place, but are not in operation shall be hooded or positioned so the lenses are not visible to any approach.
4. Signals shall be aimed and trees shall be trimmed such that all the signals for each approach shall be continuously visible for the minimum distance listed in the MUTCD.
5. Signals mounted on mast arms shall utilize a universally adjustable mast arm Astrobrac® mounting assembly, or approved equal. It shall be unpainted aluminum or galvanized finish. Banding? vs cable comment?
6. Fasteners containing dissimilar metals shall have anti-seize compound applied the threads.

P. Pedestrian Push Button: Placement and mounting height shall be per plans and in conformance with the MUTCD. Fasteners containing dissimilar metals shall have anti-seize compound applied the threads. Speech messages for buttons within 10-feet of each other shall be provided to the Engineer for review and approval prior to installation. A digital file of the speech message shall be provided to the City prior to acceptance.

Q. Flashing Beacons: Shall be mounted in conformance with the MUTCD, and installed in accordance with the directions supplied by the manufacturer.

93.4 METHOD OF MEASUREMENT

- A. Electrical Grounding and Bonding:** No field measurement will be made.
- B. Conduit:** The plan shown quantity, of each type and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- C. Junction Boxes:** Measurement will be by actual count of the various types and sizes of junction boxes furnished and installed.
- D. Concrete Footings:** Concrete footings of the various diameters will be measured to the nearest 0.1 foot.

- E. Anchor Bolts/Rods:** No field measurement will be made.
- F. Electrical Power Cable:** The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- G. Traffic Signal Control Cable:** The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.
- H. Electrical Service Cabinets:** Measurement will be by actual count of cabinets furnished and installed.
- I. Traffic Signal Poles:** Measurement will be by actual count of the various types and sizes furnished and installed.
- J. Roadway Luminaire Poles:** Measurement will be by actual count of the various types and sizes furnished and installed.
- K. Luminaires:** Measurement will be by actual count of the various types and sizes of luminaires furnished and installed.
- L. Photoelectric Control Units:** No field measurement will be made.
- M. Controller Cabinet:** No field measurement will be made.
- N. Traffic Signal Controller:** Measurement will be by actual count of controllers furnished and installed.
- O. Detector Units:** Will not be measured.
- P. Detector Loops:** Measurement will be actual count of the various types of detector loops installed.
- Q. Signal Heads:** Measurement will be by actual count of the various types and sizes of signal heads furnished and installed.
- R. Pedestrian Push Button:** Measurement will be by the actual count of pedestrian push buttons furnished and installed.
- S. Flashing Beacons:** Measurement will be by the actual count of the various types of flashing beacons furnished and installed.
- T. Emergency Vehicle Preemption System:** Will be measured by actual count of Emergency Vehicle Preemption Systems furnished and installed.

93.5 BASIS OF PAYMENT

- A. Electrical Grounding and Bonding:** The cost of furnishing and installing conduits for grounding will be incidental to the cost of footing, electrical service cabinet, or controller cabinet to be grounded.
- B. Conduit:** Conduit of each type and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- C. Junction Boxes:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- D. Concrete Footings:** Payment for concrete footings of the various diameters will be at their respective contract unit prices per foot. Payment will be full compensation for materials and labor necessary to satisfactorily install the footings.
- E. Anchor Bolts/Rods:** Cost for anchor bolts/rods shall be included in the contract unit price for the concrete for which they are incorporated with.
- F. Electrical Power Cable:** Electrical power cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- G. Traffic Signal Control Cable:** Traffic signal control cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- H. Electrical Service Cabinet:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing electrical service cabinets, including circuit breakers, fuses, contactor, photoelectric control, manual on/off switch, mounting pole, pad, and other materials and fixtures required. Payment shall also include any fees associated with hookup.
- I. Traffic Signal Poles:** Payment for traffic signal poles of the various types will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- J. Roadway Luminaire Poles:** Payment for roadway luminaire poles will be at the contract unit price per each. Payment will be full compensation for furnishing and installing roadway luminaire poles.
- K. Luminaires:** Payment for luminaires of the various types and sizes will be at their respective contract unit prices per each. Payment will be full compensation for furnishing and installing luminaires.
- L. Photoelectric Control Units:** Cost of photoelectric controls shall be included in the

contract unit price for other related contract items.

- M. Controller Cabinet:** The cost of controller cabinets is to be included in the contract unit price for traffic signal controllers.
- N. Traffic Signal Controller:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing the controller cabinet and all required items included in the cabinet.
- O. Detector Unit:** The cost of detector units shall be included in the contract unit price for traffic signal controllers.
- P. Detector Loop:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing detector loops.
- Q. Signal Heads:** Payment for this item for the various types and sizes will be at the contract unit price per each. Payment will be full compensation for furnishing and installing signal heads, including mounting hardware, required bracketing, and backplates.
- R. Pedestrian Push Buttons:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing the pedestrian push buttons.
- S. Flashing Beacons:** Payment for this item will be at the contract unit price per each for the various types of flashing beacons. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- T. Emergency Vehicle Preemption System:** The Contractor will be paid the contract unit price bid for Emergency Vehicle Preemption System. This payment shall be full compensation for the detectors, phase selector, confirmation light, electrical cable for the detectors and confirmation light.

END OF SECTION

SECTION 100

PORTLAND CEMENT

100.1 DESCRIPTION

A. General: Portland cement shall be used as called for herein.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 200	Controlled Low Strength Material
Section 203	Submittals

100.2 MATERIALS

A. Portland Cement: Shall conform to AASHTO M 85 for the type specified. All cements shall not have more than 0.60% of Alkalies ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$).

Unless otherwise permitted by the Engineer, the product of only one mill of any one brand and type of Portland cement shall be used on the project.

B. Portland-Pozzolan Cement: Shall conform to AASHTO M 240.

Fly ash may not be substituted for a portion of the Portland-pozzolan cement. The Portland-pozzolan cement components, cement, and fly ash individually shall conform to the requirements shown on the plans and shall be mixed in the proportions as specified.

100.3 CONSTRUCTION REQUIREMENTS (not applicable)

100.4 METHOD OF MEASUREMENT

Portland cement shall be incidental to and shall be measured as a part of the individual bid item. There will be no separate measurement for portland cement.

100.5 BASIS OF PAYMENT

Portland cement shall be incidental to and shall be paid as a part of the individual bid item. There will be no separate payment for portland cement.

END OF SECTION

SECTION 101

AIR-ENTRAINING ADMIXTURES

101.1 DESCRIPTION

A. General: Air-entraining admixtures shall be used as called for in the related specifications section herein for all concrete that will be exposed to repeated freeze and thaw cycles.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 200	Controlled Low Strength Material
Section 203	Submittals

101.2 MATERIALS

Air-entraining admixtures for concrete shall be one hundred percent vinsol resin based or one of the products as listed on the SD DOT Approved Products List for air-entraining admixtures and shall conform to the requirements of AASHTO M 154, except as modified below:

Concrete having sufficient air-entraining admixture added to entrain 5 to 7% air shall have compressive strength at the age of 7 days of not less than 90% of the standard. The standard shall consist of a concrete of equal cement content, equal consistency, and of the same aggregates in adjusted proportions, but without the addition of an air-entraining admixture.

101.3 CONSTRUCTION REQUIREMENTS (not applicable)

101.4 METHOD OF MEASUREMENT

Air-entraining admixtures for concrete shall be as called for herein and shall be included in the individual bid item. There will be no separate measurement for air-entraining admixtures.

101.5 BASIS OF PAYMENT

Air-entraining admixtures for concrete shall be as called for herein and shall be included in the individual bid item. There will be no separate payment for air-entraining admixtures.

END OF SECTION

SECTION 102

CHEMICAL ADMIXTURES FOR CONCRETE

102.1 DESCRIPTION

A. General: Chemical admixtures for concrete shall be used as called for herein.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 101	Air-Entraining Admixtures
Section 200	Controlled Low Strength Material
Section 203	Submittals

102.2 MATERIALS

The chemical admixtures used for concrete shall conform to AASHTO M 194.

Chemical admixtures for concrete shall be a non-chloride based material containing less than 1% chloride ion by weight of admixture.

Viscosity modifying admixtures (VMA) may be used in self-consolidating concrete (SCC) to attain desired performance. The approval of the Engineer is required prior to use of any VMA.

Chemical admixtures for dry cast concrete which are not classified in AASHTO M 194 or do not meet the requirements of Section 101 must be approved by the Engineer prior to use.

102.3 CONSTRUCTION REQUIREMENTS (not applicable)

102.4 METHOD OF MEASUREMENT

Chemical admixtures for concrete shall be as called for and shall be measured in accordance with the appropriate concrete construction sections of these Specifications. There will be no separate measurement for chemical admixtures for Concrete.

102.5 BASIS OF PAYMENT

Chemical admixtures for concrete shall be as called for and shall be paid for in accordance with the appropriate concrete construction sections of these Specifications. There will be no separate payment for chemical admixtures for Concrete.

END OF SECTION

SECTION 103

FLY ASH

103.1 DESCRIPTION

A. General: Fly ash shall be from a base loaded electric generating plant using a single coal source. Plants using a limestone injection process for controlling air pollutants are not acceptable. Fly ash from the start up and shut down of the plant shall not be used.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 101	Air-Entraining Admixtures
Section 200	Controlled Low Strength Material
Section 203	Submittals

103.2 MATERIALS

A. Class C Fly Ash: Conforming to AASHTO M 295 will only be allowed in grout for pavement jacking, undersealing, controlled density fill, or when specified.

B. Class F, Modified Fly Ash: Fly ash used in all other concrete shall conform to AASHTO M 295 Class F including the optional requirements in the referenced AASHTO specification except as modified by the following:

Loss on Ignition	2.0% Maximum
Moisture Content	2.0% Maximum
Available Alkalis as Na ₂ O	1.5% Maximum*

Note: These modifications shall not apply to fly ash used in slurry for pavement jacking or undersealing operations.
 * Available alkalis up to 2.0% may be used, provided mortar expansion test results at 14 days is less than or equal to that of the control sample. The expansion test shall be run in accordance with modified ASTM C441. The control sample shall be made using cement that will be used on the project. The test sample shall be made using cement and fly ash that will be used on the project.

The total of silicon dioxide (SiO₂) plus aluminum oxide (Al₂O₃) plus iron oxide (Fe₂O₃) shall be at least 66.0% by dry weight of the total fly ash composition. The silicon dioxide (SiO₂) shall be at least 40.0% by dry weight of the total fly ash composition.

C. Number of Tests: Each sample representing 400 tons or less shall be tested for the following:

1. Fineness - #325 sieve analysis;
2. Moisture content;
3. Specific gravity;
4. Loss on ignition;
5. Soundness.
6. All other physical tests and chemical determinations shall be made on composite samples representing each 3200 tons. This composite sample shall be prepared by combining equal parts of 8 consecutive samples, each representing 400 tons.

The test data shall be furnished to the Engineer in the form of a chemical and physical analysis report.

Fly ash delivered without an acceptable Certificate of Compliance will be subject to rejection.

103.3 CONSTRUCTION REQUIREMENTS

A. Limitations: Fly ash will not be permitted when Type III cement is used.

B. Storage: Fly ash shall be stored at the concrete plant site in clearly marked separate containers. Use of divided bins in the same silo will be permitted if the silo is commercially manufactured with divided bins or if the contractor/concrete supplier has a certification by a registered professional engineer that the divided bins will structurally handle the load associated with the use of the silo.

C. Design Mix: Fly ash may be substituted for cement in concrete. The addition or deletion of fly ash from the mix will be at no cost to the City. If fly ash is used, the minimum amount of cement to be replaced is 15% and the maximum amount is 25% at a 1:1 ratio by weight.

Changes in fly ash source or mill plant coal supply will require a new mix design approval.

D. Batching: Fly ash may be weighed on a separate scale or on the same scale as the cement. If the cement scale is used, the cement must be weighed first.

103.4 METHOD OF MEASUREMENT

There will be no separate measurement for fly ash admixtures.

103.5 BASIS OF PAYMENT

There will be no separate payment for fly ash admixtures.

END OF SECTION

SECTION 104

WATER FOR USE IN PORTLAND CEMENT CONCRETE

104.1 DESCRIPTION

A. General: Water for use in portland cement concrete, mortar and cement stabilization or similar uses shall be as described herein.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 200	Controlled Low Strength Material
Section 203	Submittals

104.2 MATERIALS

A. Requirements: Water shall be from a potable water source. Water used in portland cement concrete and cement stabilization shall be clean and free of the following: oil, salt, acid, alkali, sugar, vegetation, effluent from a sewage disposal plant, and other substances detrimental to the finished product.

Water containing suspended matter shall be checked for total solids. The total solids shall not exceed 50,000 parts per million.

Water shall be tested for pH and dissolved solids. The pH shall be no less than 6.0 or more than 8.6. Maximum dissolved solids shall be no more than 2,500 parts per million.

B. Testing:

Total Solids	ASTM C1603
Dissolved Solids.....	South Dakota DOT SD 415
pH.....	Manufacturer Instructions with Meter

104.3 METHOD OF MEASUREMENT

Water used in portland cement concrete and cement stabilization shall be incidental to the various bid items. There will be no separate measurement for water used in portland cement concrete and cement stabilization.

104.4 BASIS OF PAYMENT

Water used in portland cement concrete and cement stabilization shall be incidental to the various bid items. There will be no separate payment for water used in portland cement concrete and cement stabilization.

END OF SECTION

SECTION 105

FINE AGGREGATE FOR USE IN PORTLAND CEMENT CONCRETE

105.1 DESCRIPTION

- A. General:** The fine aggregate shall consist of natural sand or, subject to approval, other inert materials with similar characteristics; or combinations having hard, strong, durable particles.

Fine aggregate from different sources 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.

B. Related Work:

Section 40	Portland Cement Concrete Pavement
Section 50	Precast Concrete
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 58	Concrete Box Culvert
Section 60	Concrete Curb and Gutter
Section 61	Concrete Sidewalk, Curb Ramps and Detectable Warning Surfaces
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 107	Coarse Aggregate for Use in Portland Cement Concrete
Section 200	Controlled Low Strength Material
Section 203	Submittals

105.2 MATERIALS

- A. Deleterious Substances:** The amount of deleterious substances shall not exceed the following limits by dry weight:

Clay lumps.....	0.5%
Coal and lignite.....	0.3%
Particles Less Than 1.95 Specific Gravity.....	1.0%
Other deleterious substances (such as alkali, mica, coated grains, soft and flaky particles).....	1.0%

The maximum amount of all deleterious substances listed above shall not exceed 2.0% by dry weight.

- B. Soundness:** When the fine aggregate is subjected to 5 cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10% by weight.

When Class M6 concrete fine aggregate is subjected to 5 cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12% by weight.

A satisfactory soundness record for deposits from which material has been used in concrete for five years or more may be considered as a substitute for performing the sodium sulfate soundness test.

- C. Organic Impurities:** The fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard number 3 shall be rejected.

Should the aggregate show a darker color than samples originally approved for the work, the aggregate shall not be used until tests have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

- D. Alkali-Silica Reactivity (ASR) Requirements:** When specified in the plans, the following items shall apply.

Fine aggregates from sources that have not been tested by the SD DOT shall be submitted to the City for ASR testing 30 days prior to performing the concrete mix design.

ASR testing shall be performed in accordance with ASTM C1260, except that the gradation of the material used for testing shall be as produced from the source. The fine aggregate shall be sampled in the presence of a City representative.

Fine aggregate with a 14 day expansion value below 0.250 shall require Type II cement with a fly ash content of 20 to 25% in the concrete mix. Fine aggregate with a 14 day expansion value of 0.250 or greater shall require Type II cement with a fly ash content of 25% in the concrete mix. Fine aggregate with a 14 day expansion value of 0.400 or greater shall not be used.

When more than one source of fine aggregate is blended to meet the gradation specifications, the expansion value of the blended sands will be used. Blended sources will be treated as a new source. The Contractor is responsible to submit the blended samples for testing 30 days prior to performing the concrete mix design.

- E. Gradation:** Fine aggregate shall be well graded from coarse to fine and shall conform to the following gradation requirements:

Table 1

Sieve Size	Percent Passing
3/8 inch	100
#4	95 – 100
#8	80 -100
#16	50 – 85
#30	25 - 60
#50	5 – 30
#100	0 – 10

The fine aggregate will have no more than 45% passing any sieve and retained on the next consecutive sieve of those shown in Table 1.

The percentage of material passing the No. 200 sieve shall be such that the composite mixture of fine and coarse aggregate will conform to the provisions of Section 107.

Fine aggregate failing to pass the minimum requirement for material passing the No. 50 or the No. 100 sieve may be used provided a satisfactory inorganic fine material is added during production to correct for the deficiency in gradation.

Blending of fine aggregate will only be allowed to correct for gradation. All fine aggregate sources shall meet the quality requirements individually prior to blending. The Engineer shall be contacted prior to the blending of fine aggregates. The blending process shall be by an approved method that can accurately control the amount of each individual fine aggregate. The blending process shall be approved prior to starting.

- F. Uniformity of Grading:** The gradation requirements given in Section E represent the extreme limits which will determine suitability for use from the source(s) of supply. The gradation will be uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity for the proposed source(s), a target Fineness Modulus (FM) value will be set based upon the gradation, or combined gradation if more than one source is used, established during mix design.

The FM requirements do not apply to fine aggregate for low slump dense concrete and Class M6 concrete.

1. For all portland cement concrete except concrete paving conforming to Section 40, and Class M6 concrete; the following will apply:

Fine aggregate shall maintain a FM within ± 0.20 from the target FM value. For determining the FM variation from the target FM value, the average of the 5 most recent FM tests will be used. Until 5 FM tests have been made; base the variation on the first FM test, then on the average of all previously run FM tests. If the FM falls outside this limit, the City must be notified. A new or adjusted mix design may be reviewed or provided.

2. For portland cement concrete paving conforming to Section 40, the following shall apply:

The fine aggregate target FM value established by the mix design will be set within the wide band limits of 2.40 to 3.10 (wide band).

A 0.20 variation (narrow band) from the established FM target value will be allowed provided the narrow band FM test results are within the wide band limits.

G. Sampling and Testing:

Sampling SD 201
 Gradation SD 202
 Particles Less Than 1.95 Specific GravitySD 208
 Soundness Test (sodium sulfate solution, five cycles) SD 220
 Organic Impurities AASHTO T 21
 Clay Lumps AASHTO T 112
 Uniformity of Grading (Fineness Modulus)AASHTO M 6

*all tests beginning with "SD" refer to South Dakota Department of Transportation Materials Manual test number

105.3 METHOD OF MEASUREMENT

Fine aggregate for use in portland cement concrete or similar uses will not be measured separately, but shall be incidental to the various bid items.

105.4 BASIS OF PAYMENT

Fine aggregate for use in portland cement concrete or similar uses will not be paid separately, but shall be incidental to the various bid items.

END OF SECTION

SECTION 106

MASONRY MORTAR SAND

106.1 DESCRIPTION

A. General: Aggregate for use in masonry mortar shall consist of natural sand or manufactured sand. Manufactured sand is the product obtained by crushing stone, gravel, or air cooled iron blast furnace slag specially processed to assure suitable particle shape as well as gradation.

B. Gradation:

Sieve Size	Percent Passing	
	Natural Sand	Manufactured Sand
#4	100	100
#8	95 to 100	95 to 100
#16	70 to 100	70 to 100
#30	40 to 75	40 to 75
#50	10 to 35	20 to 40
#100	2 to 15	10 to 25
#200	- - -	0 to 25.0

Note: Not more than 50% may be retained between any two consecutive sieves listed. Not more than 25% may be retained between the #50 and #100 sieves.

C. Deleterious Substances: The amount of deleterious substances shall not exceed the following limits by dry weight:

1. Clay lumps and friable particles.....1.0%
2. Lightweight particles having a specific gravity of less than 1.950.5%

D. Soundness: When the fine aggregate is subjected to 5 cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10% by weight.

A satisfactory soundness record for deposits from which material has been used for 5 years or more may be considered as a substitute for performing the sodium sulfate soundness test.

E. Organic Impurities: The aggregate shall be free of injurious amounts of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected.

Aggregate failing in the test may be used provided that the principally due to the presence of small quantities of coal lignite, or similar discrete particles.

Aggregate failing the colorimetric test may be used provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days (when calculated in accordance with Section 10 of AASHTO T 71, the Organic Impurities in Fine Aggregate on Strength of Mortar), is not less than 95%.

106.2 METHOD OF MEASUREMENT

Sand for mortar shall be incidental to the various bid items. There will be no separate measurement for sand used for mortar.

106.3 BASIS OF PAYMENT

Sand for mortar shall be incidental to the various bid items. There will be no separate payment for sand used for mortar.

END OF SECTION

SECTION 107

COARSE AGGREGATE FOR USE IN PORTLAND CEMENT CONCRETE

107.1 DESCRIPTION

- A. Coarse Aggregate for Concrete Pavement:** Shall consist of crushed limestone ledge rock or other crushed quarry rock and shall be from a source that is approved by the SD DOT. Coarse aggregate for all other PCC pavements shall conform to Size #1 or Size #15.
- B. Coarse Aggregate for Bridge Deck Resurfacing:** For bridge deck resurfacing refer to current SD DOT specifications.
- C. Coarse Aggregate for Class M6 Concrete:** Shall consist of crushed limestone ledge rock or other crushed quarry rock and shall be from a source that is approved by the SD DOT. Coarse aggregate for Class M6 concrete shall meet the gradation requirements for Size #1.
- D. Coarse Aggregate for Precast Concrete:** Shall consist of crushed limestone ledge rock or other crushed quarry rock and shall be from a source that is approved by the SD DOT. The aggregate size shall be consistent throughout the entire structure. Only one source shall be used to produce each aggregate size. Coarse aggregate for wet cast concrete shall meet the gradation requirements of current SD DOT specifications. The gradation requirement shall not apply for dry cast concrete.
- E. Related Work:**
- | | |
|------------|--|
| Section 40 | Portland Cement Concrete Pavement |
| Section 55 | Cast in Place Concrete Structures |
| Section 56 | Class M6 Concrete for Curb & Gutter and Flatwork |
| Section 60 | Concrete Curb and Gutter |
| Section 61 | Concrete Sidewalk, Curb Ramps, and Detectable Warning Surfaces |
| Section 62 | Drop Inlets |

107.2 MATERIALS

- A. Deleterious Substances:** The amount of deleterious substances for all concrete except class M6 shall not exceed the following limits by dry weight:
- | | |
|--|------|
| Clay lumps | 0.3% |
| Shale and other materials having a specific gravity less than 1.95 | 1.0% |
| Scratch hardness | 2.0% |
| Other deleterious substances (such as alkali, mica, coated grains, flaky particles, coal, lignite, and chocolate rock) | 2.0% |

The maximum amount of deleterious substances listed above shall not exceed 2.0% by dry weight.

The deleterious substances in the coarse aggregate for Class M6 concrete shall not exceed the following limits:

Clay lumps	0.5%
Shale and other materials having a specific gravity less than 1.95.....	1.0%
Scratch hardness.....	2.0%
Other deleterious materials (such as alkali, mica, coated grains, flaky particles, coal, lignite, and chocolate rock)	3.0%

The maximum amount of all deleterious material shall not exceed 3.0% by dry weight.

- B. Percentage of Wear:** The percentage of wear, LA abrasion test, shall not be more than 40% by weight.
- C. Soundness:** When the coarse aggregate is subjected to 5 cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10% by weight. When Class M6 coarse aggregate is subjected to 5 cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12% by weight.
- D. Gradation:** Each size of coarse aggregate shall conform to the gradation requirements specified in the following table:

PERCENTAGE BY DRY WEIGHT PASSING SIEVE

Size #	Nominal Size Square Openings	2 inch	1½ inch	1 inch	¾ inch	½ inch	3/8 inch	#4	#8
1	1 inch to #8		100	95-100		25-60		0-10	0-5* ¹
1A	¾ inch to #8			100	90-100		20-55	0-10	0-5* ¹
3	¾ inch to #8				100	97-100	40-90	5-20	0-5* ¹
5	½ inch to #8				100	90-100	40-70	0-20	0-5* ¹
15	1 ½ inch to #8		100	98-100	70-90		27-53	2-20	0-6* ¹

*1 The combined mixture of fine and coarse aggregate shall be such that not more than 1.5% passes the #200 sieve. This limit shall not be more than 2.5% for Class M6 concrete.

- E. Flat and Elongated Particles:** The maximum amount of flat and elongated particles in the coarse aggregate of concrete pavement utilizing Size #15 shall not exceed 10%. Flat and elongated particles are defined as those particles with a ratio of maximum to minimum dimension greater than 5:1.

F. Sampling and Testing:

Sampling.....	SD 201
Gradation	SD 202
Clay lumps	AASHTO T 112
Particles Less Than 1.95 Specific Gravity.....	.SD 214
Scratch Hardness.....	SD 218*
Flat and Elongated Particles	SD 212
Chocolate Rock.....	SD 216*
LA Abrasion.....	SD 204
Soundness Test (sodium sulfate solution, five cycles)	SD 220
Material Finer than #200 Sieve	SD 206

* Not required for ledge rock

107.3 METHOD OF MEASUREMENT

Coarse aggregate for use in portland cement concrete and similar uses will be considered incidental to the various bid items. There will be no separate measurement for coarse aggregate used in portland cement concrete and similar uses.

107.4 BASIS OF PAYMENT

Coarse aggregate for use in portland cement concrete and similar uses will be considered incidental to the various bid items. There will be no separate payment for coarse aggregate used in portland cement concrete and similar uses.

END OF SECTION

SECTION 108

CONCRETE CURING MATERIALS

108.1 DESCRIPTION

Curing materials shall conform to the following requirements as specified.

108.2 MATERIALS

A. Curing Blankets:

1. **Burlap Cloth made from Jute or Kenaf**.....AASHTO M 182
2. **Non-woven Polypropylene Geotextile Fabric:** White non-woven polypropylene geotextile fabric conforming to the following requirements may be used in lieu of burlap for horizontal applications only. This material is not to be used for curing vertical surfaces.

Property	Test Method	Unit	Minimum Average Roll Value
Weight	ASTM D 5261	ounces/square yard	8.0

B. Polyethylene Sheeting: Shall be durable to withstand the intended job use, without puncturing or tearing. During cool weather, the Engineer may permit the use of black polyethylene sheeting in lieu of white polyethylene sheeting.

C. Liquid Membrane Forming Compounds for Curing Concrete: Shall be linseed oil base emulsion unless a different type is specifically required in the plans. White pigmented cure shall not be used on colored concrete.

1. **Linseed Oil Base Emulsion:** Shall conform to the requirements of ASTM C309 Type 2, except as modified by the following:
 - a) The compound shall be a water emulsified linseed oil emulsion of 50% \pm 4% oil phase/50% \pm 4% water phase composition. (Linseed oil phase/water phase proportions shall be formulated exclusive of added pigment.) The oil and water phase composition of linseed oil base emulsion shall be tested in accordance with SD 509.
 - b) Linseed oil used in the emulsion formulation shall consist of a blend of 80% boiled linseed oil and 20% Z-8 viscosity linseed oil.
 - c) The compound shall be sprayable above 40°F.

2. **Storage:** The compounds shall be stored at temperatures above 35°F. Compound stored for a period in excess of six months may be subjected to sampling and testing for compliance prior to use.

108.3 METHOD OF MEASUREMENT

Concrete curing materials shall be incidental to the various concrete construction bid items. There will be no separate measurement for concrete curing materials.

108.4 BASIS OF PAYMENT

Concrete curing materials shall be incidental to the various concrete construction bid items. There will be no separate payment for concrete curing materials.

END OF SECTION

SECTION 112

SELECT GRANULAR BACKFILL

112.1 DESCRIPTION

A. General: This work shall consist of furnishing select granular backfill materials.

B. Related Work:

Section 8A	Water
Section 11	Utility Excavation and Backfill
Section 12	Roadway and Drainage Excavation and Embankment
Section 20	Granular Bases and Surfacing
Section 64	Under-Drains
Section 65	Riprap
Section 202	Geosynthetics for Roadways
Section 203	Submittals

112.2 MATERIALS

A. General: This material shall be free from dirt, vegetable matter, cinder, ashes, refuse, organic matter or other unsuitable foreign substance. Frozen material may not be used.

B. Utility Trench Bedding: Type 1, Type 2 or Type 3 material shall be a crushed rock having a minimum of two fractured faces and meet the following gradation requirements by dry weight:

1. Type 1 - Bedding Material:

Passing 1 inch sieve	100%
Passing 3/4 inch sieve	90-100%
Passing 3/8 inch sieve	20-55%
Passing #4 sieve	0-10%
Passing #8 sieve	0-8%

2. Type 2 - Foundation Material:

Passing a 3 inch sieve.....	100%
Passing a 3/4 inch sieve.....	50-70%
Passing a #4 sieve	20-40%
Passing a #200 sieve	0-8%

3. Type 3 - Foundation Material:

Passing a 3 inch sieve.....	100%
Passing a 1 inch sieve.....	0-15%
Passing a #4 sieve	0-8%

4. Granular Material for Storm Sewer Bedding (angular or non-angular):

- Passing a 1-1/2 inch sieve..... 100%
- Passing a 1 inch sieve..... 95-100%
- Passing a #4 sieve0-75%
- Passing a #200 sieve 0-18%

5. Water and Sewer Service Line Bedding:

PVC water or Sewer services may utilize Type 1 bedding or material listed below.

a) Crusher Fines

- Passing a 3/8 inch sieve..... 100%
- Passing a #4 sieve..... 90-100%
- Passing a #8 sieve50-90%
- Passing a #200 sieve0-25%

b) Pea Gravel and River Rock (non-angular - no crushed faces):

- Passing a 1/2 inch sieve..... 100%
- Passing a 3/8 inch sieve.....85-100%
- Passing a #4 sieve10-30%
- Passing a #8 sieve0-10%
- Passing a #200 sieve0-15%

c) Washed Sand:

- Passing a 3/8 inch sieve..... 100%
- Passing a #4 sieve.....95-100%
- Passing a #8 sieve80-100%
- Passing a #16 sieve50-85%
- Passing a #30 sieve25-60%
- Passing a #50 sieve5-30%
- Passing a #100 sieve0-10%

C. Roadway Backfill and Utility Trench Special Foundation Material: Backfill for stabilization of sub grade shall be a crushed rock with a minimum of two fractured faces and shall meet the following gradations:

1. Type 4 - Foundation Material:

- Passing the 8 inch sieve..... 100%
- Passing the 6 inch sieve.....65-85%
- Passing the 3 inch sieve.....0-20%
- Passing the #200 sieve0-5%

2. Stabilization Rock (Rip-Rap): Shall be per rip-rap specification in Section 65. Stabilization rock shall be a crushed rock with a minimum of two fractured faces.

D. Under-Drain Pipe Trench Backfill Material:

- 1. Rock used as backfill around under-drains shall be clean, washed and sound materials free of excess fines and deleterious materials as specified herein.
- 2. Rock used as backfill for under-drains or edge-drains shall be Type 1 Bedding Material. Rounded river rock meeting the Type 1 Bedding Material gradation shall be acceptable for installations located behind the curb. Installations located under or in front of the curb and gutter shall be a crushed rock with a minimum of two fractured faces.

E. Los Angeles Abrasion: Abrasion loss shall not exceed 40 percent.

F. Sampling and Testing:

Sampling	SD 201
Gradation.....	SD 202
Fractured Faces	SD 211
Los Angeles Abrasion	AASHTO T 96

Aggregate supplier shall submit sampling and testing results to the City annually for each source. The annual sampling and testing results shall be provided by a certified testing agency and the cost shall be borne by the supplier. Additional testing may be performed by the Engineer with cost borne by the City.

112.3 METHOD OF MEASUREMENT

Measurement for Select Granular Backfill materials, except as further defined below, shall be to the nearest 0.1 ton based on the total weight of the material furnished and installed as determined from valid weigh tickets.

Type 1. Bedding material for water and sewer pipe installations as described in sections 8, 9, and 11 shall be considered as incidental to the pipe being installed. The Contractor, on a regular basis, shall quantify the amount of type 1 bedding material installed along with the corresponding quantity of water and/or sewer pipe. Weekly, or at the direction of the Engineer, the Contractor shall provide weight tickets to verify the quantity of material used. The weigh tickets shall clearly state "Type 1 bedding material, incidental." All stockpiled Type 1 bedding material used for water and sewer pipe installation shall be clearly identified on the project. Type 1 bedding material used as foundation material or for uses other than bedding for water and sewer pipe shall be measured in accordance with the provisions above and shall be measured to the nearest 0.1 ton.

Stabilization Rock (rip-rap) shall be measured and paid for per Section 65. If Stabilization Rock is underlaid or overlaid with a geotextile material, the geotextile material shall be paid for per Section 202, or as otherwise specified in the plans.

Under-Drain Pipe Trench Backfill material shall be measured in accordance with Specification Section 64.4.

112.4 BASIS OF PAYMENT

Payment for Select Granular Backfill materials, except as further defined below, shall be made under the appropriate bid item for the material furnished and installed. Payment for select granular backfill materials shall include all associated costs of excavation and disposal of excavated materials, unless otherwise called for in the plans or detailed specifications.

Type 1 bedding material for water and sewer piping installations as described in specification Sections 8A, 9, and 11 shall be considered incidental to the pipe being installed. All associated costs of excavation and disposal of excavated material shall be considered incidental to the pipe installation, unless called for otherwise in the plans and detailed specifications.

Type 1 bedding material used as foundation material or for a purpose other than pipe bedding shall be paid for in accordance with the provisions above and under the appropriate bid item.

Payment for Under-Drain Pipe Trench Backfill material shall be in accordance with Specification Section 64.5.

END OF SECTION

SECTION 113

PREFORMED EXPANSION JOINT FILLER FOR CONCRETE

113.1 DESCRIPTION

Preformed expansion joint filler for concrete shall conform to the requirements of AASHTO M 213, AASHTO M 153, AASHTO M 33, ASTM D7174, or ASTM D8139.

113.2 METHOD OF MEASUREMENT

Preformed expansion joint filler shall be incidental to the various concrete construction bid items. There will be no separate measurement for preformed expansion joint filler.

113.3 BASIS OF PAYMENT

Preformed expansion joint filler shall be incidental to the various concrete construction bid items. There will be no separate payment for preformed expansion joint filler.

END OF SECTION

SECTION 114

CONCRETE JOINT SEALER

114.1 DESCRIPTION

Sealant for joints in portland cement concrete.

114.2 MATERIALS

- A. Hot Poured Elastic Joint Sealer:** The sealant shall conform to the requirements of ASTM D6690 Type II or Type IV or be on the SDDOT Approved Products List for joint sealants for asphalt over long jointed concrete pavement.

Hot poured elastic joint sealer meeting the requirements of ASTM D6690 Type IV shall not weigh more than 9.35 pounds per gallon.

Test methods shall conform to ASTM D5329, except the fine aggregate used in preparing the concrete test blocks shall conform to Section 105. The Contractor shall furnish a Certificate of Compliance for hot poured elastic joint sealer not listed on the SDDOT Approved Products List.

- B. Low Modulus Silicone Sealant:** Shall be furnished in a one-part silicone formulation. The sealant must be on the list of approved products maintained by the SDDOT and must meet the following requirements:

Test	Limit	Test Method
Tack Free Time	20-75 minutes	MIL S 8802
Specific Gravity	1.010-1.515	ASTM D792 (Method A)
Durometer Hardness Type A: [Cured 7 days at 77°F ±3° and 45% to 55% R.H.]	10-25 0°F	ASTM D2240
Tensile Stress: [150% elongation, 7 days at 77°F ±3° and 45-55% R.H.]	45 psi maximum	ASTM D412 (Die C)
Elongation: [7 day cure at 77°F ±3° and 45-55% R.H.]	1000% minimum	ASTM D412 (Die C)
Shelf Life	6 months minimum from date of manufacture	
Ozone and Ultra Violet Resistance	No chalking, cracking or bond loss after 5000 hours	

Movement Capability and Adhesion [7 day cure in air 77°F ±3°]	No adhesive or cohesive failure, *1 all 3 specimens must exceed 500% extension at 0°F	
Bond to Concrete Mortar Concrete Briquettes [air cured 7 days at 77°F ±3°]	50 psi minimum 0°F	AASHTO T 132*2

*1 Prepare the specimens using 1" x 2" x 3" concrete blocks made in accordance with ASTM D 5329, except the fine aggregate shall conform to Section 800. A sawed face shall be used for bond surface. Seal 2 inches of block leaving 1/2 inch on each end of specimen unsealed. The depth of sealant shall be 3/8 inch and the width 1/2 inch. Subject the sealant to movement at a rate of 2 inches per minute until failure.

*2 Briquettes molded in accordance with AASHTO T 132 sawed in half and bonded with approximately 10 mils of sealant and tested using clips meeting AASHTO T 132. Briquettes shall be dried to constant weight in oven 100°C ± 5°. They shall be tested in tension at a loading rate of 0.3 inches per minute.

The backer rod shall be a non-moisture absorbing, closed cell, resilient material meeting the requirements of ASTM D5249 approximately 25% larger in diameter than the width of the joint to be sealed. The backer rod shall be compatible with the sealant and no bond or reaction shall occur between the rod and the sealant.

114.3 METHOD OF MEASUREMENT

Concrete joint sealer shall be incidental to various concrete construction bid items. There will be no separate measurement for concrete joint sealer.

114.4 BASIS OF PAYMENT

Concrete joint sealer shall be incidental to various concrete construction bid items. There will be no separate payment for concrete joint sealer.

END OF SECTION

SECTION 115

AGGREGATES FOR ASPHALT CONCRETE

115.1 DESCRIPTION

The physical characteristics and quality of aggregates for asphalt concrete shall conform to the specifications for the particular asphalt material required by the contract.

The aggregate shall not contain clay balls or organic debris, and the particles shall be free from coating with clay or dust, which prevents thorough coating with asphalt.

115.2 MATERIALS

A. Mineral Aggregates: Mineral aggregate for all classes of asphalt concrete shall conform to the requirements shown in the following table and the applicable footnotes.

Requirement	<u>CLASS E</u>	
	<u>Type 1</u>	<u>Type 2</u>
Processing Required	Crushed	
Passing $\frac{3}{4}$ inch Sieve	100	
Passing $\frac{1}{2}$ inch Sieve	75 – 95	100
Passing $\frac{3}{8}$ inch Sieve		
Passing #4 Sieve	45 - 75	60 – 80
Passing #8 Sieve	30 – 55	40 – 60
Passing #16 Sieve	20 – 45	26 – 50
Passing #40 Sieve	10 – 30	15 – 35
Passing #200 Sieve	3 – 7	4 – 8
Soundness Loss, Max.	15	
Liquid Limit, Max.	25	
Plasticity Index, Max.	non-plastic	
L.A. Abra. Loss, Max.	40%	
Asphalt Coating, Min.	95%	

1. A tolerance of three percent (3%) in the amount passing the maximum size screen will be permitted, providing all material passes a screen having a one-fourth (1/4) inch larger opening.
2. The aggregate retained on the No. 4 sieve shall contain at least thirty percent (30%) by dry weight of crushed pieces having two (2) or more faces produced by crushing.

3. The aggregate retained on the No. 4 sieve shall contain at least 50 percent (50%) by dry weight of crushed pieces having two (2) or more faces produced by crushing.

4. The following requirements shall apply:

Sodium Sulfate + #4 sieve - 12% max.
 - #4 sieve - 12% max.

Shale Content + #4 sieve - 2% max.
 - #4 sieve - 2% max.

B. Class E:

1. Filler shall consist of fine, inert silt or stone dust, which is essentially free from lumps. The material shall be so fine that, when pulverized for testing, ninety percent (90%) by dry weight will pass a No. 40 sieve, and at least sixty percent (60%) by dry weight will pass a No. 200 sieve. The linear shrinkage shall not exceed four percent (4%), and the plasticity index shall not exceed six (6). The material shall be of such nature that not more than twenty-five percent (25%) by volume will separate from asphalt in the presence of water.

During production, the filler shall be screened over a screen of a size corresponding to the maximum size of the mineral aggregate. A larger size screen may be permitted or a smaller size required, if necessary, to facilitate production or to remove objectionable material. Lumps shall be pulverized prior to blending if required by the Engineer.

2. Crushed rock shall consist of hard, durable fragments of particles of rock, free of stripping, dirt, vegetable matter, and foreign substance.

3. Sand shall consist of sandy soil or crushed stone screenings. The sand shall be uniform in composition. Seams, layers, or pockets of soil encountered not meeting sand requirements shall be wasted. During production, the sand shall be screened over a screen of a size corresponding to the maximum size of the mineral aggregate. A larger size screen may be permitted or a smaller size required, if necessary, to facilitate production or to remove objectionable material.

The sand shall be pulverized at the pit prior to loading and shall meet the following requirements by dry weight:

Passing a No. 4 sieve.....	80-100%
Passing a No. 8 sieve.....	50-100%
Passing a No. 40 sieve.....	40-100%
Passing a No. 200 sieve.....	0- 60%
Plasticity Index, Max.....	6

4. Mineral filler shall consist of finely ground particles of stone, fly-ash, lime, or portland cement. It shall be thoroughly dry and free from lumps. It shall meet the following gradation requirements by dry weight when tested in accordance with AASHTO T 37.

Passing a No. 4 sieve.....	100%
Passing a No. 40 sieve.....	90-100%
Passing a No. 80 sieve.....	85-100%
Passing a No. 200 sieve.....	65-100%

C. Sampling and Testing

Sampling.....	SD 201
Gradation.....	SD 202
Liquid Limit and Plasticity Index.....	SD 207
Moisture sensitivity.....	SD 309
L.A. Abrasion Test.....	AASHTO T 96
Linear Shrinkage (Filler).....	SD 303
Soundness Test (Sodium Sulfate Solution - Five Alternations).....	SD 220
W.A.P. Test (Filler).....	SD 304
Crushed Particle Test.....	SD 211

115.3 METHOD OF MEASUREMENT

Aggregates for asphalt concrete will be incidental to the various asphalt concrete bid items. There will be no separate measurement for aggregates for asphalt concrete.

115.4 BASIS OF PAYMENT

Aggregates for asphalt concrete will be incidental to the various asphalt concrete bid items. There will be no separate payment for aggregates for asphalt concrete.

END OF SECTION

SECTION 116

AGGREGATES FOR ASPHALT SURFACE TREATMENTS

116.1 DESCRIPTION

A. General: The cover aggregate for asphalt surface treatments shall be sand, crushed rock or crushed gravel, which is free of dirt, vegetable and other foreign material. The physical characteristics and quality of the materials shall conform to the specifications for the particular material required by the contract.

B. Related Work:

Section 31	Asphalt Concrete - General
Section 37	Asphalt Surface Treatment
Section 203	Submittals

116.2 MATERIALS

Cover aggregates of the various types shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, Section 881.2.

116.3 SAMPLING AND TESTING

Sampling and testing shall meet the requirements of SDDOT Standard Specifications for Roads and Bridges, current edition, Section 881.3.

116.4 METHOD OF MEASUREMENT

Measurement for various cover aggregates for asphalt surface treatments shall be in accordance with Sections 31 & 37.

116.5 BASIS OF PAYMENT

Payment for various cover aggregates for asphalt surface treatments shall be in accordance with Sections 31 & 37.

END OF SECTION

SECTION 117

AGGREGATES FOR GRANULAR BASES AND SURFACING

117.1 DESCRIPTION

A. General: The material shall conform to the specifications for the particular material required by the contract. The material shall be sound durable particles of ledge rock or gravel. The material may include limited amounts of fine soil particles, but shall be free of vegetation or organic debris, paper, metal, glass, and other foreign material.

B. Related Work:

Section 20 Granular Bases and Surfacing
Section 203 Submittals

117.2 MATERIALS

A. Aggregates for granular bases and surfacing shall conform to the requirements of Table 1.

TABLE 1

REQUIREMENT	Subbase	Gravel Cushion	Aggregate Base Course	Limestone Ledge Rock		Gravel Surfacing
				Base Course	Gravel Cushion	
Sieve	Percent Passing					
6 inch						
2 inch	100					
1 inch	70-100	100	100	100	100	
3/4 inch		80-100	80-100	80-100	80-100	100
1/2 inch		68-91	68-91	68-90	68-90	
#4	30-70	46-70	46-70	42-70	42-70	50-78
#8	22-62	34-58	34-58	29-53	29-53	37-67
#40	10-35	13-35	13-35	10-28	10-28	13-35
#200	0.0-15.0	3.0-12.0	3.0-12.0	3.0-12.0	3.0-12.0	4.0-15.0
Other Properties						
Liquid Limit (max)		25	25	25	25	
Plasticity Index	0-6	0-6	0-6	0-3	0-3	4-12
LA Abrasion Loss (maximum)	50	40	40	40	40	40
Crushed Particles (minimum) + #4 Sieve	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF	30% 1-CF
Foot Notes		*2	*1, *2			

*¹ The fraction passing the #200 sieve shall not be greater than 2/3 of the fraction passing the #40 sieve. In no case shall the upper limit specified for the #200 sieve be exceeded.

*² Requirements apply to ledge rock other than limestone ledge rock.

B. Sampling & Testing:

Sampling	SD 201
Gradation	SD 202
Liquid Limit and Plasticity Index	SD 207
LA Abrasion Test.....	SD 204
Crushed Particles.....	SD 211

Aggregate supplier shall submit sampling and testing results to the City annually for each source. The annual sampling and testing results shall be provided by a certified testing agency and the cost shall be borne by the supplier. Additional testing may be performed by the Engineer with cost borne by the City.

When removing aggregate from a stockpile a reasonable effort shall be made to ensure well-mixed material is delivered to the project site.

C. Clay Binder: When required for gravel surfacing, shall conform to SDDOT Standard Specifications for Roads and Bridges, current edition, Section 883.

117.3 METHOD OF MEASUREMENT

Measurement of aggregates for granular bases and surfacing shall be in accordance with Section 20.

117.4 BASIS OF PAYMENT

Payment of aggregates for granular bases and surfacing shall be in accordance with Section 20.

END OF SECTION

SECTION 118

ASPHALT MATERIAL

118.1 DESCRIPTION

Transporting conveyances for asphalt material shall be free of contaminating material. A record of material hauled the previous load in truck transport tanks shall be furnished to the Engineer as a prerequisite to loading. A determination shall be made if the previously hauled material is compatible with the material to be loaded or if cleaning of the tank is required to prevent contamination.

The company or jobber furnishing asphalt materials shall furnish two copies of a Certificate of Compliance for each tank car, truck tank or other individual conveyance.

Temperatures to provide kinematic viscosities of 300 centistokes and 150 centistokes for mixing application and 200 centistokes and 50 centistokes for spray application shall be furnished to the Engineer for each load of asphalt cement or cutback asphalt, on the Certificate of Compliance.

Upon presentation of a Certificate of Compliance, the Engineer may permit incorporation into the work the asphalt material covered by the Certificate. Permission by the Engineer to use asphalt material shall not be construed as an acceptance of the material. Acceptance of asphalt material will be based on test results of the samples obtained.

Asphalt material tested and accepted for use on a project and transferred by the Contractor to another project may be accepted for use in the terminating project based on the test results of the originating project. The Contractor must request and receive from the Engineer of the originating project, prior to transfer, a letter of transfer covering the material.

118.2 MATERIALS

- A. Rapid curing cutback asphalt shall conform to the requirements of AASHTO M81.
- B. Medium curing cutback asphalt shall conform to the requirements of AASHTO M82.
- C. Slow curing cutback asphalt shall conform to the following requirements:
 - 1. The oil shall be uniform in appearance and consistency and shall show no foaming when heated to the application temperature. The residue of specified penetration shall be smooth and homogeneous in appearance.
 - 2. The grade of liquid asphalt material specified shall conform to the requirements shown in Table 1.

Table 1

REQUIREMENT	SC-70		SC-250		SC-800		SC-3000	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
Kinematic viscosity @ 60C (140F) (See Note 1) centistokes	70	140	250	500	800	1600	3000	6000
Flash Point (Cleveland open cut) Degrees C / (F)	66 150	---	79 175	---	93 200	---	107 225	---
Water Percent:	---	0.5	---	0.5	---	0.5	---	0.5
Asphalt residue of 100 pen., % by Weight	50	---	60	---	70	---	80	---
Ductility of 100 pen., residue @ 25C (77F), 5 cm per min., cm	100	---	100	---	100	---	100	---
Solubility in Trichloroethylene, %:	99.0	---	99.0	---	99.0	---	99.0	---
Distillation Test: Total distillate To 360C (680F), % by volume	10	30	4	20	2	12	---	5
Tests on residue from distillation: Kinematic viscosity at 60C (140F) Stokes	4	70	8	100	20	160	40	350

Spot Test (See Note b) with:

Standard naphtha	Negative for all grades
Naphtha xylene solvent, % xylene	Negative for all grades
Heptane xylene solvent, % xylene	Negative for all grades

Footnotes:

a) As an alternative, Saybolt-Furol viscosities may be specified as follows:

Grade SC-70	Furol viscosity at 50°C 60 to 120 sec.
Grade SC-250	Furol viscosity at 60°C 125 to 250 sec.
Grade SC-800	Furol viscosity at 82.2°C 100 to 200 sec.
Grade SC-3000	Furol viscosity at 82.2°C 300 to 600 sec.

b) The use of the spot test is optional. When specified, the Engineer shall indicate whether the standard naphtha solvent, the naphtha xylene solvent or the heptane xylene solvent will be used in determining compliance with the requirement and, in the case of xylene solvent, the percentage of xylene to be used.

D. Sampling and Testing:

Sampling	SD 301
Water	AASHTO T 55
Flash Point	AASHTO T 79
Kinematic Viscosity	AASHTO T 201
Saybolt Furol Viscosity	AASHTO T 72
Residue of Specified Penetration	SD 310

Ductility	AASHTO T 51
Solubility in Trichloroethylene	AASHTO T 44
Distillation	AASHTO T 78

- E.** Performance graded asphalt cement binder shall be used for all pavement within the City of Rapid City street right of way unless another binder is approved by the Engineer and is specified in the detailed specifications. Mainline street and intersection pavement shall utilize PG64-28 graded asphalt binder. Sidewalks, low traffic driveways, or areas where significant hand working is required may utilize PG64-22 or PG58-28 binders.

Performance Graded Asphalt Cement Binder shall conform to AASHTO Performance Graded Binder Specifications (MP1) and the Combined State Binder Group Method of Acceptance for Asphalt Binders.

Permissible modifiers for the Specific SHRP Performance Graded Asphalt Binder are Styrene-Butadiene Rubber (SBR) or Styrene-Butadiene-Styrene Rubber. Certified test results for the asphalt binder and modifier shall be provided for each load shipped to the project. The modifier shall be added at an approved blending plant.

The Contractor shall provide a Job-Mix Formula to the Engineer with supporting mix design data prior to production. The Engineer may require field adjustment of the asphalt binder content.

- F.** Emulsified asphalt shall conform to the specification requirements of AASHTO M 140. When SS-1h Emulsified Asphalt is specified, the penetration of the residue from distillation shall be from 40 to 115 penetration and, when specified for tack or flush seal coat, the cement mixing test requirement is waived.
- G.** Cationic Emulsified Asphalt shall conform to the specification requirements of AASHTO M 208. When CSS-1h is specified, the penetration of the residue from distillation shall be from 40 to 115 penetration and, when specified for tack or flush seal coat, the cement mixing test requirement is waived.
- H.** Polymer Modified Emulsified Asphalt shall conform to AASHTO M 316, with the following exceptions. The sieve test requirement on representative samples will be waived unless requested by the Engineer

	HFMS-2P		HFRS-2P		CRS-2P	
	Min	Max	Min	Max	Min	Max
TESTS ON EMULSIONS:						
Viscosity, Saybolt Furol @ 122°F	50	400	50	400	100	400
Classification test					Passes	
Particle charge test					Positive	
Sieve (%) ^{*1}		0.10		0.10		0.10
Demulsibility 50ml 0.10 N CaCl ₂ , %	40					

Demulsibility 50ml 0.02 N CaCl ₂ , %			30			
Demulsibility 35ml 0.8% Sodium dioctylsulfosuccinate, %					40	
Oil Distillate by Volume of Emulsion,% ^{*2}		3.0		3.0		1.0
Residue by Distillation, %	65		65		65	
TESTS ON RESIDUE FROM DISTILLATION TESTS:						
Penetration @ 77°F	100	200	100	200	100	175
Ductility @ 39°F 5cm/min., cm	30		30		30	
Softening Point (R&B) °F	100		100		100	
Elastic Recovery @ 50°F ^{*3}	55		55		55	
Float Test @ 140°F, sec	1200		1200			
Solubility in trichloroethylene, %					97.5	

*1 A maximum percentage of 0.30% is acceptable for samples taken at the point of use.

*2 The distillation test for CRS-2P emulsion shall be in accordance with AASHTO T 59, except that the distillation temperature shall be what the emulsion manufacturer recommends.

*3 The Elastic Recovery test shall be in accordance with AASHTO T 301, except that the residue will be obtained by distillation, not oven evaporation. The distillation temperature shall be as recommended by the emulsion manufacturer.

I. Petroleum Resin-Oil Base Emulsion shall conform to the following requirements:

TEST	LIMITS		TEST METHOD
	MIN.	MAX.	
Saybolt-Furol Viscosity (at 77 deg. F. (second))	15	40	AASHTO T 59
Residue Percent	60		AASHTO T 59 (1)
Miscibility	No Coagulation		AASHTO T 59 (2)
Sieve Test		10	AASHTO T 59 (3)
Particle Charge	Positive		
Tests on Residue Kinematic Viscosity (at 140 deg. F.) centistokes	100	200	AASHTO T 201
Asphaltene Percent		75	ASTM D 2007
Maltenes Dist. Ratio	0.3	50	ASTM D 2007 (4)

PC + A1

S + A2

Footnotes

1. T 59 residue by evaporation test for percent residue is made by heating a 50-gram sample to 300° until foaming ceases, then immediately cooling sample and calculating results.

2. Test procedure identical with T 59, except Normal Calcium Chloride solution shall be used in place of distilled water.
3. Test procedure identical with T 59, except distilled water shall be used in place of 2% Sodium Oleate solution.
4. In the Maltenes Distribution Ratio Test by ASTM D 2007:

PC = Polar Compounds A1 = First Acidaffins
 A2 = Second Acidaffins S = Saturates

The material shall have the capability of increasing the ductility and penetration of the asphalt binder in the asphalt concrete surface when applied at the specified rate.

- J. Petroleum Resin-Oil Base Emulsion (Diluted) shall be diluted with potable water in the ratio of approximately two parts emulsion to one part water by volume.

The petroleum Resin-Oil Base Emulsion, prior to dilution, shall conform to the requirements of "G" above.

The diluted emulsion shall meet the following requirements:

TEST	LIMITS		TEST METHOD
	MIN.	MAX.	
Residue Percent	40		AASHTO T 59(1)
Sieve Test		10	AASHTO T 59(3)
Tests on Residue Kinematic Viscosity (at 140 deg. F.)			AASHTO T 201
centistokes	100	200	

See Paragraph I for footnotes.

- K. "High Float" Emulsified Asphalt shall conform to the following requirements:

TABLE 1

TEST	GRADE AE150S		GRADE AE200S		GRADE AE300	
	MAX.	MIN.	MIN.	MAX.	MIN.	MAX.
Viscosity (Saybolt Furol) (at 122°F (50°C) Sec.)	35	150	35	150	35	500
Sieve Test – Percent		.30		.30		.30
Oil Portion Dist. (% by Volume)	.5	3	1	6		8
Residue by Dist. (% by Weight)	62		62		65	
Tests on Residue From Distillation Float Test (at 140°F (60°C) sec.)	1200		1200		1200	

Penetration (at 77°F, 100 g. 5 sec. – 0.1mm)	140	225	250		300	
Solubility in Trichloroethylene (%)	97.5		97.5		97.5	
Ductility (at 77°F, (25°C), 5 cm/min. – cm)	40		40		40	

The properties of the Emulsified Asphalt shall be determined in accordance with AASHTO T 59.

Float test properties on the residue from distillation shall be determined in accordance with AASHTO T 50.

118.3 TEST REPRODUCIBILITY TOLERANCE

Test results which fall outside the specifications limits for a particular test but within the reproducibility tolerance as set forth below, will be acceptable:

<u>TEST</u>	CUTBACK ASPHALT	<u>TOLERANCE*</u>
Flash Point		
Tag Open Cup		
(Av. of three tests).....		4°F
Cleveland Open Cup.....		15°F
Viscosity		
Kinematic, 140° F		
(to 3000 CS).....		1.5%
Kinematic, 140° F		
(above 3000 CS).....		4.5%
Saybolt-Furol.....		4.5%
Distillation		
Distillate % by vol.		
(up to 347° F).....		1.8% pts.
Distillate % by vol.		
(above 347° F).....		1.0% pt.
Residue % by vol.....		1.0% pt.
Test on Residue		
Penetration.....		8%
Solubility in CH ₃ CCl ₃		0.13% pt.

EMULSIFIED ASPHALTS

Distillation		
Residue by % vol.....		1.0% pt.
Test on Residue		
Penetration (100 or more).....		15 pen pts.
Penetration (less than 100).....		8 pen pts.

ASPHALT CEMENT

Penetration, 77° F

(Less than 50).....	2 pen pts.
Penetration, 77° F (50 or above).....	4%
Flash Point	
Cleveland Open Cup.....	15° F
Pensky-Marten's Closed Cup (below 220° F).....	3° F
Pensky-Marten's Closed Cup (above 220° F).....	13° F
Viscosity	
Kinematic, 275° F	4.4%
Absolute, 140° F	5.0%
Solubility in Ch ₃ CCl ₃	0.13% pt.
Thin-Film Test	
Loss on Heating.....	20%
% of Original.....	4% pts.

* When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit, whichever is applicable.

118.4 METHOD OF MEASUREMENT

Asphalt material will be measured in accordance with the various asphalt construction items.

118.5 BASIS OF PAYMENT

Asphalt material will be paid for in accordance with the various asphalt construction items.

END OF SECTION

SECTION 120

DRAINAGE PIPE MATERIALS

120.1 DESCRIPTION

A. General: Drainage and culvert piping material shall conform to the following specifications. Pipe materials and minimum sizes allowed for Public Works Construction are determined by the Engineer, Infrastructure Design Criteria Manual, and City policy.

B. Related Work:

Section 11	Utility Excavation and Backfill
Section 54	Drainage Pipe Installation
Section 58	Concrete Box Culvert
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes
Section 203	Submittals

120.2 MATERIALS

A. Reinforced Concrete Pipe: Shall conform to the requirements of AASHTO M170, M206 and M207, and Section 50 Precast Concrete. The pipe and fittings shall be manufactured at a pre-cast facility that is certified by the American Concrete Pipe Association and is approved for supplying products to the South Dakota Department of Transportation. Pipe joints shall conform to ASTM C443.

Flexible watertight gaskets shall conform to ASTM C1619 or ASTM C1628.

B. RCP Tie Rods/Pipe Ties/Tie Bolts: Shall conform with ASTM F1554 Grade 36 or ASTM A36, with heavy hex nuts conforming to ASTM A563, and washer conforming to ASTM F436. Adjustable eye bolts shall be galvanized in accordance with ASTM A153.

C. Polypropylene (PP) Pipe: Shall be Type S dual wall pipe with corrugated exterior and smooth interior. Pipe, couplings, and fittings shall conform to the requirements of AASHTO M 330 and ASTM F2881 / F2881M.

D. PVC Pipe: Shall conform to the requirements of Section 9.

E. Bituminous Coated Corrugated Metal Pipe: Bituminous coated corrugated metal pipe shall conform to AASHTO M 190, except the pipe shall conform to AASHTO M 36 or AASHTO M 196 before coating.

F. High Density Polyethylene (HDPE) Pipe: High density polyethylene pipe shall be

Type S dual wall pipe with corrugated exterior and smooth interior. Pipe, couplings, and fittings shall conform to the requirements of AASHTO M 294 and ASTM F2306 / F2306M.

120.3 METHOD OF MEASUREMENT

Measurement shall be as called for in Sections 54.

120.4 BASIS OF PAYMENT

Payment shall be as called for in Sections 54.

END OF SECTION

SECTION 123

CONCRETE REINFORCEMENT

123.1 DESCRIPTION

- A. Bar Reinforcement – Structures and Paving (excluding dowel and tie bars):** Bar reinforcement for structures and concrete pavement, shall conform to the requirements of AASHTO M 31 (ASTM A615) Grade 60. Bar reinforcement shall be deformed, unless otherwise noted.
- B. Welded Wire Reinforcement:** Shall conform to ASTM A1064. The optional yield strength measurement will only be required for welded wire reinforcement utilized in box culverts.
- C. Epoxy Coated Reinforcement:** A Certificate of Compliance and a copy of all quality control test results for the epoxy coating shall be furnished for each shipment supplied for use on a project.

Dowel bars for concrete pavements shall be epoxy coated and shall conform to AASHTO M 254 Type B except the film thickness shall be from 5 to 13 mils after cure.

All other epoxy coated reinforcement shall comply with ASTM A775.

- D. Tie Bars:** Shall conform to the requirements of AASHTO M 31, Grade 40, except rail steel shall not be used for tie bars that are to be bent and re-straightened. Tie bars shall be deformed. Tie bars shall be epoxy coated.

Sawing or shearing of the tie bars to obtain the specified length will be permitted provided the coating is not damaged and the resulting bar is free from burring and other deformations. The cut ends shall be coated.

- E. PCC Paving Dowel Bars and Dowel Bar Assemblies:** The steel cores of dowel bars and plain round bars shall be plain round bars conforming to AASHTO M 31 (ASTM A615) Grade 40 or 60, M 227 (ASTM A663) Grade 70 minimum, or M 255 (ASTM A675) Grade 75 minimum. The bars shall be the diameter shown in the plans, free from burring or other deformation restricting slippage in the concrete. Dowel bars shall be epoxy coated.

Sawing or shearing of the dowel bars will be permitted provided the coating is not damaged and the resulting bar is within the permissible deformations. The cut ends are not required to be coated. Any deformation larger than true shape shall not exceed a 0.04 inch increase in diameter or thickness and shall not extend more than 0.40 inch from the dowel end.

Bond breakers used to pre-coat dowel bar assemblies shall be one of the products from the SDDOT Approved Products List.

123.2 METHOD OF MEASUREMENT

Reinforcing Steel will be measured as specified in plans. If reinforcing steel measurement is not specified in plans it shall be incidental to the associated concrete bid item.

123.3 BASIS OF PAYMENT

Reinforcing steel will be paid for as specified in plans. If reinforcing steel payment is not specified in plans, it shall be incidental to the associated concrete bid item.

END OF SECTION

SECTION 190

WATERING

190.1 DESCRIPTION

This work consists of furnishing and applying water either directly on the road or to the materials being incorporated in the work. These provisions do not apply to any water used in the production or curing of concrete.

The Contractor shall be responsible for providing water for compaction of earthen and granular materials used for, but not limited to, grading, subgrade preparation, and trench backfill. The Contractor is also responsible for water needed for sod and seed irrigation, street cleaning, dust control, and other miscellaneous items. The City will provide water for water main testing and dechlorination.

If the Contractor elects to purchase water from the City's water system, he will be required to pay for meter fees and installation onto a fire hydrant. Contact the City's Water Division to arrange for meter hook-ups to be added to fire hydrants and to obtain the current rate that will be charged.

190.2 MATERIALS

The water shall be furnished by the Contractor and shall be free from injurious matter.

190.3 CONSTRUCTION REQUIREMENTS

Watering may be accomplished by sprinkling, pre-irrigation, pre-mixing or by other methods approved by the Engineer. The contractor shall make every reasonable effort to minimize fugitive dirt or dust because of construction activities. The Engineer may require the Contractor to water or take other actions necessary to prevent blowing dirt and/or dust and other nuisance conditions.

- A. Sprinkling:** Sufficient equipment shall be available to apply the amount of water required to secure the proper compaction before evaporation, absorption or drainage prevents or interferes with the specified results to be obtained.
- B. Pre-Irrigation:** Pre-irrigation of excavation areas shall be under the control of the Engineer. The Engineer shall have the authority to prohibit or stop pre-irrigation when wind, temperature or soil conditions are such that satisfactory results cannot be obtained.

If requested, the Contractor shall furnish to the Engineer the manufacturer's charts for recommended pressure, rate of discharge and effective area of irrigation for the various nozzles to be used. The pressure at the sprinkler head or nozzle shall be adjusted to minimize atomization and subsequent evaporation. The recommendation

of the manufacturer shall be followed. The use of pressure reducing valves may be required to maintain uniform nozzle pressure.

Prior to pre-irrigation, the Contractor shall drill test holes to the depth and spacing required over the area to be watered to determine the average natural moisture percentage present in the soil and the average optimum moisture requirement. Unless otherwise permitted, drill holes shall be at least 6 in. in diameter.

The Contractor shall furnish the Engineer, for review, a plan showing the limits of excavation, sprinkler placement, depth of cut to be watered by each sprinkler and the anticipated length of operating time of each sprinkler.

Should soil or vegetation conditions warrant, the Engineer may require the Contractor to rip areas to be pre-irrigated. Such ripping shall be along the contour of the ground to a minimum depth of 2 feet.

Pre-irrigated areas shall not be excavated until a sufficient time has elapsed, normally about one day per foot of excavation depth, to allow the water to penetrate to the lower levels of the cut.

Prior to the start of grading operations, the Contractor shall drill test holes in the pre-irrigated areas to check the penetration of moisture.

C. Pre-Mixing: Water added to the material before delivery or placement on the roadbed shall be mixed uniformly into the material. The amount of water added shall be carefully controlled to conform to the requirements of the particular item of work.

D. Equipment Loading/Filling: Equipment filled from City water mains or other potable water systems shall be equipped with an air gap or backflow preventer to prevent backflow into the potable water system.

190.4 METHOD OF MEASUREMENT

The costs for purchasing, loading, transporting and applying/incorporating water shall be incidental to the various items where water is required. There will be no separate payment for water.

190.5 BASIS OF PAYMENT

Payment will be full compensation for equipment, labor and incidentals necessary to complete the work as specified.

END OF SECTION

SECTION 200

CONTROLLED LOW STRENGTH MATERIAL

200.1 DESCRIPTION

A. General: This work consists of furnishing, handling, and placing Controlled Low Strength Material (CLSM).

B. Related Work:

Section 8A	Water
Section 8B	Corrosion Protection – Plastic Pipe Systems
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 55	Cast in Place Concrete Structures
Section 56	Class M6 Concrete for Curb & Gutter and Flatwork
Section 100	Portland cement
Section 101	Air-Entraining Admixtures
Section 102	Chemical Admixtures for Concrete
Section 103	Fly Ash
Section 104	Water for Use in Portland Cement Concrete
Section 203	Submittals

200.2 MATERIALS

Materials shall conform to the following sections.

A. Cement: Section 100. Cement shall be Type I, Type II, Type III, or Type V cement may be used, unless otherwise specified.

B. Fine Aggregate: Fine aggregate shall be a natural sand conforming to the following gradation:

Sieve Size	Percent Passing
3/8 inch	100
#200	0-10.0

C. Water: Section 104.

D. Admixtures: Controlled low strength material (CLSM) performance additive (foaming admixture) as listed on the South Dakota Department of Transportation approved products list.

E. Fly Ash: Section 103.

200.3 CONSTRUCTION REQUIREMENTS

- A. General:** Controlled density fill shall be a mortar material with a free flowing consistency.
- B. Mix Design:** The controlled density fill mix design shall be in accordance with Section 56, except as modified below:

Unless specified otherwise, the controlled density mix may conform to either of the two alternate mix designs.

1. Standard Mix Design:

Material	Rate per Cubic Yard
Cement	100 pounds
Fine Aggregate	2,600 pounds
Water	60 Gallons
Fly Ash	300 pounds

2. Alternate Mix Design:

Material	Rate per Cubic Yard
Cement	200 pounds
Fine Aggregate	2,600 pounds
Water	35 Gallons
CLSM Performance Additive	As recommended by the CLSM performance additive manufacturer to produce a target air content* ¹ of 20% ±5

*¹ evaluated for specification at mix design only

Both alternate mix designs shown above are designed to produce a minimum compressive strength of 100 psi.

- C. Placement:** The Contractor may adjust the proportion of water during placement to provide the necessary consistency of the mix, as approved by the Engineer.

Controlled density fill shall be contained within the required limits with sandbags or other methods approved by the Engineer. The Contractor shall prevent floatation, uplift, and movement due to the buoyant force of the controlled density fill until the controlled density fill hardens. Overlying surfacing materials shall not be placed sooner than 4 hours after placement of the controlled density fill.

200.4 METHOD OF MEASUREMENT

Controlled low strength material shall be measured to the nearest 0.25 cubic yard of material placed, unless other measurement provisions are specified. Measurement

provisions shall be consistent with the Bid Proposal. In lieu of actual field measurement for volume of material placed, truck delivery tickets will be used.

200.5 BASIS OF PAYMENT

Controlled low strength material will be paid at the unit price established in the Bid Proposal.

END OF SECTION

SECTION 201

CONSTRUCTION STAKES, LINES AND GRADES (CONTRACTOR FURNISHED STAKING)

201.1 DESCRIPTION

- A. General:** This work shall consist of furnishing and placing construction stakes necessary to construct the project. The staking work includes establishing project centerline; re-establishing plan and Rapid City Network control points; setting additional benchmarks and control points as needed; measuring volumes of necessary topsoil stockpiles; topographic surveys for final cross sections earthwork quantities; verifying undercut, muck, rock and dig-out removal quantities; staking right-of-way (ROW), easements, and project limits; and other miscellaneous construction survey work.

The surveyor performing work under this section shall either be licensed or shall be under the direct supervision of a Registered Land Surveyor. Surveyor shall perform all construction layout and reference staking necessary for accurate control and completion of all structure construction, grading, paving, drainage, fence, permanent control points, ROW monuments and all other appurtenances required for the complete construction and acceptance of the work. The layout shall include, but not be limited to, staking clearing line; removal limits; slope staking and slope stake referencing; grade staking (blue top dirt grade and base course grade hubs); paving hub staking; staking of water mains, fittings, hydrants and valves; staking of sewer mains, bends, manholes, and services; staking of culvert pipes and structures; re-establishing property corners; and performing the miscellaneous staking as described in the plans and in these specifications.

Horizontal and vertical control shown on plans shall be referenced to at least two City network control points.

Upon request the Engineer may allow construction staking to proceed at the contractors risk prior to actual construction operations. Such conditional approval shall not be considered the start of the project day count. The Contractor shall not begin actual work on the project until a complete Notice to Proceed is received, at which point the project day count will begin.

B. Related Work:

Section 8A	Water
Section 9	Sanitary Sewer
Section 11	Utility Excavation and Backfill
Section 54	Drainage Pipe Installation
Section 62	Drop Inlets
Section 63	Storm Sewer Junction Boxes and Manholes

201.2 MATERIALS

- A. The Contractor shall furnish all materials of adequate quality for the purpose intended, including all stakes, stake chasers, paint, field note books, and all other materials necessary to properly perform the required work.
- B. Stakes shall be suitable for general field construction staking and shall be durable enough to last the duration of the project without undue weathering so as to make the stake illegible or difficult to read or use. Stakes that become illegible shall be remarked or reset at the Contractor's expense.
- C. Paint, when used in lieu of plastic flagging to mark survey stakes, shall be brightly colored or fluorescent pink to be visible from passing equipment. Paint that becomes faded shall be remarked or reset at the Contractor's expense.
- D. Plastic flagging shall be brightly colored or fluorescent pink plastic ribbon securely tied to the survey stake. Plastic flagging that becomes faded, torn or dislodged shall be replaced at the Contractor's expense.
- E. Property pins/markers shall meet current South Dakota requirements for legal property monuments.
- F. Field note books shall be made of quality, heavy, water resistant paper and may be bound with a permanent binding or may be in loose leaf binding. Notes shall be made with a waterproof pen or pencil.

201.3 CONSTRUCTION REQUIREMENTS

- A. **General:** A South Dakota Registered Land Surveyor will be required to re-establish property corners per South Dakota Law. The Contractor shall submit the name and registration number of the land surveyor who will perform the corner and monument relocation work on the project. A record of survey on how the corner was re-established shall be submitted to the Engineer upon completion of the work.

All other work shall be done by or under the supervision of a South Dakota Licensed Land Surveyor or a South Dakota Professional Engineer who is experienced and competent in urban street and road construction surveying and staking. The Land Surveyor or Professional Engineer shall be available to review work, resolve problems and make decisions in a timely manner. A crew chief, who is competent to perform all required surveying duties and who is under the direct supervision of the surveyor or engineer, shall be onsite to supervise and/or perform the staking in the absence of the surveyor or engineer on the project.

The Contractor shall also submit a proposed starting date of the staking and the anticipated surveying work schedule, and these dates must be consistent with the anticipated construction work schedule.

The Contractor, through the Contractor's surveyor or engineer, shall be responsible for the accuracy of the staking. All errors and discrepancies found on previous surveys, plans, or specifications shall be called to the attention of the Engineer prior to proceeding with further survey and construction work.

The overall supervision of the construction staking personnel shall be the responsibility of the Contractor. Any deficient survey layout or staking performed by the Contractor's surveyor or engineer, or any unreported errors in previous surveys that may result in construction errors, shall be corrected by the Contractor at no additional cost to the City.

Field notes shall be kept in conventional, handwritten note books or in a computerized form acceptable to the Engineer. Notes shall be kept in a clear, orderly and neat manner, with all pertinent information duly noted therein. The field notes shall be made available for inspection and review by the Engineer at any time during or after the project.

If required, final cross sections (terrain data), where required, shall be submitted to the Engineer in an electronic file compatible with City survey and computer equipment. The Contractor shall convert the terrain data, as necessary, to suitable format compatibility at no additional expense to the City prior to submittal. When required by plans and specifications, printed cross sections showing original sections and as-constructed data shall be submitted to the Engineer upon completion of the project.

If the Contractor encounters a property pin, benchmark, or ROW marker not identified in the plans, they shall immediately notify the Engineer.

Stakes which are damaged, destroyed or made unusable during construction shall be replaced by the Contractor at no additional expense to the City.

The Engineer may check the accuracy and control of the Contractor's survey work at any time. The checks performed by the Engineer will not relieve the Contractor of the responsibility for the accuracy of the survey layout or the construction work.

The level circuit to check the plan benchmarks shall be run the full length of the project.

- B. Slope Staking:** Shall be set at the catch points. The slope stake reference hubs shall be offset behind the slope stake a sufficient, set, consistent distance to prevent disturbance during construction.

Slope stakes shall be clearly referenced and shall be set at intervals consistent with the plan stationing. Horizontal curves and vertical curves will require additional slope stakes set at intervals sufficient to maintain adequate grade and line control. Intervals shall be maximum 100 feet in tangent sections and maximum 50 feet in curve sections. The Engineer has authority to increase the staking interval. Slope stake tolerances shall be ± 0.2 feet horizontal and ± 0.1 feet vertical. Slope stake reference hubs shall reference the subgrade shoulder and tolerances will be ± 0.2 feet horizontal and ± 0.05 feet vertical.

The Contractor shall retain the slope stakes and hub references until the grading work is completed and accepted by the Engineer.

- C. Grade Staking:** The grade finishing stakes (blue tops) for grade elevations and horizontal alignment shall be set on the roadway crown/centerline and at the top of the subgrade at the outer limits of base course, where there is no existing curb and gutter. Where curb and gutter shall remain, only crown/centerline stakes are required. Blue tops are required for finished subgrade and finished base course grade. Contractor may request alternative methods to blue topping outer limits of the basecourse. If curb and gutter stakes are utilized for a reference, they must be placed within three (3) days of base course placement.

Transverse distance between blue tops shall not exceed 20 feet. Intermediate blue tops will be required and shall be approved by the Engineer when transverse distance exceeds this value.

The blue top grade stakes shall be set at station intervals consistent with the plans not to exceed 50 feet on tangents and horizontal and 25 feet vertical curves. The horizontal tolerance is ± 0.2 feet and the vertical tolerance is ± 0.02 feet.

The subgrade shall be finished to within minus 0.08 feet to plus 0.02 feet from the design grade and typical section shown in the plans and to within $\pm 0.5\%$ of the typical section cross slope. The quarter crown within any 12 foot transverse length shall not exceed 0.04 feet above or below a straight edge, string line, or by other suitable equipment measuring between the crown and edge of roadway. The centerline shall be finished to a transverse distance within ± 0.25 feet of the plans shown location of centerline.

The Contractor shall furnish stakes of sufficient length to provide a solid set in the ground. Half-length lathe stakes or stake chasers shall be placed adjacent to or on the blue top hubs for guards. Stakes not meeting these requirements shall be reset at no additional expense to the City.

The Contractor shall retain the outer-most roadway blue tops and guards through placement of the gravel base course material.

For asphalt paving the contractor is required to set grade stakes at the top of the gravel base course material, the blue tops shall remain in place until the gravel base course material is finish graded and accepted by the Engineer.

Paving hubs for portland cement concrete paving shall be set at each transverse joint. Closer spacing which may be required by the paving contractor will be at no additional expense to the City. Horizontal and vertical tolerance is ± 0.02 feet.

Grading, blue tops, and paving hub notes will become the property of the City.

- D. Machine Control Grading (MCG):** The contractor may elect to use grading equipment with an automated machine control system for MCG provided the equipment and methods used provide the same results in the finished work as conventional construction staking. Equipment shall be properly calibrated and shall be referenced daily to established benchmarks. Records of daily calibration shall be provided to the Engineer. The contractor shall have an appropriate number of calibration points on the perimeter of the project. The calibration points shall be verified by the Engineer. The Engineer may require the Contractor to revert to conventional staking methods for all or part of the work at any point during construction if, in the Engineer's opinion, the MCG produces unacceptable results. There shall be no assumption that the necessary digital files will be available for any project, unless specifically stated in the detailed plans and specifications. Even when MCG is utilized, a minimum amount of staking is still required.
- E. Re-establish Property and ROW Markers:** Contractor shall immediately notify the Engineer if any property corner is disturbed or if he anticipates disturbing a property corner. All property corners, ROW markers, or other monuments shall be properly replaced by a licensed land surveyor. Known property corners and ROW markers shall be shown on the plans.
- F. Rapid City Network Control Points:** All Rapid City control network monuments within the project limits shall be shown on the plans and any Rapid City control networks points destroyed or damaged shall be replaced under the supervision of a Registered Land Surveyor to the satisfaction of the City Land Surveyor. The Contractor shall notify the Engineer if they encounter a control network monument that is not shown on the plans.

Installation procedures for Rapid City Network Control Points shall be approved solely by the City Land Surveyor.

G. Miscellaneous Staking:

1. Final earthwork (or terrain data) cross sections at the same intervals, stations and plus stations as the original cross sections when required by plans and detailed specifications;
2. Approach road/driveway staking;
3. Topsoil stockpile measurement;
4. Ditch/drainage staking;
5. Staking and/or measurement of sub-excavation, muck excavation, rock excavation, undercut excavation and dig-outs;
6. Staking of signs, pavement markings, guardrail, curb and gutter, light poles, conduit, junction boxes and irrigation systems, and related items;

7. Water and sanitary sewer mains and services including pipe, manholes, valves, bends, fittings, hydrants, appurtenances and related items;
8. Mark limits of removal items (trees, foundations, curb and gutter, sidewalk, etc.);
9. Storm pipe culvert and storm sewer staking including drop inlets, manholes and related items. Set reference stakes for the storm sewer inlet and outlet locations. Stake ditches and inlet and outlet grades to ensure proper drainage.

The horizontal tolerance for water and sanitary sewer main and storm sewer staking is ± 0.05 feet and the vertical tolerance is ± 0.03 feet. When sanitary sewer is being installed at minimum grade, project specific tolerances may be required by the Engineer.

201.4 METHOD OF MEASUREMENT

- A. **Staking:** Shall be lump sum when shown as lump sum in the proposal.
- B. **Remove and Reset Property Pins:** Shall be per each when shown in the proposal.

201.5 BASIS OF PAYMENT

- A. **Staking:** Shall be paid at the lump sum unit price established in the bid proposal where such work is proposed as a lump sum item. Partial payment of lump sum unit price, when allowed, shall be made according to the following schedule:

Percentage of Contract Amount Completed (Excluding Construction Staking Itself)	Percentage of Construction Staking Paid
Five Percent (5%)	Twenty-Five Percent (25%)
Twenty Percent (20%)	Fifty Percent (50%)
Thirty-Five Percent (35%)	Sixty Percent (60%)
Fifty Percent (50%)	Seventy Percent (70%)
Seventy-Five Percent (75%)	Ninety Percent (90%)
Project Completion	One Hundred Percent (100%)

- B. **Remove and Reset Property Pins:** Will be paid at the per each unit price established in the bid proposal where such work is proposed as a per each item.

END OF SECTION

SECTION 202

GEOSYNTHETICS FOR ROADWAYS

202.1 DESCRIPTION

A. General: Items of work covered by this specification are those pertaining to the supply and installation of nonwoven, woven geotextile, and multiaxial (biaxial or triaxial) geogrids for roadway applications. Geosynthetics shall not be used for reduction in basecourse or pavement depths.

B. Related Work:

Section 12	Roadway and Drainage Excavation and Embankment
Section 20	Granular Bases and Surfacing
Section 65	Riprap
Section 66	Gabions
Section 117	Aggregates for Granular Bases and Surfacing
Section 203	Submittals

202.2 MATERIALS

Unless otherwise specified slit-film / slit-tape geotextiles shall not be used.

A. Materials Certification: Engineer reserves the right to require verification of any or all of the following certifications.

1. Contractor shall provide to the Engineer a manufacturer certificate stating the material properties are in compliance with this specification.
2. The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. The manufacturer shall have a quality control program that includes an on-site laboratory accredited by the Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP) to perform the required test methods.
3. The manufacturer's certificate shall state that the furnished geosynthetic meets Minimum Average Roll Value (MARV) requirements, except as otherwise specified, of the specification as evaluated under the manufacturer's quality control program.
4. For woven and non-woven geotextiles only, the manufacturer must participate in the AASHTO National Transportation Product Evaluation Program's (NTPEP) Audit Program for Geotextiles (GTX). Upon request, the manufacturer will provide:
 - a) Public status data in NTPEP's DataMine website.

- b) Current publicly released NTPEP Reports on Laboratory Results of Evaluations showing the physical properties of the geosynthetic product or product line is in compliance with the specifications.
- B.** Products without proper identification or labelling, mislabeling, or misrepresentation of materials shall be reason to reject those geosynthetic materials. Identification includes an NTPEP stamp at every 15 feet along a length of a roll.

C. Submittals:

1. The contractor shall provide the Engineer a Manufacturer's Certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile for review and approval before being used.
2. Certificates with distributor or private label letterhead will not be accepted. Technical or Material Data Sheets will not be accepted.
3. The contractor shall provide the Engineer the Manufacturer's valid GAI-LAP laboratory accreditation certificate.
4. Preliminary review of the material as represented by the test results shall not constitute general acceptance of all the material or source of supply.
5. Rejected material will not be paid for. The Engineer has the right to request roll test data or additional testing if there are any concerns with the proposed geosynthetic.

D. Delivery and Storage:

1. Each geotextile roll shall be wrapped with a material that will protect the geosynthetic, including the ends of the roll from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipment and storage. Each geotextile roll shall include an inner core made from a different material that shall protect, ensure ease of handling, and prevent damage from forklifts or other equipment used to transfer or move the geosynthetic roll.
2. During delivery and storage, the geotextile shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultra violet radiation, chemicals that are strong acids or strong bases, flames and sparks, temperatures in excess of 150° F, and any other environmental condition that may damage the physical property values of the product.

E. General: For the purposes of this specification, Geosynthetics shall be divided into the following functional categories:

1. Separation and Filtration Applications:

- a) This specification is applicable to the use of a geotextile to prevent mixing of a subgrade soil and an aggregate cover material (subbase, base, select embankment). The secondary function is allowing moisture to travel through the plane of the geotextile while preventing the migration of fine soil particles.
- b) The geotextile for under drains and storm sewer joints shall be an AASHTO M288-17 Class 2 nonwoven meeting the requirements of the following table. All numerical values in the table except Apparent Opening Size (AOS) represent MARV in the weakest principal direction. Values for AOS represent maximum average roll value.
- c) The geotextile to be placed beneath rip-rap and gabion baskets shall be an AASHTO M288-17 Class 1 nonwoven meeting the requirements of the following table. All numerical values in the table except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll value.

Table 202-1

Non-Woven Geotextile Specifications and Physical Properties			
Properties	ASTM Test Method	AASHTO Class 1 Non-woven	AASHTO Class 2 Non-woven
Apparent Opening Size (AOS) US Standard Sieve	D 4751	40-100	40-100
Permittivity, Sec ⁻¹	D 4491	0.05 Min.	0.1 Min.
Grab Strength, lbs	D 4632	200	160 lbs
Elongation, %	D 4632	≥50%	≥50%
Trapezoidal Tear Strength, lbs	D 4533	80	55
Puncture Strength, lbs	D 6241	430	310
UV Strength Retention, %	D4355	50	50

- d) The severity of installation conditions for the application generally dictate the required geotextile class. Class 1 nonwoven geotextile shall be used for more severe or harsh installation conditions.

2. Stabilization Applications: Geotechnical engineer's recommendations for use of geosynthetics shall be followed on projects with known unstable subgrade. The California Bearing Ratio (CBR) ranges listed are for general guidance when unknown unstable subgrade is encountered during construction. Use of all **geosynthetics for unstable subgrade** shall be approved by the Engineer.

- a) These products shall be installed where identified in detailed plans and

specifications or as directed by the Engineer, and are typically used for saturated conditions to provide the coincident functions of separation, filtration, reinforcement, and confinement.

- b) The geotextile shall meet the requirements of the following table. All numerical values in the table except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll value.

Table 202-2

Stabilization Woven Geotextile Specifications and Physical Properties			
Properties	ASTM Test Method	Moderate (2% < CBR < 3%)*	Severe (CBR < 2%)**
Tensile Strength (at ultimate)	D 4595	3200 lbs/ft	4800 lbs/ft
Tensile Strength (at 5% strain)	D 4595	1500 lbs/ft	2400 lbs/ft
Flow Rate	D 4491	30 gal/min/ft ²	30 gal/min/ft ²
Permittivity	D 4491	0.4 sec ⁻¹	0.4 sec ⁻¹
Apparent Opening Size (AOS)	D 4751	0.6 mm	0.60 mm

* shear strength between 9.0 psi and 13.0 psi

** shear strength below of 9.0 psi. AASHTO Class 1A.

- c) Alternatively, a separation/filtration nonwoven geotextile meeting section 1 combined with a multiaxial geogrid meeting the requirements of the following table can be used. All numerical values in the table represent MARV in the weakest principal direction.

Table 202-3

Specifications and Physical Properties for Biaxial Geogrid		
Properties	ASTM Test Method	FHWA Class 1 Geogrid
Tensile Strength (at ultimate)	D 6637	1300 lbs/ft
Tensile Strength (at 2% strain)	D 6637	400 lbs/ft
Tensile Strength (at 5% strain)	D 6637	800 lbs/ft
Junction Strength	D 7737	1200 lbs
UV Stability (after 500 hr)	D 4355	50%

202.3 CONSTRUCTION REQUIREMENTS

A. Geosynthetic Installation:

1. These installation instructions are intended for use in conjunction with the material specification for geosynthetics. The specification details material properties for geosynthetics used in separation, subsurface drainage, permanent erosion control, and stabilization applications. The material properties are only one factor in a successful installation involving geosynthetics. Proper material handling,

construction, and installation techniques are essential in order to ensure that the intended function of the geosynthetic is fulfilled.

2. Atmospheric exposure of the geosynthetics to the elements following laydown shall be a maximum of 14 days to minimize damage potential.
3. The installation site shall be prepared by clearing, grubbing, and excavating or filling the area to the design grade. This includes the removal of topsoil and vegetation.

B. Roadway Applications:

1. Soft spots and unsuitable areas will be identified during site preparation or subsequent proof rolling. These areas shall be excavated and backfilled with select material and compacted using normal procedures.
2. The geosynthetic shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geosynthetic panels shall be overlapped or sewn as required in the plans. See Table 202-5 for overlap requirements.

Table 202-5

$\text{CBR} \geq 3\%$	12 – 18 inch overlap
$1\% \leq \text{CBR} < 3\%$	24 - 36 inch overlap
$0.5\% \leq \text{CBR} < 1\%$	36 inch overlap or sewn
$\text{CBR} < 0.5\%$	sewn

3. When using a multiaxial geogrid for subgrade stabilization, the separation/filtration nonwoven geotextile will be placed directly upon the subgrade and the multiaxial geogrid will be placed directly on top of the separation/filtration nonwoven geotextile.
4. On curves, the geotextile may be cut to conform to the curves. The overlap shall be in the direction of construction and held in place by piles of granular base course or granular subbase course. Pins or staples should not be used.
5. Prior to covering, the geotextile shall be inspected to ensure that it has not been damaged during installation. The inspection shall be done by the Engineer. Damaged geotextiles, as identified by the Engineer, shall be repaired immediately. Cover the damaged area with a geotextile patch that extends an amount equal to the required overlap beyond the damaged area.
6. Place and compact soil layers in accordance with Section 12 and granular base course per Section 20.
7. The granular base course shall be placed by end dumping onto the geotextile from the edge of the geotextile or from previously placed base course. Construction vehicles shall not be allowed directly on the geotextile. The granular base course shall be placed such that at least the minimum specified lift thickness shall always be

between the geotextile and equipment tires or tracks. Minimum first lift thickness shall be six (6) inches, or per geotechnical engineer's or manufacturers recommendation, whichever is greater. Turning of vehicles shall not be permitted on the first lift above the geotextile.

8. On subgrades having a CBR value of less than 1.0%, the subbase aggregate should be spread in its full thickness as soon as possible after dumping to minimize potential of localized subgrade failure due to overloading of the subgrade.
9. Any ruts occurring during construction shall be filled with additional subbase material and compacted to the specified density.

202.4 METHOD OF MEASUREMENT

Measurement of geosynthetics shall be per the nearest whole square yard (SY). Separation fabric beneath rip-rap, underdrains, and on pipe joints shall not be measured, they are incidental to the associated bid item.

202.5 BASIS OF PAYMENT

Payment for geosynthetics shall be per the contract unit price per square yard (SY), and shall not include joint overlap.

END OF SECTION

SECTION 203

SUBMITTALS

203.1 DESCRIPTION

- A. **General:** This Section includes definitions, descriptions, transmittal, and review of submittals.
- B. **Related Work:** Rapid City Standard Specifications for Public Works Construction

203.2 MATERIALS

A. Definitions:

1. **Shop Drawings:** Include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.
2. **Catalog Cuts:** Include standardized drawings of materials provided by the supplier or manufacturer.
3. **Product Data:** Includes standard printed information on materials, products, and systems; not custom-prepared for this project, other than the designation of selections from available choices.
4. **Administrative Submittals:** Are those nontechnical submittals required by the contract documents or deemed necessary for administrative records. These submittals include maintenance agreements, bonds, project photographs, physical work records, statements of applicability, copies of industry standards, project record data, schedules, security/protection/safety data, and similar type submittals.
5. **Certificates and Guarantees:** Are those submittals on materials where a written certificate or guarantee from the manufacturer or supplier is called for in the specifications.

B. Quality Requirements:

1. Submittals such as shop drawings and product data shall be of suitable quality for legibility and reproduction purposes.
2. Documents submitted to the Engineer that do not conform to specified requirements shall be subject to rejection, and upon request, Contractor shall resubmit conforming documents. Contractor's failure to initially satisfy the requirements of this specification will not justify a reduction in the City's review

timeframe.

C. Language and Dimensions: All submittals shall be in english units and language.

D. Submittal Completeness:

1. Submittals shall be complete with respect to dimensions, plans and detailed specifications, standard specifications, materials of construction, and other information specified to enable the Engineer to review the information effectively.
2. Where standard drawings are furnished, which cover a number of variations of the general class of materials, each drawing shall be annotated to indicate exactly which parts of the drawing apply to the materials being furnished. Contractor shall clearly highlight or identify drawing content that applies to the submittal.

E. Form of Submittals:

1. Submittals and other project documents shall be transmitted in hardcopy or electronic format (electronic preferred). Electronic submittals shall be contained in one file, and hardcopies shall be bound together in one complete document.
2. Contractor shall submit four (4) hard copies, or one (1) electronic file.
3. Contractor submittals shall be accompanied with a completed transmittal letter.
4. All Contractor transmittal letters submitted to the Engineer shall contain, as a minimum, the following information:
 - a) Prime Contractor's name;
 - b) City project name and project number;
 - c) Description of the information contained in the specific submittal;
 - d) Revision number;
 - e) Deviations from contract documents or specifications;
 - f) Submittal type;
 - g) Date of submittal.
5. Nonconforming submittals are subject to rejection by the Engineer.

203.3 TECHNICAL SUBMITTALS

A. Items shall include, but not be limited to, the following:

1. Manufacturer's specifications;
2. Catalogs, or parts thereof, of manufactured materials;
3. Shop drawings;
4. Bills of material and spare parts list;
5. Instruction books and operating manuals;
6. Material lists or schedules;
7. Materials testing results;
8. Current mix design information;
9. All drawings, catalog cuts, manufacturer's specifications and data, samples, instructions, and other information specified or necessary:
 - a) For the Engineer to determine that materials conform to the design and comply with intent of the contract documents.
 - b) For proper installation, operation, and maintenance of materials which the Engineer will review for general content but not for basic details.

B. Submittal Review Process:

1. Contractor shall check and approve submittals of subcontractors, suppliers, and manufacturers prior to transmitting them to the Engineer. Contractor's submission shall constitute a representation to the Engineer that the Contractor approves of the submittals and has determined and verified that all materials supplied meet the plans and detailed specifications, standard specification, quantities, dimensions, field construction and installation criteria, materials, catalog numbers, compliance with Laws and Regulations, and similar data, and Contractor assumes full responsibility for doing so; and Contractor has coordinated each submittal with the requirements of the work and the contract documents.
2. The Engineer shall respond within seven (7) working days of receiving the submittal.
3. The Engineer shall place a review action stamp on the submittal prior to returning to the Contractor. Review status designations listed on the Engineer's action stamp are defined as follows:
 - a) **No Exception Taken:** Signifies Material represented by the submittal conforms with the plans and detailed specifications and complies with the intent of the contract documents and is approved for incorporation in the work. Contractor is to proceed with fabrication or procurement of the items and with

related work.

- b) **Make Corrections Noted:** Signifies material represented by the submittal conforms with the plans and detailed specifications and complies with the intent of the contract documents and is approved for incorporation in the work in accordance with the Engineer's notations. Contractor is to proceed with fabrication or procurement of the items and with related work in accordance with the Engineer's notations.
 - c) **Revise and Resubmit:** Signifies Material represented by the submittal appears to conform with the plans and detailed specifications and comply with the intent of the contract documents but information is either insufficient in detail or contains discrepancies which prevent the Engineer from completing their review. Contractor is to resubmit revised information responsive to the Engineer's annotations. Correction shall be noted on the returned submittal and summarized in the letter of transmittal. Fabrication or procurement of items represented by the submittal and related work is not to proceed until the submittal is approved.
 - d) **Rejected:** Signifies Material represented by the submittal does not conform with the plans and detailed specifications or comply with the intent of the contract documents and is disapproved for use in the work. Contractor is to provide submittals responsive to the contract documents.
 - e) **Submit Specified Item:** Signifies item(s) within submittal are lacking detail and additional information for a specific item is required. Contractor is to submit such additional information to proceed.
4. Engineer may return either electronic copies or hard copies with their action stamp. If the Contractor is required to resubmit for review, the Engineer shall have an additional seven (7) days to review the re-submittal.
 5. Make all modifications noted or indicated by the Engineer and return the required number of revised submittals in the same fashion as the original submittal until approved. Contractor shall identify any changes to the submittal that are in addition to the modifications called for by the Engineer. Previously approved submittals transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, corrections shall be submitted for review.
 6. Any work related to items within the submittal performed prior to the Engineer's review shall be at the sole expense and responsibility of Contractor.
 7. A copy of approved submittals shall be kept at the job site.
 8. Engineer's review and approval will not extend to design data reflected in submittals which is within the special expertise of Contractor, Contractor's subcontractor(s), or suppliers. Review and approval of a component item as such

will not indicate approval of the assembly in which the item functions.

9. Engineer's review and approval of shop drawings, product data, or samples will not relieve Contractor of responsibility for any deviation from requirements of the contract documents unless contractor has in writing called the Engineer's attention to such deviation at the time of submission, and the Engineer has given written concurrence and approval of the specific deviation. Approval by the Engineer shall not relieve Contractor from responsibility for errors or omissions in submittals.

203.4 INFORMATIONAL SUBMITTALS

- A. Informational submittals are comprised of technical reports, administrative submittals, and guarantees which relate to the work, but do not require Engineer's approval prior to proceeding with the work. Informational submittals shall include, but not be limited to:

1. Shipping or packing lists;
2. Weigh tickets;
3. Job progress schedules;
4. Equipment and Material delivery schedules;
5. Requests for information (RFI);
6. Warranties and guarantees.

- B. **Transmittal of Informational Submittals:**

1. All informational submittals furnished by subcontractors, manufacturers and suppliers shall be submitted to the Engineer by Contractor unless otherwise specified.
2. Identify each Informational submittal by project name and number, submittal type marked thereon or in letter of transmittal. Unidentifiable submittals will be returned for proper identification.
3. At the time of each submission, call to the attention of the Engineer in the letter of transmittal any deviations from requirements of the contract documents.
4. Test Reports:
 - a) Responsibilities of Contractor, Owner, and Engineer regarding tests, inspections of equipment and materials, and completed work are set forth elsewhere in these specifications.
 - b) The party specified responsible for testing or inspection shall in each case,

unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute one copy of the test reports to the Owner, Engineer, and Contractor.

END OF SECTION

SECTION 205

TELEVISIONING

205.1 DESCRIPTION

- A. General:** This work consists of the televising of sanitary sewer mains and storm sewer mains and laterals. The Televising Contractor shall furnish all labor, materials, equipment, and incidentals to provide the televising, a National Association of Sewer Service Companies (NASSCO) – Pipeline Assessment Certification Program (PACP) compliant database, a NASSCO PACP standard video recorded in Moving Picture Experts Group (MPEG)-1 format, and a NASSCO PACP certified operator. All inspections shall be in accordance with current NASSCO PACP requirements and a NASSCO PACP database shall be submitted to the Engineer. All digital video files shall be color, closed circuit TV in MPEG-1 format. The Prime Contractor shall provide all inspection data of mains, manholes, junction boxes and inlets written to a single storage device to the Engineer within 48 hours of the televising work being completed.

Each video shall be permanently labeled with the following:

1. Project name / City Job number;
2. Date of television inspection;
3. Size of sanitary sewer or storm sewer;
4. Manhole numbers and Pipe segment numbers;
5. Storm sewer inlet and junction numbers;
6. Street/easement location;
7. Name of Televising Contractor and Utility Contractor;
8. Date video submitted;
9. Video file name;
10. NAASCO Inspector Name and certificate number.

The Contractor providing the televising services, herein referred to as the Televising Contractor, shall be independent from any underground utility contractor performing work for this project. The Prime Contractor will be required to submit the name(s) and NASSCO certificate number for the personnel performing the televising to the Engineer at the preconstruction meeting.

B. Related Work:

Section 7	General Conditions
Section 9	Sanitary Sewer
Section 54	Drainage Pipe Installation

205.2 MATERIALS

A. Equipment:

1. The television unit shall have the capability of displaying in color, on the video, pipe inspection observations such as pipe defects, sags, points of root intrusion, offset joints, service connection locations, and any other relevant physical attributes.
2. The television inspection equipment shall have an accurate footage counter which displays on the monitor the exact distance of the camera from the entrance of the pipe.
3. A camera with rotating and panning lens capabilities is required.
4. The camera shall have the ability to illuminate the interior of the pipe so the full pipe is clearly visible during televising procedures.
5. The camera height shall be centered in the pipe being televised.
6. The speed of the camera through the pipe shall not exceed 40 feet per minute.
7. The Televising Contractor shall be required to have all materials, equipment, and labor force necessary to complete all videotaping on the job site prior to isolating the sewer manhole segment and beginning videotaping operations.

205.3 CONSTRUCTION REQUIREMENTS

After completion of the utility work specified in the contract documents including sanitary service taps, and any undercut or dirt work required to achieve final cross section, but prior to placement of the granular surfacing, the newly constructed or rehabilitated sanitary sewer and/or storm sewer shall be televised and all inspection data submitted to the Engineer within 48 hours. Televising shall be observed by the Engineer and utility contractor, as the camera is run through the system. The Engineer shall notify the contractor of any necessary repairs required or the approval of the infrastructure within three (3) working days from the date the video was submitted.

Televising Contractor is to coordinate the video procedures including naming schemes for pipe segments, manholes, junction boxes and inlets with the Engineer and Utility maintenance personnel prior to commencement of any work, including mobilization to the project. The database must include all the televised segments for the entire project, or for each worksite. The Televising Contractor shall provide a line diagram sketch and written log for each completed segment of videoed sewer main describing the section being televised, flow and camera direction, recorded distances to center of service connections, the clock position of service connections, description and location of any defects, overall pipe condition, weather conditions, and other significant observations.

The method(s) used for securing passage of the camera are at the discretion of the Contractor, and as approved by the Engineer. The Televising Contractor shall not be allowed to float the camera. Flow in the section being televised shall be bypassed if the pipe is in service and the flow exceeds 25% of the internal pipe diameter. The Contractor shall pay the cost of any jetting or pre-cleaning of pipe segments as needed for televising. No additional payment shall be made for additional setups required.

All lateral connections shall clearly indicate distance to the center of the service connection and which side of the sanitary sewer main it was installed from. At each manhole, junction box, inlet or other related structure the contractor shall stop the camera and provide a full pan view of each structure to show all interior surfaces. Any issues with manholes, junction boxes, inlets or other related structures shall be identified on the report. Any abnormalities such as, but not limited to, misaligned joints, cracked/defected pipe, rolled gaskets, shall be clearly identified during the video and shall be repaired by the Contractor solely at their expense.

Any sections requiring repair for any reason shall be re-televised from manhole to manhole to verify condition of repair. The Contractor is solely responsible for any damage of sewer mains as a direct result of their televising operations, jetting and/or pre-cleaning operations. Any repair required shall be the responsibility of the Contractor. No separate and/or additional payment will be made for any excavation, man entry, or any other method which may be required to retrieve video equipment that may have been hung up, destroyed, and/or lost during the operation.

If the Televising Contractor provides a video of such poor quality that it cannot be properly evaluated, the Televising Contractor shall re-televising as necessary and provide a video of good quality at no additional cost to the City. If the Contractor cannot provide a video of such good quality that can be reviewed by the City, the City may elect to televise the line at the Contractor's expense.

When the depth of flow at the upstream manhole of the pipe section being worked is above the maximum allowable for television inspection, the flow can be reduced to allowable levels by performing bypass pumping, or other methods as approved by the Engineer.

If bypass pumping is required by site conditions or as per plan note, refer to Section 9 Sanitary Sewer for bypass pumping requirements.

205.4 METHOD OF MEASUREMENT

Measurement for televising shall be made by the linear foot to the nearest whole linear foot. Measurement shall be from center of Manhole or Structure to center of Manhole or structure and shall include any appurtenances installed as part of the contract documents.

205.5 BASIS OF PAYMENT

Payment will be made for the work done on the basis of the unit bid price per linear foot (LF) for "Video Inspection, Sanitary Sewer" or "Video Inspection, Storm Sewer" for total length of the utility regardless of diameter.

No additional payment will be made for any cleaning required for televising of the mains.

No additional payment will be made for re-televising or re-cleaning of the mains.

Bypass pumping required by the Contractor to complete the televising efforts will be incidental to the unit bid price bid per LF of "Video inspection, Sanitary Sewer".

END OF SECTION