Casper College
Josendal Road Reconstruction Project
(November 2015)

using the

City of Casper
Standard Specifications
for
Public Works Construction
and
Infrastructure Improvements

City of Casper
Casper, Wyoming

January, 2006
Casper College
Josendal Road Reconstruction
Project
(November 2015)

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City of Casper Standard
Specifications for
Public Works Construction and
Infrastructure Improvements

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GENERAL

The City of Casper Standard Specifications for Public Works Construction and Infrastructure Improvements, January 2006 Edition apply to this project. It should be noted however that the City of Casper has no involvement or jurisdiction over the project except for any standard permits required for this type of work within the Casper City limits. In any instance where the Standard Specifications indicate review or approval by the City of Casper, this may not be applicable and will instead refer to the Owner (Casper College).

DIVISION 100 – GENERAL CONSTRUCTION REQUIREMENTS

SECTION 101.12 City Permits

Permits required to be secured for this project by the Contractor shall include an Erosion and Sediment Control Plan as defined by Casper City Code. Contractor shall provide a copy of the plan and approved Permit to the Owner for information only.

SECTION 101.16 Design Mixes, Testing and Quality Assurance

Delete the two existing paragraphs in their entirety and replace with the following:

The testing requirements and cost responsibilities of design mixes, testing requirements, and quality assurance testing listed in each specific section of these specifications shall be revised such that it is the Contractor’s responsibility to provide all design mixes and quality control testing for the project. The Owner will provide Quality Assurance testing if deemed necessary.

Contractor shall employ a qualified testing laboratory to provide the quality control testing described in each specification section. Contractor’s testing firm shall provide Engineer with test results within 24 hours of completing tests.

END OF SPECIAL PROVISIONS
DIVISION 100

SECTION 101

GENERAL CONSTRUCTION REQUIREMENTS

101.01 Description.

To establish uniform requirements for construction of water distribution facilities, sanitary sewerage collection facilities, storm sewer collection systems, streets, and associated appurtenances which will enable the construction to be performed in accordance with Local, State, and Federal laws.

101.02 Definitions.

A. For the purposes of these specifications, the words and phrases set out in the following articles shall have the meanings as follows:

1. “City” means the governing body of the city of Casper, Wyoming.

2. “Contractor” means the individual, partnership, firm, or corporation contracting with the developer or the City which will be performing the work, or which will be performing the construction activities.

3. “Developer” means partnership, firm, or corporation developing property where construction will be performed.

4. “Engineer” means the consultant or project Engineer.

5. “Owner” means the individual, partnership, firm or corporation being the owner of record of property where construction will be performed.

6. “Underground facility” means any item of personal or public property buried or placed below ground for use in connection with the storage or conveyance of electronic, water, sewage, telephonic or telegraphic communications, cable television, electric energy, oil, gas, hazardous liquids, or other substances and including, but not limited to pipes, sewers, water, stormwater, conduits, cables, valves, lines, wires, manholes, and attachments.

B. The following abbreviations shall have the designated meanings:


4. “AASHTO” means the American Association of State Highway & Transportation Officials.

C. Reference to a specific specification, i.e., AWWA C900, means the latest Edition of that specification.

101.03 Scheduling and Construction Progress.

A. Prior to the start of any work, the Contractor shall submit in writing to the Engineer for review, a progress schedule that shall be followed as closely as possible. Progress scheduling using critical path method is approved and encouraged. Once work has started on a street, it must be pursued continuously until all work on that street is finished.

1. The Contractor shall schedule a preconstruction conference prior to the start of work. Persons attending shall include representatives of the Contractor, subcontractors, owner, developer, Engineer, and affected utilities.

B. Each successive phase of work will follow the preceding phase as closely as possible so that the time any one street is under construction is kept to a minimum.

C. In the event that the work is not being accomplished expeditiously or in accordance with the time period set forth in the progress schedule, or if the work on an excavation has ceased or is abandoned without due cause, the Engineer may give written notice to the Contractor and/or the surety company for the project.

101.04 Notification of Landowners, Residents, and Businesses

A. At least one (1) week prior to beginning construction operations Contractor shall notify in writing, all those directly affected by the Work, including the Fire, Ambulance, Police Departments, and the Engineer’s Office. The notification shall include the following as a minimum:

1. Name, address, telephone number, and contact person for Developer, Developer’s Contractor, Owner, and Engineer.

2. A brief description of the proposed Work.

3. Name and telephone number of Contractor’s person to contact in emergency.

4. A map showing the Work area, the traffic control plan, and the planned access to be provided to the affected properties. The map should also show the property or business owners’ access during construction, and access in case of
an emergency for fire, ambulance, police, or other emergency service agency vehicles.

5. A schedule for start up and completion of the Work. Schedules shall be updated as needed as the work progresses.

6. Contractor shall notify property owner and occupant 24 hours in advance of any disruption of service or access.

101.05 Available Maintenance Personnel

The Contractor shall have personnel available to maintain the Work as required, 24 hours per day every day. Accordingly, the Contractor shall furnish the City, the Owner, the Engineer, and the Casper Police Dispatcher with the names, addresses, and telephone numbers of local employees or representatives who will be available to maintain the Contractor’s work during non-working periods, evenings, nights, weekends, and holidays.

101.06 Utility Locates.

A. It is the responsibility of the Contractor to obtain locates for buried facilities within the project area prior to the start of work as necessary and as required by law. The Contractor is responsible for any damage to buried utilities or damage or injury to persons or property resulting from Contractor’s work in the vicinity of the utilities.

It is the responsibility of the Contractor to provide advance notice to all utility notification centers serving that area. The Contractor shall request the notification center to provide the nature, location, and elevation of the utility at each location and at whatever interval is necessary for the work. If the utility company cannot or will not provide the information, the Contractor shall obtain the information by whatever means are necessary. For each location that the utility is exposed, the Contractor shall locate the utility by tying it both horizontally and vertically by coordinates, to the datum established by the City.

B. At all utility crossings the Contractor shall locate the utility at a minimum of one point directly over the proposed line or appurtenance. When existing utilities that parallel the proposed line or appurtenance are exposed by excavation, the Contractor shall locate the utility by tying it both horizontally and vertically to the datum and include the information on the record drawings. At a minimum, the utility shall be tied horizontally and vertically at 300-foot (90 m) intervals.

C. If during the field location of the utilities, additional unforeseen utilities are discovered, the Contractor shall immediately notify the Engineer and proceed in accordance with approval of the Engineer. The utility must be located by the Contractor as specified above and include the information on the record drawings.
D. The Contractor must protect all existing utilities and improvements, public or private, located on the right-of-way, and other work areas, during the entire period of his work. Special care must be taken in backfilling and compacting under and around such improvements. Any breakage or damage to underground facilities caused by trenching, backfilling, resurfacing, or any other activity associated with the work shall be the responsibility of the Contractor.

E. Whenever utility mains or services are crossed, the utility owner shall be notified and the crossing shall be constructed in accordance with the utility owner’s requirements.

F. Before the Contractor begins his grading operations, he shall confer with the owners of any underground or overhead utilities which may be in or in close proximity to the grading areas, and shall arrange for the necessary disconnection of these utilities in accordance with the regulations of the utility companies concerned. The Contractor shall take such measures as the Engineer may direct in protecting these utilities properly throughout the period his grading operations are in progress. The party or parties owning or operating overhead or underground utilities shall perform the actual work of moving, repairing, reconditioning, or revising the utilities, except as otherwise specified in this Section. Whenever and wherever such operations are undertaken by the owners of utilities, the Contractor shall cooperate to the extent that ample protection of their work will be provided so that the entire work as contemplated may be expedited to the best interests of all concerned, as judged by the Engineer.

G. Protect and safeguard existing service lines and utilities structures, the locations of which have been made known to the Contractor by the owners of the utilities or by others, prior to excavation or construction of fills or embankments, from damage during grading operations. Any damage to such lines or structures shall be repaired at the Contractor’s expense. The above provisions are applicable to all service lines or utilities structures, all or any portion of which protrude above the original ground or street surfaces, or lie beneath such surfaces in any grading area or any other area upon which the Contractor has encroached.

101.07 Protection of Existing Buildings and Structures.

The Contractor shall guard against, and be responsible for, any movement, settlement, or collapse of adjacent buildings, sidewalks, structures, and underground or above ground utilities. The Contractor shall repair damage done to the owner's property or any other property, on or off the premises, by reason of his operations. The Contractor shall adequately brace walls during backfilling and compacting operations.
101.08 Construction Stakes – Alignment and Grades.

A. All work shall be constructed in accordance with lines and grades shown on the drawings and as designated by the Engineer. These lines and grades may be modified by the Engineer as provided in the General Conditions.

B. The Contractor shall provide experienced personnel, materials, and equipment necessary to complete all survey, layout, and measurement work. The Contractor shall keep the Engineer informed a reasonable time in advance, of the times and places he wishes to do work so that initial control points may be designated.

101.09 Restoration of Street Surface, Street Signs, Curbs, Driveways, Sidewalks, Irrigation and Landscaping.

A. Wherever existing improvements are removed, damaged or otherwise disturbed by Contractor’s activities, Contractor shall replace or repair the improvements to conditions equal to or better than the condition prior to the start of work. Any crushed rock, sod, or natural vegetation disturbed by the Contractor shall be replaced, rebuilt or restored to conditions equal to or better than the condition prior to the start of work.

101.10 Temporary Utilities, Public Access and Safety.

A. Contractor shall provide temporary water and sewer service to properties when permanent facilities will be out of service for eight (8) hours or longer, or when other circumstances make it necessary. Where service cannot be interrupted, such as sewer mains, Contractor shall provide plant and equipment to pump around the sections which are out of service.

B. Where the Engineer deems necessary, the Contractor shall provide access wherever possible to public and private property to prevent serious inconvenience to pedestrian and vehicular traffic. This shall not be construed to require the Contractor to provide such access at the times and locations where it will interfere with his construction progress. The Contractor shall furnish, place, and maintain sufficient flags, flares, barricades, signs, etc., along the location of his work in accordance with the Federal Highway Administration, "Manual on Uniform Traffic Control Devices." Flag persons shall be utilized if necessary to maintain safe traffic flow.

101.11 Erosion and Sediment Control

Erosion and sediment control shall be performed in accordance with Casper City Code Chapter 12.20 – Erosion and Sediment Control.
101.12 City Permits

All necessary permits shall be obtained prior to the beginning of any construction project. Those permits may include: City of Casper/WDEQ Permit to Construct, Excavation Permits, Traffic Control Permits, Bonds, and Erosion and Sediment Control Permit, as well as any other appropriate permits required for the project by the City.

101.13 Punchlist and Final Closeout

A. Initial City Punchlist

1. The Contractor, Owner, Engineer, and City personnel will conduct an initial walkthrough and develop a list of deficiencies that will be presented to the Contractor by the Engineer.

2. The Contractor, Owner, and Engineer will conduct a walkthrough identifying items to be corrected. A final punchlist will be developed by the Contractor and Engineer. The punchlist will contain dates for completion of the various identified items.

3. All items on the list will be completed to the satisfaction of the City prior to acceptance of the project and start of the one-year warranty period.

101.14 Submittals

The Contractor shall submit for approval by the Engineer a minimum of five (5) copies of data required by specific sections of this specification.

101.15 Workmanship and Cleanup.

A. All debris and rubbish caused by the operations of the Contractor shall be removed, and the areas occupied during his operations shall be left in a neat and presentable condition satisfactory to the Engineer. Construction cleanup and all backfill operations shall immediately follow installation of underground facilities. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc. During construction, all existing gutters, storm drains, runoff channels, etc. shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

B. Excess, unsuitable, and waste materials from the project (including that from trench excavation, pavement removal, curbwalk removal, and grading operations), shall be suitably disposed of, offsite, by Contractor.
C. Excess material resulting from parkway and shoulder finishing and other final operations shall not be permitted to accumulate on the pavement surface and shall be removed concurrently with the finishing operations. Care shall be taken to prevent the entrance of this material into drainage structures or other waterways during the construction period. It shall be the responsibility of the Contractor to properly dispose of all excess material.

101.16 Design Mixes, Testing and Quality Assurance.

The testing requirements and cost responsibilities of design mixes, testing requirements, and quality assurance testing are listed in each specific section of these specifications.

Unless specified by the contract documents, or addressed specifically within these Standard Specifications, the Owner will be responsible for moisture/density/compaction testing only. If the initial moisture/density/compaction test fails to meet the minimum standards as established by these specifications, the Contractor shall pay for any and all additional tests until a moisture/density/compaction test meeting the minimum standards is obtained.
201.01 Description.

This section covers work for all excavations, embankments, grading, parkway finishing, and incidental excavation items for street earthwork.

201.02 Definitions.

A. Unclassified Excavation Above Subgrade. Unclassified excavation above subgrade is defined as any material excavated above the subgrade elevation within the street right-of-way which is placed in fill or disposed of as directed by the Engineer, and any material taken from borrow pits and deposited as embankments or fill within the streets above the proposed subgrade elevation.

B. Relative Compaction. Relative compaction is defined as the ratio, in percent, of the as-compacted filled dry density to the laboratory maximum density. The laboratory maximum dry density is defined in accordance with ASTM D4253 and D4254, Method C. Corrections for oversize material will be applied as determined by the Engineer.

C. Optimum Moisture Content (OMC). Optimum moisture content is defined by ASTM D698.

D. Unclassified Excavation Below Subgrade. Unclassified excavation below subgrade is defined as any material excavated below the subgrade elevation within the street paving width which is placed in fill or disposed of, as directed by the engineer, and any material taken from borrow pits and deposited as embankment or fill within the street paving width below the proposed subgrade elevation.

E. Imported Borrow Excavation. Imported borrow excavation shall consist of excavation made from borrow areas inside or outside the project limits, and outside the normal grading limits for completion of embankments.

201.03 Excavation to Grade.

A. Excavation shall be made to grade dimensions and cross-sections as shown on the plans or as directed by the engineer. The top of the finished subgrade shall be of such smoothness that when tested with a ten foot (10') (3m) straight edge it shall not show any deviation in
excess of one-half inch (1/2") (12.5mm) from true grade as established by grade hubs or pins. Any deviations in excess of these amounts shall be corrected by loosening, adding, or removing materials, reshaping, and recompacting by wetting and rolling.

B. Excavation shall be done in two (2) stages. The first stage shall consist of the removal of material down to the top of the subbase. The second stage shall consist of removing the material from the top of the subbase to the top of the subgrade. When the first stage of excavation has been completed, the material at subbase grade shall be examined and inspected by the engineer. If the material at proper grade and depth conforms to or exceeds the requirements of material for subbase course, as specified in Division 400, Section 401, and as determined by the Engineer, further excavation will not be required and the subbase course will be omitted. If suitable subbase material is not encountered, the excavation shall be completed until suitable material is encountered.

C. When naturally existing subbase material is used, it shall be rolled, watered, and treated as specified in Division 400, Section 401 of these Specifications.

201.04 Subgrade Preparation.

A. Subgrade material shall be defined as that soil or other natural existing material in the street which supports the pavement. In the case of flexible type pavement, the subgrade shall be that surface supporting the prepared subbase, base, and surface course.

B. Excavation above subgrade shall be cut approximately one inch (1") (25mm) above subgrade and the subgrade shall be scarified six inches (6") (150mm) the moisture adjusted to within ±2% of optimum moisture content and compacted to at least 95% of maximum density as determined by ASTM D698. The compacted subgrade shall extend one foot (1') (.3m) beyond the outside edges of the pavement base course or from lip to lip of curbwalk gutter, if the latter is in place, and have a uniform density across the entire width of the street.

C. Excavation below subgrade shall be performed where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the engineer, will not provide a suitable foundation for the subbase or base course, the unsuitable material shall be removed to the depth specified by the engineer and replaced with acceptable material. Replacement material shall be moisture conditioned and compacted to a minimum of 95% maximum density, as determined by ASTM D698 and a moisture content of ± 2% of optimum.

201.05 Subgrade Protection.

During construction, subgrades and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained so as to drain effectively at all times. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped, and recompacted prior to
placing of subbase or base course. The storage or stockpiling of materials on the subgrade will not be permitted. No subbase course shall be laid until the subgrade has been checked, proofrolled, and approved by the Engineer. Under no circumstances shall subbase or base material be placed on a muddy subgrade.

201.06 Imported Borrow Excavation.

A. Where fill is required for embankment, the fill shall be composed of clean earth, sand, or gravel, free from vegetable matter or other objectionable foreign material. The area to receive fill shall be stripped of all vegetation and other unsuitable material before fill placement is started. Slopes shall have surfaces broken up in such a manner that fill material will bond with existing surface as directed by the Engineer. The fill shall be placed in layers not to exceed six inches (6") (150mm) compacted thickness eight inches (8") (200mm) loose thickness. The material in each layer shall be moistened to within ±2% of optimum moisture content as directed by the Engineer and shall be rolled until at least 95% of maximum density as measured by ASTM D698. When borrow is required, it shall be taken from a source approved by the Engineer. Fill shall be defined as imported borrow excavation.

B. All curbwalk shall be backfilled in the parkway (or shoulder) prior to laying any base course.

201.07 Parkway and Shoulder Finish.

Promptly after completion of curbwalk construction, the areas between the curbwalk and the property lines, shall be brought to a uniform, smooth grade, unless otherwise directed by the engineer. Hand raking may be required around trees and in areas where larger equipment cannot be used. Fill material placed in such areas shall be free from stones, sticks, or other materials which will be objectionable for seeding or sodding purposes. Backfill material shall be suitable for the growth of lawn grass. The backfill need not be compacted -- however, finished grade shall be left one inch (1") (25mm) high to allow for settlement. The Contractor shall maintain the parkway area until final acceptance.

201.08 Dust Control.

It shall be the responsibility of the Contractor to take such action as may be necessary to minimize pollution due to blowing dust. The normal method of dust control is spraying with water by means of a pressure water distributor. The Contractor shall provide on-site, at all times, a water truck to be used for dust abatement. If this method is used, care shall be taken to avoid development of mud holes and to avoid erosion. With the Engineer's approval, other methods of dust control may be utilized, such as hygroscopic materials. Such materials shall not be used if they may have a deleterious effect on future work to be accomplished on the surface to which they are applied, if they may harm vegetation with which they come in contact, if they may contribute to corrosion of metals, or if they are dangerous or irritating to humans or to animals.
201.09 Subgrade Proofrolling.

A. Before the placing of any type of hard surfacing on the finished subgrade, such subgrade shall be proofrolled with at least one pass of coverage for its full width and length with a self-propelled pneumatic roller. Ground contact pressure of all tires shall be 85-90 psi (585-621 kPa). At the discretion of the Engineer, the specified ground pressure may be lowered. When the proofrolling shows an area to be unstable, such area shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material.

B. Schedules for Proofrolling.

1. All utilities, including laterals or service pipes located under the street or the curb, gutter, and sidewalk, must be in place before the proofrolling operation is performed.

2. Proofrolling shall not take place more than 24 hours prior to the placing of the concrete for the curb, gutter, and sidewalk section, or the hot mix asphalt street section.

3. The Owner, City representatives, and Engineer must be notified, and approval of the base given, prior to the installation of any portion of the street section including curb, gutter, and sidewalk.
DIVISION 200  
SECTION 202  
CRACK SEALING

202.01 Description

The work consists of preparing and sealing random cracks in asphaltic concrete paving with hot-poured, elastic-type crack sealant.

202.02 Materials

The sealant shall conform to AASHTO M 173. The sealant manufacturer shall provide a written certification stating the quantity of sealant and that the sealant conforms to AASHTO M 173.

202.03 Preparation of Cracks.

A. Cracks less than three-eighths inch (3/8") (9mm) wide. For cracks less than three-eighths inch (3/8") (9mm) width, the crack shall be widened using a router to form a sealant reservoir which is one-half inch (1/2") (12mm) wide and three-quarters to one-inch (3/4" to 1") (20-25mm) deep.

1. The routed crack shall then be cleaned of dust, dirt, and other loose deleterious materials with oil-free compressed air. Cracks shall be dried with a compressed air heat lance immediately in advance of sealing. The heated air from the heat lance shall have a minimum temperature of \(2800^\circ F\) (\(1550^\circ C\)), and a minimum velocity of 2800 feet per second (850m/s). Direct flame driers shall not be used. Pavement shall not be oxidized or burned with the heat lance. The prepared cracks shall be inspected by the Engineer prior to sealing.

B. Cracks less than one-quarter inch (1/4") (6mm). Cracks less than one-quarter inch wide shall be sealed during the seal coating.

C. Cracks wider than three-eighths inch (3/8") (9mm) wide. Cracks wider than three-eighths inch (3/8") (9mm) in width shall be cleaned for the entire crack depth using sandblasting, brushing, and airblowing techniques as required to provide a crack free from all debris, dust, loose material, and moisture.

1. The routed crack shall then be cleaned of dust, dirt, and other loose deleterious materials with oil-free compressed air. Gouging or plowing may be required to remove incompressibles deep in the crack. Cracks shall be dried with a compressed air heat lance immediately in advance of sealing. The heated air from the heat lance shall have a minimum temperature of \(2800^\circ F\) (\(1550^\circ C\)), and
a minimum velocity of 2800 feet per second (850m/s). Direct flame driers shall not be used. Pavement shall not be oxidized or burned with the heat lance. The prepared cracks shall be inspected by the Engineer prior to sealing. The cleaned crack shall then be filled with sealant from the bottom up to surface level in a manner which does not result in sealant bridging or entrapped air pockets. With deep cracks, settlement of the sealant may occur, thus requiring application of a second layer of sealant material.

D. Depressed surface cracks. For cracks which have a depressed surface on each side of the crack, the crack shall be overfilled to level with the pavement surface and then "squeeged" to fill in the depressed area. The cracks shall be prepared as in paragraph B above.

202.04 Crack Sealing

A. Conditions

1. Crack sealing shall be done only when the weather conditions are dry, and in accordance with the sealant manufacturer’s recommendations. Two copies of the sealant manufacturer’s recommendations for preparation, handling, mixing, and application shall be furnished to the Engineer before beginning sealing.

B. Equipment

1. The equipment used for routing cracks shall produce a reservoir with vertical sides and a flat bottom. The pavement adjacent to the reservoir shall not show any signs of damage resulting from the routing operation. If the adjacent pavement is damaged, the Contractor shall alter the equipment and/or the procedure to eliminate the damage to the satisfaction of the Engineer.

2. The machine used to apply the sealant shall continuously maintain the recommended sealant application temperature. If the sealant temperature cannot be maintained while adding additional sealant, two sealing machines shall be used. The sealing machines shall be equipped with a positive-acting device to continuously agitate and mix the sealant during application.

C. Application Of Sealant

1. The sealant shall be applied to the crack from the bottom up. The sealant shall be recessed slightly below the pavement surface. Any excess material shall be smoothed tightly against the pavement surface.

2. The sealant shall not be tracked or pulled out during construction. Sealant damaged by tracking shall be replaced at the Contractor’s expense.
203.01 Description

The work covered in this article includes the furnishing of all materials, labor, tools and equipment to restore topsoil, seeding, and lawn restoration as described in the specifications.

203.02 Restoration of Lawn and Grassed Areas.

A. Any sod which is disturbed during the project or its appurtenances shall be replaced with similar sod including necessary topsoil, by the Contractor.

B. Top soil shall be replaced to a thickness equal to that removed up to a maximum of one foot (1’’ (300mm). No sod or seed shall be laid on less than four inches (4”’ (100mm) of topsoil. Topsoil shall be light friable loam containing a liberal amount of humus and shall be free from heavy clay, coarse sand, stones, plants, roots, sticks, and other foreign materials.

C. Sod shall be rolled within 24 hours after its placement with a roller that leaves the sod smooth and the joints properly closed. The new sod shall be trimmed neatly to match old sod, curbs, and walks. In all sod areas, the Contractor shall be responsible for ensuring adequate moisture until the new sod has properly established itself.

D. In other areas, the Contractor shall reseed as specified in the City’s Standard Specifications.

1. In general, Type 1 seeding shall be used in developed areas where the disturbed vegetation would not be classified as sod; Type 2 seeding shall be used in undeveloped areas having a “native” grass vegetation. After the trench has been backfilled as specified, the Contractor shall place four inches (4”) inches (100mm) of topsoil over the trench area, prior to Type 1, seeding. Topsoil is not required with Type 2 seeding. The area to be seeded shall be made smooth and uniform and shall conform with the finished grade.

2. The seedbed, if not loose, shall be loosened to a depth of from 1 to 2 inches (25-50mm) below finished grade. Seeds and fertilizers can be sown with standard agricultural drills, or other approved methods. Grass seeds may be sown broadcast or with a special seeder attachment on agricultural drills, but
shall not be covered with more than ½-inch (12mm) of soil, whether drilled or raked in. If not covered by the drill, all uncovered seed shall, immediately after sowing, be slightly raked or harrowed to cover the seed. No seed shall be broadcast during high wind.

3. Seeding shall not be done between November 15 and February 15, nor between July 1 and August 15, unless irrigated by sprinkler system. During other periods, the time of sowing shall be determined by the Engineer, whose decisions will be based on the moisture content of the soil and weather conditions.

203.03 Seed Specifications.

A. Type 1 seed shall be applied at the rate of 75 pounds per acre (84 kilograms/hectare). The seed mixture shall not contain in excess of 0.5 percent weed, 0.5 percent crop seed, and 6.0 percent inert matter and shall meet the following specifications:

<table>
<thead>
<tr>
<th>Name of Seed*</th>
<th>Percentage Seed by Weight</th>
<th>Minimum Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park Kentucky Bluegrass</td>
<td>30%</td>
<td>80%</td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>40%</td>
<td>75%</td>
</tr>
<tr>
<td>Perennial Ryegrass</td>
<td>30%</td>
<td>90%</td>
</tr>
</tbody>
</table>

All seed mixtures and seeding methods shall be submitted for approval.

*All seed shall be turf quality varieties.

Grass seed mixtures under brand names may be acceptable if they approach the above specifications and if accepted by the City Engineer.

B. Type 2 seed

1. Type 2 seed shall be as follows:

   (i) Streambank Wheatgrass - 8 lbs. pure live seed/acre (9 kg/hectare).
   (ii) Fairway Crested Wheatgrass - 8 lbs. pure live seed/acre (9 kg/hectare).
   (iii) Western Wheatgrass - 14 lbs. pure live seed/acre (16 kg/hectare).

203.04 Fertilization and Mulching

A. Fertilizer shall be applied in the amount to result in forty (40) pounds (45 kg/hectare) of available nitrogen per acre. Straw or hay mulch shall be applied in the amount of two (2) tons per acre (4492 kg/hectare). Cellulose hydromulch
shall be applied according to manufacturer’s recommendation.

203.05 WARRANTY

A. Weed control in planted areas shall be the responsibility of the contractor. Watering schedules of City-owned property shall be the responsibility of the contractor during the warranty period. Contractor shall coordinate water schedules with the City of Casper mowing operations.
DIVISION 200

SECTION 205

EXCAVATION, TRENCHING, AND BACKFILL FOR UNDERGROUND FACILITIES

205.01 Description.

The materials and work covered under this section shall cover excavation, trenching, and backfill for underground utilities, crossing streets, roads, or alleys which surfaces have been improved with asphalt, concrete, or gravel.

205.02 Submittals.

Before placement of control density backfill, the contractor shall provide to the engineer and/or owner for review, information on the product data, mixture composition, and material testing characteristics.

205.03 Definitions.

A. Control density backfill shall also be referred to as flow-fill, cement treated fill, non-shrink backfill or sand-cement slurry material. Controlled density backfill is a composite material that consists of water and a cement binding medium within which are embedded particles or fragments of aggregate.

B. "Underground facility" means any item of personal property buried or placed below ground for use in connection with the storage or conveyance of electronic telephonic or telegraphic communications, cablevision, electric energy, oil, gas, hazardous liquids, or other substances and including, but not limited to, pipes, conduits, cables, lines, wires, manholes, attachments, and those parts of poles below ground. Underground facility excludes water, sanitary, or storm sewer conveyance or storage systems covered under other sections of this specification.

205.04 Materials.

A. Cement. Cement shall conform to all requirements for cement set forth under Division 300, Section 301.

B. Aggregate. Aggregate shall consist of fine aggregate and shall conform to all requirements for fine aggregate set forth under Division 300, Section 301.

C. Admixtures. Pozzolan admixtures shall conform to all requirements for pozzolan admixtures set forth under Division 300, Section 301.
D. Pipe Zone Material. Pipe zone material shall conform to all requirements set forth under Division 600, Section 602 of the Standard Specifications.

205.05 Control Density Backfill Mixture Requirements.

A. Control density backfill shall meet the following requirements:

<table>
<thead>
<tr>
<th>Mixture Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Cement factor (lbs. per cubic yard) (kg/cu.m)</td>
</tr>
<tr>
<td>Pozzolan admixture (lbs. per cubic yard) (kg/cu.m)</td>
</tr>
<tr>
<td>Water cement ratio (gal. per sack) (lit/sack)</td>
</tr>
<tr>
<td>Slump (inches) (m)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum Compressive Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Break</td>
</tr>
<tr>
<td>7 day</td>
</tr>
<tr>
<td>28 day</td>
</tr>
<tr>
<td>28 day</td>
</tr>
</tbody>
</table>

B. The mix design for flow-fill can vary greatly provided that it meets a twenty eight day (28) compressive strength of between thirty and sixty pounds per square inch (30 – 60 psi) (210 – 415 kpa). An acceptable design can be found in section 02510 of the Wyoming public works standard specifications, “Portland cement treated mixtures”. The Engineer may modify this design to allow reject or recycled materials provided that the twenty eight day (28) compressive strength is confirmed by lab testing to be between thirty and 60 pounds per square inch (30 – 60 psi) (210 – 415 kpa). Non-specification material is not recommended for heavy loading or water and sewer crossings in which structural support depends on the flow-fills shear strength.

C. Air should be entrained at 1.5 – 2.5 % to improve workability.

205.06 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. Fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#) (43kg) shall be considered as one sack. The contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete.
cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

205.07 Measurement of Aggregate.

A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.

B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.

C. The contractor shall provide a sufficient number of fifty pound (50#) (23kg) standard test weights for calibrating the weighing equipment.

D. The volume of control density backfill mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.

205.08 Mixing Control Density Backfill.

A. Consistency. The quantity of water to be used shall be determined by the engineer and shall not be varied without his consent. The contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.

1. In general, the minimum amount of water shall be used which will produce the required workability.

B. Mixer. The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper
amount of water accurate to one percent (1%) and for automatically timing each batch of control density backfill so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered.

1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.

2. No materials for a batch of control density backfill shall be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregate, but shall not be started before the entrance into the drum of part of the aggregate. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregate is in the drum. The inside of the drum shall be kept free from hardened control density backfill.

3. Control density backfill from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the control density backfill contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Control density backfill from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the engineer. Any control density backfill shall comply with all of the requirements of these specifications. The control density backfill must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.

4. Hand mixing will not be permitted except with the permission of the engineer and then only in very small quantities or in case of an emergency.

205.09 Execution.

A. Excavation for Underground Facilities (General).

1. Excavate to the lines and grades shown, or as approved to accomplish construction. Allow for forms, working space, and materials types where required.

2. Do not excavate deeper than the elevations shown or approved. Excavations carried deeper than the elevations shown or approved shall be backfilled with approved compacted material. Excavation carried deeper than the elevations shown or approved shall be corrected by similarly cutting adjoining areas and creating a smooth transition to facilitate backfill and compaction. Backfill material type, placement, and compaction requirements shall be as determined by the engineer. The contractor shall bear all cost for correcting cuts below grade.
3. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material. The contractor shall correct any disturbance to underlying material by compacting soil material to at least 95% standard proctor, ASTM D698.

4. The engineer may direct excavations to be carried below the lines and grades shown on the drawings if, in the opinion of the engineer, such work is necessary to ensure adequate support of the proposed structure or pipe.

B. Dewatering

Dewatering, if required by site conditions, shall be provided by the contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12”) (300mm) or more below the bottom of the excavation.

2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

3. The contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

4. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (WDEQ). Before starting any construction, the contractor shall submit an application to discharge to the WDEQ along with this proposed dewatering plan for review. The application shall be submitted on “National Pollutant Discharge Elimination System, Application to Discharge From a Construction Project, Short Form E”. If the dewatering plan is revised during construction, a revised plan will be immediately sent to the WDEQ by Contractor. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the DEQ shall be notified immediately. The Contractor will then comply with WDEQ conditions.

5. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an
excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

C. Limits of Excavation

Conditions of the excavation permit may set limits of excavation designating the location of the completed utility and/or maximum dimensions of the excavation to prevent encroaching on adjacent improvements. Contractor shall confine excavation to those limits. Limits of excavation to safely accomplish the work shall be determined by the contractor. All excavations shall be free of overhangs and the sidewalls shall be kept free of loose material. As a minimum, slope all excavations to prevent these conditions and to comply with state OSHA regulations.

D. Disposal of Excess Material

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.

2. Dispose of broken concrete, rock and other debris resulting from utility construction activities in a legal manner, off-site.

205.10 Installation of Underground Facilities.

A. Trench Excavation.

1. Safety. The contractor shall not open up more trench in advance of the underground utility operations than what can be completely backfilled properly in one day's operation.

3. Asphalt and Concrete Removal. Where trench excavation or structure excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spadebitted air hammer, concrete saw, or similar approved equipment to obtain a straight, square, clean break. Concrete shall be cut at the location of standard joint spacing. One half inch (1/2”) (12.5mm) expansion joint material shall be installed between existing concrete and new concrete.

3. Limiting Pipe Zone Widths. Trenches shall be excavated to a width which will provide adequate working space and clearances for proper installation, jointing, and embedment of the underground utility. Excavated material shall be placed at a distance away from the sides of the trench equal to the depth of the trench. Install sheeting, shoring, bracing, and sloping as excavation proceeds.
B. Underground Utility Installation.

1. Reasonable care shall be exercised in handling and laying the underground utility materials and fittings. When strung along the trench, materials shall be placed where they will not be subject to injury from vehicles or equipment. The Contractor's facilities for lowering the utility into the trench shall be such that neither the underground utility materials nor trench will be damaged or disturbed.

2. Open excavation shall be satisfactorily protected at all times.

205.11. Trench Backfilling.

A. Trenches.

1. **Encasement Material.** Encasement material shall be placed to twelve inches (12") (300mm) above the utility, but in no case closer than twelve inches (12") to finish grade. Spread and surface grade encasement material to provide continuous and uniform support beneath the underground utility at all points. Encasement material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Encasement material shall be compacted to 90% maximum density, as determined by ASTM D698 at a moisture content of +3% of optimum for depths over forty-eight inches (48") (1.2m) below finish grade. Between forty-eight inches (48") (1.2m) below finish grade, compaction shall be a minimum of 95% of maximum density. Encasement material shall not exhibit pumping (horizontal or vertical displacement) after compaction.

2. **Trench Backfill Above the Encasement.** Trench backfill above the encasement material and below the subbase course of the roadway may be select material moisture conditioned to +2% to –4% of optimum and compacted to 95% of maximum density as determined by ASTM D698. From the bottom of the subbase course of the street section to the surface, the material and material thickness shall comply with applicable portion of the City of Casper Standard Specification for public works construction. Trench backfill above the encasement may consist of control density backfill (CDB) material. CDB material shall be used when trenching beneath asphalt or concrete paved streets. CDB material shall be placed into the excavated trench by means of concrete chutes or tremie tubes. CDB material shall be placed to the bottom of the asphalt mat. CDB material shall be vibrated using a mechanical vibrator to consolidate the material.

3. All trenches awaiting final paving shall be backfilled with properly compacted grading “W” base course. Paving shall be completed within two (2) weeks of the date the excavation was opened.

B. Care of Utilities. In excavating and backfilling for pipelines or structures, extreme care shall be taken so as not to damage or injure any adjacent gas, telephone, sewer, water, power, television lines, or other utilities. In the event of damage to a utility, the utility
owner and the City Engineer, shall be notified immediately. See Division 100, Section 101.06 for more detail on utility locates.

205.12 Pavement Replacement

Asphalt or concrete paving, curb and gutter and sidewalk construction shall comply with applicable sections of the City of Casper standard specifications.

205.13 Cleanup.

A. Construction cleanup and all backfill operations shall immediately follow installation of underground facilities. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.

B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

C. See Division 100, Section 101 for additional cleanup requirements.

205.14 Protection.

It shall be the responsibility of the Contractor to protect from damage all freshly poured CDB material regardless of the location or type of structure for a minimum period of seven (7) days from date of installation.

205.15 Quality Control Testing.

A. The owner or consultant shall employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to City Engineering Office, consultant, owner, and Contractor as soon as possible upon completion of tests.

1. Control Density Backfill. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.

   i. Tests may be required for each day's run or according to the following schedule:

<table>
<thead>
<tr>
<th>Total Cubic Yards of Control Density Backfill (cu.m)</th>
<th>Minimum Number of Tests (3 Cylinders Each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 100 (0-75)</td>
<td>One for 7 days, two at 28 days</td>
</tr>
<tr>
<td>100 – 1000 (75-760)</td>
<td>One for each 50 cu. yds. (40)</td>
</tr>
<tr>
<td>1000 – 2000 (760-1525)</td>
<td>One for each 125 cu. yds. (95)</td>
</tr>
<tr>
<td>2000 and Over (1525)</td>
<td>One for each 175 cu. yds. (135)</td>
</tr>
<tr>
<td></td>
<td>One for each 250 cu. yds. (190)</td>
</tr>
</tbody>
</table>

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i. Results of all tests shall be furnished to the engineer as soon as they are available.

ii. **Slump.** Slump tests shall be conducted in accordance with ASTM C172. A test shall be performed for each day’s pour of control density backfill and for each set of compressive strength tests.

2. **Compaction.** Compaction testing shall be performed a minimum of once for each trench, for each two hundred feet (200') (61m) of trench and for each material used including asphaltic cement paving.

**205.16 Standard Detail Sections.**

205/1 Standard Trench Detail for Utility Cuts
DIVISION 200
SECTION 206
TEMPORARY TRAFFIC CONTROLS

206.01 Description

To establish uniform requirements for detours, signs and barricades, and traffic control plans associated with construction activities performed on or affecting City of Casper streets. All traffic control work shall comply with the “Standard Specifications for Road and Bridge Construction,” Wyoming Highway Department, latest edition. The work in this article shall consist of furnishing, erecting, maintaining, relocating, and removing temporary traffic control devices at the locations specified on the drawings and as directed by the Engineer. All traffic control devices shall conform to the provision for construction signing as set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) latest edition.

206.02 Traffic Control Products

A. Sign Panels

1. Sign panels will be constructed of ¾” plywood conforming to plywood sign panels and barricades of the standard specification for road and bridge construction; or 6061-T6 or 5052-H38 aluminum alloy sheeting conforming to ASTM B209.

2. Wood sign panels will be backed with metal backing angles; except that backing is not required for those sign panels 48” x 60” or smaller.

3. Aluminum sign panels will be 0.125” thick and backed with metal backing angles; except that those sign panels 48” x 60” or smaller may be:
   i. 0.080” thick and backed with metal backing angles or 2 x 4 lumber; or,
   ii. Unbacked, 0.125” thick.

4. Special signs which are unique to the project, i.e., signs not shown on the plans or included in part VI of the MUTCD, and signs shown on the plans which contain a message that is unique to the project, will be furnished by the contractor, as specified on the plans, and erected by the Contractor. Posts and hardware for fixed special sign installations, and all equipment for portable special sign installations will be furnished by the contractor. Post lengths will be specified by the Engineer. Upon removal, the special sign panels, posts,
hardware, and portable installation equipment will remain the property of the Contractor.

i. Special signs will be erected on fixed mountings unless portable mountings are authorized by the Engineer.

B. Barrels will be plastic conforming to the MUTCD, with 6” wide reflective stripes.

C. Temporary markings

1. Temporary reflective pavement markings will be paint, preformed tape, or raised pavement markers, and will be suitable for use on either Portland cement concrete or asphalt pavements. Minimum acceptable standards are as follows:

   i. Paint used for temporary markings will be commercially manufactured highway striping paint. The paint will be applied without dilution.

   ii. All painted stripes will be 4” wide, and will be reflectorized by dropping or spraying glass beads onto the wet paint.

   iii. The reflective beads will conform to AASHTO Specification M247, type 1.

2. Temporary reflective pavement striping tape will be 4” wide, pressure-sensitive tape manufactured for use as pavement striping.

   i. Striping tape applied to finished pavement surfaces which will be returned to normal traffic use will be a removable type.

   ii. Striping tape applied to temporary pavement surfaces which will be obliterated may be a non-removable type.

   iii. Striping tape applied to the surface of intermediate lifts of asphalt pavement may be non-removable type, and may be let in place. If a removable type is used, it will be removed before placing the next lift.

3. Temporary retro-reflective raised pavement markers manufactured by Astro Optics of Schaumburg, Illinois, Model No. TPM, or Stimsonite Products of Niles, Illinois, Model No. 66, or an approved equal will be acceptable.

4. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Kent, Washington, Model NO. TRPM, or TOM, or an approved equal will be acceptable. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Kent,
Washington, Model No. TRPM, or TOM, or an approved equal will be acceptable.

206.03 Traffic Control Plans

A. A complete traffic control plan shall be submitted to the Engineer and the Casper City Engineering office at least one week prior to the start of construction.

1. Traffic will be permitted to use the street at all times, unless a detour is specifically permitted on the drawings or by the Engineer. Access to all abutting residences and properties shall be maintained to the maximum extent possible.

2. The Contractor shall construct and maintain temporary crossings, complete with flagmen, whenever necessary to expedite the work or to maintain traffic. The Contractor shall furnish not less than two flagmen at each location where loading or depositing of material requires the turning of the trucks on any highway or street and where the operation of construction equipment endangers traffic. Temporary crossings shall be of ample size to safely carry the load which comes upon them.

   i. The Contractor shall maintain the streets in a passable condition. The work shall be conducted so as to create a minimum of inconvenience to traffic.

   ii. Excavations which traverse a street shall be limited to one-half the width of the street at any one time, unless an emergency situation exists which requires that the entire width of the street be excavated. City Engineer’s office approval is required prior to excavation traversing an entire street.

3. The Contractor shall furnish sufficient signs and barricades to facilitate the directing of traffic. Unless directed otherwise by the Engineer, all signs and barricades shall conform to:


4. The Contractor shall have a sufficient number of barricades and signs on hand prior to the start of the construction

   i. Each detour sign shall be reflectorized and shall be illuminated with two battery-powered blinkers with six-inch (6”) amber lenses.

   ii. All barricades shall have blinker lights on each end.

   iii. It shall be the Contractor’s responsibility to make necessary checks and inspections of all lights and barricades every day, including Sundays and holidays.
5. Temporary suspension of work does not relieve the Contractor of the responsibility outlined in the above requirements.

206.04 Permits

A. The Contractor shall obtain all necessary permits from the City Engineer’s office for any closure of any street or portion thereof, as provided in the Casper Municipal Code. Along with the permit application, the Contractor shall provide a sketch showing traffic routing and traffic control devices to be used. The construction traffic control sketch shall be approved by the City Engineer’s office before the permit is issued.

206.05 Street Closure

A. The City Engineer may permit the closing of streets to all traffic for a period of time prescribed by the office if, in the City Engineer’s Opinion, it is necessary.
DIVISION 200

SECTION 207

TRAFFIC SYSTEMS

207.01 Description

This specification includes the requirements for the installation, equipment, and materials associated with traffic system installation.

207.02 Related Documents

All equipment furnished under this contract shall comply with Section 624 of the Standard Specifications for Road and Bridge Construction (Wyoming Transportation Department), as specified herein.

207.03 Foundation Concrete

The concrete for the foundations for the traffic signal supports, luminaire supports, and a traffic signal controller base shall be four thousand pounds per square inch (4000 psi) (27,600 kPa) concrete complying with the requirements of Division 300, Section 301.

207.04 Materials and Installation

A. One inch (1") (25mm) PVC Conduit, two inch (2") (50mm) PVC Conduit, four inch (4") (100mm) PVC Conduit.

1. Plastic conduit shall be placed as shown on the drawings, and shall be Schedule 40 type.

2. Conduit shall be jointed using a solvent welded slipfitter coupling to make a watertight joint.

3. Where plastic conduit runs are placed parallel to other conduit runs or cross over one another, they shall be separated by a minimum of three inches (3") (75mm) of sand or soil cushion. All bending of conduit shall be carefully done to avoid damage. Free ends of conduit shall be capped to prevent the entry of moisture, dirt, or rocks.

4. Plastic conduit shall terminate ten inches (10") (3m) from the top of pull box.
B. Pull Boxes

1. Pull boxes shall be of the type shown on the plans, and installed at locations shown. The contractor may, at his own expense, install such additional pull boxes that he may deem necessary to facilitate the work, with the approval of the Engineer.

2. The pull boxes shall be of the type as manufactured by “Armorcast.”
   a. Pull boxes shall be: Type “B” – thirty inches by seventeen inches by eighteen inches (30” x 17” x 18”) (.75m x 425mm x 450mm) (LxWxD).
   a. Pull boxes shall bear the wording “City of Casper” on the covers.
   iii. Pull boxes shall be placed on a crushed stone base, as shown on the details.
   a. This item includes excavation, placing of the pull box, electrical bond, backfill and repair of surface to the original condition.

C. Traffic Signal and Communication Cable

1. Cable shall be installed as shown on the plans and wiring schematics. For proper function of the signals, conductors shall be stranded copper conductors with spade type cramped terminals. Cable shall conform to International Municipal Signal Association (IMSA) Specification 20-1, 1984.

2. Cables shall be used as follows:
   i. 3C No. 14 AWG
      a. From controller cabinet junction box to pedestrian pushbutton on shaft. Direct runs to each support, no splices in pull boxes.
      a. 5C No. 14 AWG
      a. From terminal compartment or base of shaft to inboard signals on mast arms.
   iii. 7C No. 14 AWG
      a. From terminal compartment or base of shaft to signals at end of mast arm uprights.
iv. 15C No. 14 AWG

   a. Direct runs from traffic signal controller cabinet and pull box to terminal compartment or base of signal support shaft.

   b. No splices in pull boxes.

v. 6 Pair, No. 16 AWG Signal Communication Cable. For signal interconnect system.

3. At the controller cabinet and pullbox and base of support poles, cables shall be tagged to show their routing. Individual wires shall be tagged with branded type wire markers that conform to the terminal they hook to.

4. There shall be no splices of cables in pull boxes. Cable conductors shall terminate only at terminal block or base of signal supports.

5. Cable within cabinets, pull boxes, etc., shall be neatly arranged. Powdered soapstone, talc, or other approved lubricants shall be used when inserting cable in conduit. Before proceeding to pull cable in the underground conduit runs, the contractor shall clean all dirt or accumulations of moisture from conduit runs.

6. Cabinet pullbox and cabinet terminated by City staff.

D. No. 6 AWG, No. 8 AWG, and No. 10 AWG

1. Conductors shall be used for electrical service to the controller, street lighting, and equipment bonding and ground.

2. The conductor shall be stranded copper. The insulation for the conductor shall be THWN with a 600-volt rating.

3. Conductors shall be joined in pole bases or pull boxes using watertight connectors. Connectors shall be readily accessible in pole bases through the hand hole.

4. Fused connector shall be used only in pole bases to connect the service wires to the luminaire drop wire (3C No. 12 AWG). All drop wires from luminaries shall be 3C No. 12 AWG cable to the connectors in the pole bases. All fuses shall be the midget ferrule type rates at 10 amps.

E. Controller, Controller Cabinet and Base

1. The traffic signal controller shall be an Econolite ASC/2-2100 with the following:

   Section 207, Page 3 of 13
i. Conflict Monitor – EDI MMU-16E

ii. Load Switches – EDI 510 Series (12 Load Switches)

iii. Flasher – EDI 810 Series

2. The controller cabinet shall be a Type "TS" 2 Econolite cabinet, unpainted aluminum shot-blasted finish. The cabinet shall be completely NEMA compatible with the following features:

i. All necessary panels and harnesses for local and telemetry and ASC/2M master telemetry.

ii. Wire for eight (8) channels of intersection detection (Veh phase 1-8), eight (8) channels of system detection, and four (4) channels of 3M-Opticom detectors.

iii. Surge Arresters EDCD-No SHP or approved equal.

iv. Heating element mounted on insulated spacers against cabinet wall (not directly to cabinet metal). Heating element terminals to be unexposed or electrically insulated to prevent accidental short-circuiting.

v. Terminals of mercury switch to be unexposed or electrically insulated to prevent accidental short-circuiting.

vi. Provide a separate 15-amp single pole branch circuit (12 AWG THWN) and circuit breaker for the cabinet-heating unit.

vii. On-Auto time switch.

3. The base and concrete apron shall be sized appropriately for the equipment. The anchor bolt size and location shall comply with manufacturer’s recommendations.

4. Auxiliary Equipment

i. The following auxiliary equipment shall be placed in the cabinet, and wiring provided.

a. Model – US Robotics Sportstem 56 K

b. The opticom unit shall include the following:

   - phase selector model 752, and
optical detector model 721, 711 or 722 and opticom detector cable model 138 (length as required).

F. Traffic Signals, 3 Color, 1 Way, 12-12-12 and 12-12-12 w/BP

1. Traffic signals to be furnished and installed by the contractor are shown on the plan. Typical signal mounting is shown on the detail sheet.

2. The traffic signal indications shall meet or exceed the general specifications and definitions for adjustable signal heads as specified in the Institute of Transportation Engineers Technical Report No. 1, USAS D-10.1-1966, UDC 656.057, with latest revisions, or as specified or altered herein.

3. All mast arm mounted signals shall have minimum road clearance of nineteen feet (19’) (6m) to the bottom of the signal backplate.

4. The signal indication housing shall be made from die cast aluminum which is free of flaws, cracks, blow holes or other imperfections. Signal indication housings shall be constructed so that they can be individually attached to each other, are one piece, interchangeable, adjustable, and have holes top and bottom to receive a one and a half inch (1½") (37.5mm) fitting. Color: Federal Highway Yellow.

5. The optical unit shall consist of an LED lens of the appropriate size. The lens shall be of the color as shown on the plans. Each lens shall be a true to color.

   The twelve-inch (12") (300mm) diameter signals have LED traffic signal 120-volt bulbs.

6. Each signal indication shall have a tunnel (open bottom) visor made from sheet aluminum no less that 0.050 inch (0.050") (1mm) thick. The length of tunnel visors shall be twelve inch (12") (300mm) for twelve inch (12") (300mm) diameter indications.

7. Backplates shall be supplied that fit the signal heads and form a five-inch (5") (125mm) border around them. The backplates shall be louvered, made from aluminum and painted with a flat black synthetic backing enamel. Holes shall be drilled in the backplates so that they can be attached to the signal heads supplied.

8. All mast arm signals shall be supported with Astro-Brac as manufactured by Pelco Products Inc.

9. All brackets used for assembling and mounting signal indications are to be entirely weather-tight. All mounting brackets shall be made from no less than
one and a half inches (1½”) (37.5mm) I.P.S. pipe so that the traffic signal control wires can be threaded through them.

10. All mounting brackets shall be fabricated so that when placed in use they supply plumb or level support and are securely attached to the supporting structure.

11. A terminal compartment (12 terminals) shall be furnished with each mounting bracket for shaft mounted signals.

G. Traffic Signal/Luminaire Support, Signal Mast Arms, Luminaire Arms

1. The complete mast arm signal and luminaire support assembly shall consist of a tapered round shaft, a “sweep type” tapered round mast arm, anchor bolts, and necessary nuts and associated appurtenances to provide a complete installation.

2. The design shall be as to latest edition of Wyoming Transportation Department Standard Specifications for Road and Bridge Construction. Shop drawings shall comply with Section 501.03 of those specifications, and shall be approved by the City of Casper prior to manufacturing the signal supports. The shop drawings shall show assumed signal head and sign placement, with loading, in addition to the requirements of Section 501.03.

3. Supports shall be designed for a section head at end of all mast arms, with two inboard signals. Sign area design shall be for a minimum of seven and a half square foot (7.5 ft²) (7m²) of sign near the end of support, and ten square foot (10 ft²) (9m²) street sign at the connection of the shaft and mast arm.

4. Wire hand holes, four inches by six inches (4” x 6”) (100mm x 150mm) (7.5 ft²) (7m²) shall be located on the shaft, one approximately eighteen inches (18”) (450mm) above the base and one opposite the mast arm connection for feeding wire into the mast arm.

5. Finish shall be galvanized. Any damage in shipment shall be repaired or replaced to the satisfaction of the Engineer.

H. Loop Detectors, Prefab

1. The loop detectors shall be placed at locations by Engineering or the Traffic Department. Size of the loops is shown on the Loop Schedule.

2. Wiring for the loops shall be encased in one-inch (1”) (25mm) rigid PVC conduit of the shape as shown on the plans.

4. In place asphalt shall be removed to the base six inches (6") (150mm) outside the loop area. The area shall be resurfaced over the loops. Materials and workmanship shall be to City Standards.

I. Loop Amplifier, 4 Channel

1. The Vehicle Loop Detector Amplifier shall be 4 channels, contained in the same unit, of solid state construction, capable of detecting vehicles and motorcycles (digital) when passing over the loop areas placed in the pavement, as manufactured by the 3M Company, Model P824-OD, or approved equal.

J. Loop Lead-in Cable, 3M

1. The lead-in cable shall be Model CC-30003, as manufactured by the 3M Company. It shall consist of 4 No. 18 AWG stranded conductors enclosed in an aluminized shield and polyethylene jacket.

2. Connections of the cable to the loop detectors shall be made only in the pull box nearest the loop, using a waterproof connection.

K. Pedestrian Signal, ICC Unit

1. The pedestrian signal supplies shall be the unit as manufactured by Indicator Control Corp., Rancho Dominguez, California 90221, or approval equal.

2. The general construction of the Pedestrian Indications shall include a single piece cast aluminum housing, a sealed message module with a polycarbonate message lens, a single piece cast aluminum swing-down doorframe, and black-out egg crate type sun visor with clam shell mounting.

3. The approximate overall dimension of the signal shall be eighteen and a half inches (18½") (462mm) wide, eighteen and three/fourths inches (18¾") (460mm) high1, and nine inches (9") (225mm) deep, including egg crate type visor and hinges.

4. The message module shall be sealed into an integral assembly with a one-piece sponge neoprene gasket fitted around the perimeter to provide positive protection of the enclosed lighting from handling, weather, and moisture. The message display shall be Don’t Walk-Walk.
4. The message module shall be provided with electrical contacts which will plug directly into recessed contacts in the transformer enclosure when the module is in proper position, thus totally eliminating secondary high tension leads. Removal and insertion of the module shall not require the use of tools.

5. Each signal shall be provided with an egg crate type visor designed to eliminate sun phantom.

7. The case for pedestrian signals shall be dust proof, weatherproof, corrosion-resistant, and shall provide for easy access to and replacements of all components.

8. The case, doorframe, and egg crate visor (aluminum portion only) shall be thoroughly cleaned, and a chromate conversion coating applied inside and out per Military Specification MIL-C-5541. A synthetic enamel conforming to Military Specification IIE-520 shall then be electrostatically applied. The final finish shall be Flat Black for the door and face, and Federal Highway Yellow on other exterior areas.

L. Pedestrian Push Buttons

1. Pedestrian push buttons shall be furnished and installed by the contractor.

2. Pedestrian push buttons shall be installed on poles as indicated on the panels. Push buttons shall be located so that the arrow on the sign points in the direction of the pedestrian crossing, and so that the buttons are on the side of the pole most accessible to the pedestrian.

3. Signal standards shall be field drilled and tapped as required for wire entry and mounting of push buttons. The holes shall be treated with "Galvicon" (or an approved equal), per the manufacturer's directions, to protect against corrosion.

4. The pedestrian sign shall have the message as shown on the plans.

M. Opticom Cable

1. The Opticom control wire shall be M-138 Detector Cable as supplied by the 3M Company. The wire is 3-conductor No. 20 AWG, shielded cable with drain wire.

N. Aluminum Signs

1. Stop and yield signs shall be fabricated with 3m high intensity, all other sign faces and legends shall be fabricated 3M Reflective Engineering Grade, meeting FHWA specification FP74 level A.
2. All sign panels shall be .080 (2mm) thick anodized aluminum for signs less than six square feet (6 ft²) (5.5m²). Signs six square feet (6 ft²) (5.5m²) or larger shall have panels of .100 (2mm) thick anodized aluminum.

3. All standard signs shall be in accordance with the Manual Of Uniform Traffic Control Devices (MUTCD).

4. Sign attachments shall be Type "C" or "C", as shown on the plans, as to sign size. The signs are to be mounted on the mast arms and shafts as shown on the plans.

5. Ground mount signs shall be placed as directed by the Engineer. Mounting as to post size and attachment devices shall be to City Standards.

O. Luminaries, 250 W High Pressure Sodium Vapor (HPSV)

1. Luminaries shall be placed on each traffic signal/luminaire support. Luminaire assemblies shall be slipfitter type end mounting on a two-inch pipe tenon. Type M-N-III distribution, semi-cutoff shall be used on all luminaries. All luminaries shall be wired for 120 volts.

2. A photoelectric cell shall be part of each assembly, all units set to come on and off at approximately the same time.

207.05 Electric Service

A. Service shall be from the location shown on the plans.

B. Service equipment shall be for 120/240 volt, single phase service and include a meter base, surge protector and circuit breaker in NEMA 3R weathertight enclosure(s), of the type fabricated by Midwest Electrical Products.

C. The main circuit breaker shall be 60 ampere, two pole. Branch circuit breakers shall be 40 ampere single pole for traffic signals and 30 ampere single pole for roadway lighting. The meter base shall be the manual bypass type as required by Pacific Power Company (verify prior to releasing order).

207.06 Pavement Markings

A. Pavement markings shall be preformed for the crosswalk bars, arrows and messages, and pavement marking paint for lane lines, centerlines and other lines, as shown on the plans.

B. The preformed pavement markings shall be Stamark 5730 with Stamark P46 adhesive, as manufactured by the 3M Company. The markings shall be placed as shown on the plans or as directed by the Engineer.
C. Paint pavement markings shall meet the specifications of the Wyoming Department of Transportation for yellow and white paint, and shall be applied as to the same specification. The removal of the pavement markings in place shall be included under this item. Removal and placement of the pavement markings shall be as shown on the plans or as directed by the Engineer.

207.07 Sign Standards.

This guide will indicate the proper way to install City of Casper traffic signs and supports. Covered will be the installation process, materials used, mounting heights, locations and priorities.

A. Installation

The City of Casper currently uses the V-Loc telespar post system. The V-Loc base is driven into the ground with a special tool designed to fit the base. It is driven in flush with the surface and the square Telespar post is inserted into it using a special wedge to hold it in place. If the sign is to be installed in a concrete sidewalk, a piece of 6” PVC shall be placed in the ground prior to pouring. This will leave a free space to insert the V-Loc into the ground and leave room in case it must be removed later for any reason. This requires the fins to be cut off so it will fit. In the event of an installation in dirt, the fins shall be left intact. See the attached drawings.

B. Materials

The City of Casper uses the V-Loc sign support system manufactured by Tapco. It makes for easy installation and maintenance. The V-Loc holds the sign post in place using a metal wedge made by the same company. The sign support shall be a 12 gauge, 2” O.D. square perforated galvanized post. The perforations shall be 3/8” holes with 1” centers.

C. Mounting Heights and Positioning

All traffic signs in the City of Casper shall conform to the Manual of Uniform Traffic Control Devices. (See figure 2A-1 in the MUTCD) A typical positioning for a neighborhood sign shall be two feet (2’) (0.6 meters) from the edge of the curb to the nearest edge of the mounted sign. The sign shall be a minimum of seven feet (7’) (2.1 meters) from the ground to the bottom of the sign.
D. Priorities

If an intersection has or will have stop or yield signs installed, the roadway shall not be opened to traffic until all signs have been properly installed. Motorist and pedestrian safety is the highest priority.
V-LOC SIGN BASE FOR 2" SQUARE TUBING
16" PVC AND V-LOC MOUNTED FLUSH WITH SURFACE
FINS CUT OFF V-LOC WHERE INDICATED

2" PERFORATED
TELESER SQUARE
TUBING

V-LOC WEDGE

V-LOC

Section 207, Page 12 of 13
Figure 2A-1. Height and Lateral Location of Signs for Typical Installations

- Roadside Sign: Rural District
  - Not less than 1.8 m (6 ft)
  - Not less than 1.5 m (5 ft)

- Roadside Sign: Rural District
  - Not less than 1.8 m (6 ft)
  - Not less than 1.5 m (5 ft)

- Roadside Sign: Business or Residential District
  - Not less than 0.6 m (2 ft)
  - Not less than 2.1 m (7 ft)

- Roadside Assembly: Rural District
  - Not less than 1.6 m (6 ft)
  - Not less than 1.5 m (5 ft)

- Warning Sign with Advisory Speed Plate: Rural District
  - Not less than 1.8 m (6 ft)
301.01 Description.

This Article covers work necessary to furnish and place Portland cement. All terms and words used within this Article shall as be defined by ASTM C125.

301.02 Materials.

A. Cement.

1. Cement, Regular. Portland Cement shall conform to all requirements of the "Standard Specifications for Portland Cement," ASTM. Specification C150 for Type II modified, low C3A (less than 5%).

B. Fine Aggregate.

1. Fine aggregate for concrete shall consist of sand and shall conform to the following ASTM requirements, ASTM C33, ASTM C136, and ASTM D75.

   i. General Composition. Concrete sand shall be composed of clean (washed), hard, durable, uncoated grains, free from injurious amounts of clay, dust, soft flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall not contain appreciable materials which have unsatisfactory expansive properties when combined with Portland Cement and water. When required by the Engineer, expansion tests shall be made. Expansion shall not exceed 0.2 percent at age of one year as determined by ASTM Designation C-342.

   ii. Sieve Analysis. Fine aggregate shall be graded within the following limits:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>% Passing by Weight</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot; (9.5mm)</td>
<td></td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>No. 4 (4.75mm)</td>
<td></td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>No. 8 (2.36mm)</td>
<td></td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>No. 16 (1.18mm)</td>
<td></td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>No. 30 (600um)</td>
<td></td>
<td>25</td>
<td>60</td>
</tr>
<tr>
<td>No. 50 (330um)</td>
<td></td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>No. 100 (150um)</td>
<td></td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>No. 200 (75um)</td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>
Material shall be well graded and within the ranges stated above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples submitted by the Contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from a fineness modulus of the representative sample submitted by the Contractor, may be rejected. The fineness modulus is defined in ASTM Definition C-125.

- **Deleterious Substances.** The fine aggregate shall not contain more than the following maximum amounts of deleterious substances:

<table>
<thead>
<tr>
<th>Material</th>
<th>Max. % of Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps</td>
<td>1.0</td>
</tr>
<tr>
<td>Coal, lignite, or shale</td>
<td>1.0</td>
</tr>
</tbody>
</table>

  The sum of the above materials and other deleterious substances such as shale, alkali, mica, coated, grains, or soft and flaky particles shall not exceed 4% by weight.

iv. **Organic Impurities.** Fine aggregate subjected to the colorimetric test as per ASTM C40 for organic impurities and producing a color darker than the standard shall be rejected unless it passes the mortar strength test as specified in Section 301.03(B) Organic Impurities ASTM C40.

v. **Soundness.** Fine aggregate shall not have a loss greater than 15 percent weighted average loss at 5 cycles when tested in magnesium sulfate. Tests shall be made in accordance with ASTM C88.

C. **Coarse Aggregate.** Coarse aggregate for concrete shall consist of crushed stone or gravel and shall conform to the following requirements:

1. **General Composition.**

   i. **Broken stone** shall consist of clean (washed), hard, tough, durable fragments of rock (excluding schist, shale, or slate) of uniform quality throughout, shall be free from an excess of soft, thin, or elongated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the stone.

   ii. **Gravel** shall consist of clean, hard, durable uncoated pebbles and shall be free from soft, thin, or laminated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the gravel.

   iii. **Coarse Aggregate** shall not be obtained from sources of supply that contain appreciable percentages of material which is considered to have unsatisfactory expansive properties when it is combined with Portland Cement and water.
iv. **Percent Crushed Stone.** Not less than fifty percent (50%) of the coarse aggregate by weight shall have at least one (1) fractured face.

Expansion shall be considered excessive when it exceeds 0.2 percent at age of one year. ASTM Designation C-342.

2. **Sieve Analysis.** The coarse aggregate shall be graded within one of the following limits. Aggregates for concrete shall be combined in proportions that will provide a mixture within the grading limits shown below, unless otherwise approved in writing by Owner. Not less than fifty percent (50%) of coarse aggregate, by weight, shall have at least one fractured face.

<table>
<thead>
<tr>
<th>Nominal Size of Material</th>
<th>% Passing by Weight</th>
<th>1-1/2&quot;(37.5mm)Max.</th>
<th>3/4&quot;(20mm) Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 1/2&quot; (37.5mm)</td>
<td>---</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>Passing 1&quot; (25mm)</td>
<td>95</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Passing 3/4&quot; (20mm)</td>
<td>---</td>
<td>---</td>
<td>100</td>
</tr>
<tr>
<td>Passing 1/2&quot; (12.5mm)</td>
<td>25</td>
<td>65</td>
<td>---</td>
</tr>
<tr>
<td>Passing 3/8&quot; (9.5mm)</td>
<td>---</td>
<td>---</td>
<td>55</td>
</tr>
<tr>
<td>Passing No. 4 (4.75mm)</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Passing No. 8 (2.36mm)</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

3. **Deleterious Substances.** The coarse aggregate shall not contain more than the following maximum amounts of deleterious substances:

<table>
<thead>
<tr>
<th>Deleterious Substance</th>
<th>Max. % of Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps</td>
<td>0.5</td>
</tr>
<tr>
<td>Material passing No. 200 sieve</td>
<td>2.0</td>
</tr>
<tr>
<td>Shale or coal</td>
<td>1.00</td>
</tr>
<tr>
<td>Other deleterious substances such as friable, thin, elongated, or laminated pieces</td>
<td>3.0</td>
</tr>
</tbody>
</table>

The sum of the above and other deleterious material shall not exceed 5% by weight.

4. **Soundness.** When subjected to 5 cycles of the soundness test, as set forth in ASTM C88, the loss in weight of coarse aggregate weighted in accordance with the grading of a sample complying with the grading requirements specified, shall not exceed 18 percent when magnesium sulfate is used, 12 percent for sodium sulfate.

5. **Abrasions.** The coarse aggregate shall not have an abrasive loss greater than 40% as determined by ASTM C131.

D. **Water for Concrete.** The water shall be clean and free from objectionable amounts of oil, acid, alkali, organic matter, or other deleterious materials and shall not be used until the source of supply has been approved. If at any time the water from an approved source...
becomes of unsatisfactory quality or insufficient quantity, the Contractor will be required to provide satisfactory water from another source. Water of questionable quality shall be subject to the acceptance criteria of Table I, as specified in ASHTO T26.

E. **Air-Entraining Admixture.** The Contractor shall use a regular Portland Cement with the addition of an air-entraining admixture meeting requirements of ASTM C260. Air-entraining admixtures to be used in air-entrained concrete shall be Darex AEA, Neutralized Vinsol Resin, and Protex, or any other air-entraining agent meeting the approval of the Engineer. Air-entraining admixtures shall contain no chlorides. The air-entraining characteristics of the admixture, in suitable proportions in combination with Portland Cement, fine aggregate and water, within the limits of the proportion specified, shall be such that the resulting concrete will have a satisfactory workability, and the total air content shall be as herein specified for the concrete as determined by ASTM Test C-138 or by the air meter.

F. **Chemical Admixtures.** Chemical admixtures shall conform to ASTM C494, except TYPE C accelerating admixtures shall contain no chlorides, shall be non-toxic after thirty (30) days, and shall be compatible with air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

G. **Pozzolan Admixture.** Pozzolan admixture shall conform to the requirements of ASTM C311 and ASTM C618-85 (including Table IA) for either Class C or Class F. The amount of fly ash shall not exceed 15 percent of the total weight of flash ash plus cement.

### 301.03 Sampling and Testing Materials.

A. **Cement.** Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specifications, provided the cement is the product of a mill with a record for production of high quality cement. Certificates of compliance shall be furnished the Engineer by the Contractor, for each lot of cement furnished prior to use of cement in the work. This requirement is applicable to cement for job-mixed, ready-mixed, or transit-mixed concrete. Cement proposed for use where no certificate of compliance is furnished, or where, in the opinion of the Engineer, the cement furnished under certificate of compliance may have become damaged in transit or deteriorated because of age or improper storage, will be sampled at the mixing site and tested for conformance to the specifications.

1. Cement will be approved for use if it satisfactorily passes the fineness, soundness, and time of set test requirements specified, provided the general run of materials has been satisfactorily meeting the 28-day strength requirements. Any approved cement failing to pass the 28-day strength requirements, if unused, shall be rejected. If, in the judgement of the Engineer, it is considered necessary, other lots of shipments from the same mill may be held for the results of tests before being used.

2. If cement is supplied from a new source or from a source of unknown quality, it may be held for the results of strength test before being approved.

B. **Fine and Coarse Aggregate.** At least two (2) weeks in advance of the beginning of concrete
work the Contractor shall submit to an approved materials testing laboratory approximately five hundred pound (500#) (225kg) samples of each concrete aggregate proposed for use. All tests which are necessary to determine the compliance of the concrete materials with these specifications shall be performed on these samples. These samples shall also be used by the laboratory as the basis for a concrete mix design. The results of all tests and the concrete mix design shall be submitted to and approved by the City Engineer prior to the start of any concrete work. Standards shall conform to the latest applicable codes. The sampling and testing shall conform to the following standard procedures:

**FINE AGGREGATE**

<table>
<thead>
<tr>
<th>Sampling Aggregates</th>
<th>ASTM D75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Analysis</td>
<td>ASTM C117</td>
</tr>
<tr>
<td>Organic Impurities</td>
<td>ASTM C40</td>
</tr>
<tr>
<td>Fineness Modulus</td>
<td>ASTM C136</td>
</tr>
<tr>
<td>Soundness</td>
<td>ASTM C88</td>
</tr>
<tr>
<td>Clay Lumps</td>
<td>ASTM C142</td>
</tr>
</tbody>
</table>

*Potential Volume Change of Cement Aggregate Combinations*  
ASTM C342

* If required by Engineer.

**COARSE AGGREGATE**

<table>
<thead>
<tr>
<th>Sampling Aggregates</th>
<th>ASTM D75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Analysis</td>
<td>ASTM C136</td>
</tr>
<tr>
<td>Percent Passing No. 200 Sieves</td>
<td>ASTM C117</td>
</tr>
<tr>
<td>Clay Lumps</td>
<td>ASTM C142</td>
</tr>
<tr>
<td>Soundness</td>
<td>ASTM C88</td>
</tr>
</tbody>
</table>

*Potential Volume Change of Cement Aggregate Combinations*  
ASTM C342

* If required by Engineer.

### 301.04 Storage of Materials.

#### A. Cement

The Contractor shall provide adequate protection for the cement against dampness. No cement shall be used that has become caked or lumpy. Accepted cement which has been held in storage more than 90 days after shipment from the mill shall be retested, and if failing to meet the requirements specified herein shall be rejected.

1. Accepted cement which has been stored in approved sealed bins at the mill for not more than six (6) months may be used without further testing unless a retest is specifically requested by the Engineer.

#### B. Aggregate

Aggregates shall be handled and stored in separate piles at the site in such manner as to avoid a separation of the coarse and fine particles and contamination by foreign materials. Sites for stockpiles shall be prepared and maintained in such a manner as to prevent the mixing of deleterious materials with the aggregate. The Contractor shall deposit material in stockpiles at the batching plant site until the moisture content becomes uniform. Stockpiles
shall be built in layers not to exceed three feet (3') (1m) in height, and each layer shall be completed before beginning the next one.

1. Coning or building up stockpiles by depositing the materials in one place will not be permitted. The storing of aggregates in stockpiles, or otherwise, upon the subgrade or shoulders will not be permitted.

301.05 Concrete Mixture Requirements.

A. The concrete shall meet the following requirements:

<table>
<thead>
<tr>
<th>TABLE OF CONCRETE REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Cement factor</td>
</tr>
<tr>
<td>Water-cement ratio</td>
</tr>
<tr>
<td>Entrained air</td>
</tr>
<tr>
<td>Slump</td>
</tr>
</tbody>
</table>

Volume Ratio of Fine to Total Aggregates

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>Ratio</td>
<td></td>
</tr>
<tr>
<td>1” (25mm) Aggregate</td>
<td>0.40</td>
<td>0.55</td>
</tr>
<tr>
<td>3/4” (20mm) Aggregate</td>
<td>0.35</td>
<td>0.50</td>
</tr>
<tr>
<td>1/2” (12.5mm) Aggregate</td>
<td>0.30</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Minimum Compressive Strength

<table>
<thead>
<tr>
<th>28 day</th>
<th>psi(kPa)</th>
<th>4000 (27,600)</th>
</tr>
</thead>
</table>

1. If it is found impossible to produce concrete having the required air content with the materials and mixing procedures that are being used, the Contractor shall make such changes in the materials or mixing procedures, or both, as may be necessary to insure full compliance with the requirements of air content in the concrete.

2. The total weight of aggregates per sack of cement and the relative proportions of coarse and fine aggregate shall be determined by yield tests made during the progress of the work. The Engineer may, at his discretion, adjust the laboratory mix design to obtain the proper yield, and consistency of concrete.

3. The Contractor shall receive written permission from the Engineer prior to adding Pozzolan admixture to Portland Cement Concrete.

4. Any combination of aggregates which requires the use of more than six and one-half
gallons (6.5g) (25l) of water per sack of cement to produce a workable mixture, with the brand of cement used will be considered as being unsatisfactory, and all such combinations of aggregate will be rejected.

5. Coarse aggregate having moisture absorption of more than 1.0 percent (1%) (as computed from oven dry to saturated surface dry basis) shall be saturated with water before it is used. The wetting shall be performed sufficiently in advance to permit complete filling of the open pores of the particles of aggregate.

6. Concrete shall be uniformly plastic, cohesive, and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface. Workability shall be obtained without producing a condition such that free water appears on the surface when finished. The consistency of the mixture shall be that required for the specified conditions and methods of placement; however, the previously determined maximum water cement ratio shall not be exceeded.

7. The properties of the concrete mixture will be determined by the Engineer to insure compliance with these specifications. Modifications will be made in the material proportions as are necessary to provide satisfactory concrete. The above properties will be determined by the following methods:

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump</td>
<td>C143</td>
</tr>
<tr>
<td>Weight Per Cubic Foot, Yield</td>
<td>C138</td>
</tr>
<tr>
<td>Compressive Strength of Cylindrical Concrete</td>
<td>C39</td>
</tr>
<tr>
<td>Making and Curing Concrete Test</td>
<td>C31</td>
</tr>
<tr>
<td>Specimens</td>
<td>C231</td>
</tr>
<tr>
<td>Air Content by Pressure Method</td>
<td>C618</td>
</tr>
</tbody>
</table>

301.06 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. The coarse and fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#) (43kg) shall be considered as one sack. The Contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete. When the cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

301.07 Measurement of Aggregate.
A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2.3kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.

B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.

C. The Contractor shall provide a sufficient number of fifty-pound (50#) (23kg) standard test weights for calibrating the weighing equipment.

D. The volume of concrete mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.

E. When the aggregates are delivered to the mixer in trucks, each batch shall be in a separate compartment of the capacity required by the Engineer. Suitable covers shall be provided for the batch compartments of the trucks to protect the cement from the wind. All trucks, truck bodies, bulkheads, and compartments used in proportioning and transporting to the mixer of concrete materials shall be so designed and operated to insure the charging of the mixer, batch by batch, with the proper amounts of each material without overspillage, intermixing of batches or wastage. Any units which, in the opinion of the Engineer, do not operate satisfactorily, shall be removed from the work until properly rebuilt and corrected.

301.08 Mixing Concrete.

A. **Consistency.** The quantity of water to be used shall be determined by the Engineer and shall not be varied without his consent. The Contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.

1. In general, the minimum amount of water shall be used which will produce the required workability. The mortar shall cling to the coarse aggregate and shall show no free water
when removed from the mixer.

B. **Mixer.** The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper amount of water accurate to one percent (1%) and for automatically timing each batch of concrete so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered. If the time device becomes broken or fails to operate, the Contractor will be permitted to continue the balance of the day without the timing device while the same is being repaired, provided that each batch of concrete is mixed two (2) minutes.

1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.

2. No materials for a batch of concrete shall be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregates, but shall not be started before the entrance into the drum of part of the aggregates. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregates are in the drum. The inside of the drum shall be kept free from hardened concrete.

3. The use of mixers having a chute delivery will not be permitted except by permission of the Engineer. In all such cases the arrangement of chutes, baffle plates, etc., shall be such as will insure the placing of fresh concrete without segregation.

4. Ready-mixed concrete from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the concrete contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Ready-mixed concrete from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the Engineer. Any ready-mixed concrete shall comply with all of the requirements of these specifications. The concrete must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.

   i. Hand mixing will not be permitted except with the permission of the Engineer and then only in very small quantities or in case of an emergency.

5. In using air-entraining admixtures, the mixer shall be equipped with a suitable automatic dispensing device which will proportion the air entraining admixture accurately to each batch of concrete. The device shall be calibrated and adjusted to deliver to each batch of concrete the quantity of admixture required to produce the specified air content in the concrete.

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6. The manufacturer of the concrete shall furnish to the purchaser with each batch of concrete before unloading at the site, a delivery ticket specifying information as outlined in Section 16.1 ASTM C94. The purchaser shall provide the Engineer with one (1) copy of each delivery ticket.

301.09 Protection.

It shall be the responsibility of the Contractor to protect from damage all freshly poured concrete regardless of the location or type of structure for a minimum period of seven (7) days or for such longer period as the Engineer may direct. Any concrete which is damaged shall be repaired to the satisfaction of the Engineer prior to acceptance of the completed work.

301.10 Quality Control Testing.

A. The Owner or Consultant will employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to Consultant, Owner, and Contractor as soon as possible upon completion of tests.

1. Compressive Strength Tests. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.

2. Tests may be required for each day’s run or according to the following schedule:

<table>
<thead>
<tr>
<th>Total Cubic Yards of Concrete Placed (m(^3))</th>
<th>Minimum Number of Tests* (3 cylinders each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 100 (0-75)</td>
<td>One for 7 days, two at 28 days</td>
</tr>
<tr>
<td>100 – 1000 (75 -750)</td>
<td>One for each 50 cu. Yds. (38m(^3))</td>
</tr>
<tr>
<td>1000 – 2000 (750 – 1500)</td>
<td>One for each 125 cu. Yds. (100m(^3))</td>
</tr>
<tr>
<td>2000 and Over (1500)</td>
<td>One for each 175 cu. Yds. (125 m(^3))</td>
</tr>
<tr>
<td></td>
<td>One for each 250 cu. Yds. (200 m(^3))</td>
</tr>
</tbody>
</table>

*One test per pour minimum.

iii. Results of all tests shall be furnished to the Engineer as soon as they are available.

2. Slump. Slump test shall be conducted in accordance with ASTM C172. A test shall be performed for each day’s pour of each type of concrete and for each set of compressive strength test.

5. Air Content. Air content shall be tested in accordance with ASTM C143 or ASTM C231. Air content test shall be performed for each set of compressive strength tests of each type of air-entrained concrete.
DIVISION 300
SECTION 302
CONCRETE CURB, CURB AND GUTTER, CURBWALK
VALLEY GUTTERS, SIDEWALK, AND DRIVEWAYS

302.01 Description.

The work covered by this section consists of furnishing all equipment, labor, and materials necessary for constructing concrete curb, curb and gutter, curbwalk, valley gutters, sidewalks, and driveways on natural or prepared subgrades and bases, completed in accordance with the following specifications and dimensions shown on the plans.

302.02 Materials.

A. Portland Cement Concrete. Portland Cement Concrete shall conform to the requirements specified under Division 300, Section 301.

B. Reinforcing Steel and Fibers.
   1. Reinforcing steel for concrete reinforcement shall meet the requirements of ASTM A615, Grade 60.

   2. Welded wire fabric for concrete reinforcement shall meet the requirement as ASTM A185. Mesh shall be welded plain cold-drawn steel wire fabric.

   3. Reinforcing Fibers. Concrete reinforcing fibers shall be polypropylene collated, fibrillated fibers designed and engineered specifically for use as secondary reinforcement for concrete, shall be three-quarter inch (3/4") (20mm) to one inch (1")(25mm) in length and be manufactured by Fibermesh Company, Forta Corporation, or approved equal.

C. Preformed Expansion Joint Material. Preformed joint material shall comply with the requirement of ASTM D994, ASTM D1751, or ASTM D1752.

D. Leveling Base Course. Base course materials, if specified, shall conform to the requirements of sand with less than 10% passing No. 200 sieve.

E. Forms. Concrete forms shall be wood, steel, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Forms shall be coated with a non-staining agent that will not discolor or deface surface of concrete.
F. **Curing Compound.** Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.

G. **Foundation Material.** Refer to Division 600, Section 602.

H. **Aggregates.** Course and fine Aggregates shall meet the requirements of ASTM C33 and Article 2. Concrete mix under this Section shall meet one and one half inch (1½") (37.5 mm) sieve size, as specified in Division 300, Section 301.

**302.03 Subgrade and Base.**

A. **Natural Subgrades.**

1. The subgrade shall be cut to a depth below finish grade sufficient to accommodate the thickness of a leveling base course and concrete specified. The upper eight inches (8") (200mm) of the subgrade shall be compacted to a dry density of at least 95% of maximum dry density as determined by ASTM D698 at a moisture content of ± 2% of optimum. The finished surface of the subgrade shall be smooth, free from surface irregularities, and true to line and grade as established by grade hubs or pins.

2. Compaction tests shall be performed a minimum of every one hundred fifty feet (150') (45m) of curb walk or side walk, once for each valley gutter, and once for each driveway not part of a section of curb walk being tested.

3. Trenches crossing curbwalk, valley gutters, or other concrete paving within the City right-of-way shall be compacted the full depth of the trench in accordance with Division 601.06. This applies to all trenches installed for any purpose.

B. **Prepared Subgrades with Select Backfill.**

1. Where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the Engineer is unsuitable for subgrade, such unsuitable material shall be removed to a minimum of twelve inches (12") (300mm) below the four inch (4") (100mm) thick leveling base course, and replaced with foundation material. The Engineer may direct the Contractor to excavate deeper than the specified twelve inches (12") (300mm). All select backfill material shall be compacted to 95% of maximum dry density, as determined by ASTM D698 at a moisture content of ± 2% of optimum. Any boulders encountered shall be removed. Tree roots shall be removed at least one foot (1') (300mm) laterally and twelve inches (12") (300mm) vertically below all prepared subgrades.
C. Proof Rolling

Subgrades shall be proof rolled after compaction testing requirements have been passed and prior to placement of the leveling base course. Proof rolling shall be performed in the presence of the Engineer and a representative of the City Engineer’s office.

D. Leveling Base Course.

1. Just prior to placement of concrete, the four inch (4") (100mm) thick leveling base course shall be accurately graded to conform to the grade of the forms, and sprinkled if necessary until the moisture content is at or near optimum moisture content. Optimum moisture content shall be determined by the Engineer in accordance with ASTM D698. In no case shall concrete be placed on a saturated base or if free water is standing on the base.

302.04 Forms.

A. All forms shall be of wood or metal, straight, free from warp, and of sufficient strength when staked to resist the pressure of the concrete without springing, and the upper edge shall form a true line. Outside forms for the curbwalk shall be of a depth equal to the full depth of the sidewalk, and the inside forms shall be of the depth of the gutter and shall be so designed as to permit secure fastening to the outside form. All forms shall be cleaned thoroughly and greased or oiled before concrete is placed against them. Forms that have become worn, bent, or broken shall not be used. Forms shall be securely set true to line and grade.

B. On short radii curves, steel plates, which can be readily formed to the desired radii, shall be used. Face forms, if used, shall be preshaped to the proper radii. Care shall be exercised to insure the maintenance of the required cross-section around the entire radius.

C. The Contractor shall provide an approved metal straight edge, ten feet (10’) (3m) in length for use in checking the alignment of the forms prior to placing the concrete and also to check the concrete surface during the finishing operation. Forms and the final product shall not deviate more than one-quarter inch (1/4”) (6.25mm) from a straight edge ten feet (10’) (250mm) in length and shall be sloped to achieve complete drainage without “bird baths.”

D. Forms shall remain in place at least twelve (12) hours after concrete has been placed against them or for a longer period if so directed by the Engineer. Crowbars or other heavy tools shall not be used against green concrete in removing the forms. Forms shall be well cleaned before reoiling and reuse.

E. Screed guide templates shall be pulled prior to the concrete taking initial set. In those cases where initial set takes place prior to pulling of the templates, the joint shall be sealed with an asphaltic sealing compound approved by the Engineer.
302.05. Protection.
Protect fresh concrete from deleterious effects of weather and from traffic until adequately cured. Concrete shall not be placed on frozen subgrade or when weather is stormy, dusty, or otherwise inclement to the point that it precludes good workmanship. Air temperature shall be a minimum of 40°F (4°C) and rising when the pour is started. Adequate measures shall be employed to protect the concrete from freezing for a period of at least seventy-two (72) hours after it is poured. Concrete may be placed when air temperature is below 40°F if conditions stated in the Section 513.4.2 of the Standard Specifications for Road and Bridge Construction, Wyoming Department of Transportation, 2003 Edition are followed.

302.06. Joint Construction.

A. Expansion Joints. All expansion joints shall be constructed straight, plumb, and shall extend through the full width and depth of the section. Expansion joint material shall be flush with the finished surface to three-quarters inch (3/4") (20 mm) below the finished surface. Edges adjacent to expansion joint material shall be tooled. Expansion joints shall be constructed at the intersection with any existing curbwalk or curb and gutter, at the tangent point of curb radii, at alley returns, and at intermediate intervals of not more than sixty feet (60') (18m) or at such lesser spacing as may be determined by the Engineer.

B. Contraction Joints. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals of five feet (5') (1.5m). Joint depth shall average at least one-fourth (1/4) of the cross-section of the concrete.

1. Contraction joints may be sawed, handformed, or made by one-eighth inch (1/8") (3mm) thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be handformed either by 1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete; or, 2) inserting one-eighth inch (1/8") (3mm) thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete.

2. After removal of templates and finishing, contraction joints shall be reopened with a mason's trowel to a depth of one-fourth (1/4) the thickness of the section, the line of cut coinciding with and extending into the joint formed by the template. The joints shall be finished with a jointer.

C. Construction Joints. At end of day's run, or in case of an interruption which would result in cold joint, construction joints shall be made at right angles to the longitudinal axis of the curbwalk and shall be located at the regular five foot (5') (1.5m) spacing designated for contraction joints unless otherwise specifically permitted by the Engineer. In no case shall any length of curbwalk be less than five feet (5') (1.5m) between joints.

1. Construction joints shall be formed by use of a bulkhead or divider which shall be removed before continuing with the next run. Edges of construction joints shall be edge

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tooled to form a recess for sealing compound.

302.07. Concrete Placement.

A. Concrete shall be placed either by an approved slipform/extrusion machine, by the formed method, or by a combination of these methods. Concrete shall not be placed until base courses and forms have been checked for depth and alignment. The method used shall adequately vibrate and compact the concrete to achieve a homogeneous dense concrete free from honeycomb and pockets of segregated aggregate.

B. Machine Placement. The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

C. Formed Method. Construct forms to the shape, lines, grades, and dimensions called for in the Drawings. Set wood or steel forms securely in place, true to line and grade. Forms shall be braced to prevent change of shape or movement in any direction resulting from the weight of the concrete during placement. Tops of forms shall not depart from grade line more than one-fourth inch (1/4") (6.25mm) when checked with a ten-foot (10') (3m) straightedge. Alignment of straight sections shall not vary more than one-fourth inch (1/4") (6.25mm) in ten feet (10') (3m).

302.08. Finishing.

A. Finishing shall be done with a metal screed or mule designed to give proper shape to the section as detailed. Particular care shall be used to finish the gutter flow line to a true, uniform grade that will drain completely without “bird baths”. The back of the curbwalk and toe of the gutter shall be edge tooled. Traffic surfaces shall be broom finished at 90° to the direction of traffic. All honeycombed areas or small defects shall be patched with 1:2 mix mortar.

B. After stripping forms, exposed concrete surfaces shall be finished smooth and even by means of a moist wood float or a moist brick.

C. Sides of concrete exposed by the removal of forms shall be protected immediately to provide continuance of curing and preventing injury to the edge and the underlying subgrade. After the forms have been removed, suitable fill material shall be placed along the edge of the walk and tamped by either hand or mechanical tampers to a density at least equal to that of the adjacent ground. The finish grade and section shall be as indicated on the drawings and to the satisfaction of the Engineer.
302.09 Curing

Concrete shall be sprayed uniformly with curing compound immediately after finishing of the surface and before the set of the concrete has taken place. Curing compound shall be applied at the manufacturer’s recommended rate. Curing compound shall also be applied immediately to the exposed concrete once forms have been removed. See section 302.02 for approved curing compounds.

302.10 Jointing New and Existing Curb Sections.

Where the new curbwalk sections will join existing curb or curbwalk with a different cross-section, a five foot (5') (1.5m) long minimum transition section shall be constructed.

302.11 Fiber Reinforced Concrete.

Where specified or approved by the Engineer, provide polypropylene fibers added to the concrete mix to control shrinkage cracks. Polypropylene fibers shall be added at the rate of three pounds (3#) (1.4 kg) of fiber per cubic yard of concrete. Fibers shall be added to the concrete in accordance with the manufacturer's recommendations.

302.12 Standard Detail Section

302/1 Standard Curbwalk Details for Existing Construction
302/2 Standard Curbwalk and Sidewalk Details
302/3 Standard Pathway Sections
302/4 Typical Concrete Curb and Gutter Section
302/5 Typical Concrete Curb and Gutter Section
302/6 Typical Curb Cut Section for Existing Construction
302/7 Driveways, Approaches & Median Cuts for ADA Accessibility
302/8 Standard Valley Gutter Sections
302/9 General Sidewalk Requirement for ADA Accessibility
302/10 Type I Perpendicular Curb Ramps for ADA Accessibility
302/11 Type II and Type III Curb Ramps
302.13 Cutting and Patching of Asphalt Paving.

When curb cuts, curb walk, or other concrete structures are installed adjacent to existing asphaltic concrete paving, the asphalt paving shall be saw cut parallel to and a minimum of eighteen inches (18") (450mm) away from the edge of the concrete. The excavation between the concrete and the asphalt paving shall be backfilled with a minimum of four inches (4") (100mm) of asphalt placed and compacted in two lifts over a minimum of six inches (6") (150mm) of compacted grading “W” base course. Base course and asphaltic concrete paving shall comply with City of Casper standard specification. Where the existing pavement and base course sections exceed the minimums specified above, the replacement thickness shall match the existing.

302.14 Colored Concrete

Colored concrete shall match the color of the concrete installed for curb ramps for ADA accessibility on other City projects. The color required is Solomon No. 489 Maroon dye added to City of Casper standard six (6) sack, 4,000 psi mix at a rate of 25 pounds per cubic yard.
DIVISION 300

SECTION 303

PORTLAND CEMENT CONCRETE PAVEMENT

303.01 Description.

This work shall consist of constructing a pavement composed of Portland cement concrete constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or designated by the Engineer.

303.02 Materials.

A. Materials shall meet the requirements of Division 300, Section 301.

B. Joint Fillers and Sealers. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening satisfactory to the Engineer.

1. Poured sealer for joints shall conform to the requirements of ASTM D3406-75T unless otherwise shown on the plans.

2. Elastic Joint Sealer, where called for on the plans, shall be two component polyurethane or polysulfide-base sealant meeting the physical flow characteristics, and strength requirements of A.N.S.I. A116.1-1060.

   i. Sealant for horizontal joints may be either Class A (self-leveling) or Class B (non-sag). Sealant for sloped or vertical joints shall be Class B.

3. Preformed joint filler shall conform to the requirements of AASHTO M-213 unless otherwise shown on the plans, and shall be punched to admit the dowels where called for on the plans.

4. Preformed Compression Joints shall be manufactured to the size and shape shown on the plans, from materials conforming to the requirements of ASTM D-2628.

   i. The Contractor shall furnish a certification for each shipment of joints indicating that the material has been sampled, tested, and inspected in accordance with the provisions of ASTM D-2628. Each certification so furnished shall be signed by an authorized agent of the manufacturer or independent testing agency.
ii. If recommended by the manufacturer, an approved lubricant-adhesive may be used to provide lubrication and bond for the joint. The lubricant shall be manufactured of material that is compatible with the sealer.

1. **Curing Materials.**

Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.

**303.03 Construction Requirements – Proportioning.**

A. The Engineer shall determine the proportions of the materials to be used that will produce a workable concrete having a maximum slump of three and one-half inches (3 ½") (88mm), and the design flexural strength. The cement content shall not be less than 6.0 sacks per cubic yard. The water content including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be not more than 5.3 gallons (20l) per sack of cement (water-cement ratio of 0.47).

B. The percentage of air entrained in the mix shall be $6 \pm 1$ percent.

C. When aggregates proposed for use on the project have been approved for use, the Engineer will designate the cement content per cubic yard; the maximum water-cement ratio; entrained air content; and the consistency of the mix. The cement content shall be that which an Independent Testing Laboratory has determined to be required for use with the particular combination of aggregates. The exact proportions will be based upon trial mixes with the materials to be used in the work and will be so adjusted to produce concrete of the required plasticity and workability. The proportions will be stated in terms of aggregates in a saturated, surface-dry condition, and the batch weights will have to be adjusted periodically to take into account the actual moisture content of the aggregates at time of use.

D. The designated proportions shall govern during the progress of the work, except as provided below in Paragraphs 1 through 4, inclusive.

1. If the cement content of the concrete varies by more than two percent (2%) from the designated value, the proportions will be adjusted by the Engineer so as to maintain a cement content which does not vary more than two percent (2%) from the designated value.

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2. If it is found impossible to obtain concrete of the desired plasticity and workability with
the proportions originally designated by the Engineer, he will make such changes in
aggregate weights as required, provided that in no case shall the cement content
originally designated be changed except as provided below in Paragraphs 3 and 4.

3. If it is found impossible to produce concrete having the required consistency without
exceeding the maximum allowable water-cement ratio specified, the cement content
shall be increased as directed by the Engineer so that the maximum water-cement ratio
will not be exceeded.

4. No change in the sources or character of the materials shall be made without due notice
to the Engineer, and no new materials shall be used until approved by the Engineer and
he has designated new proportions based upon independent laboratory tests and trial mixes.

**303.04 Equipment.**

A. Equipment and tools necessary for handling materials and performing all parts of the work
must meet the approval of the Engineer as to design, capacity, and mechanical condition,
and the equipment must be at job site sufficiently ahead of the start of construction
operations to be examined thoroughly and approved.

1. Batching Plant and Equipment.

   i. **General.** The batching plant shall include bins, weighing hoppers, and scales for the
   fine aggregate and for each size coarse aggregate. If cement is used in bulk, a bin,
   hopper, and separate scale for cement shall be included. The weighing hopper shall
   be properly sealed and vented to preclude dusting during operation.

   ii. **Bins and Hoppers.** Bins with adequate separate compartments for fine aggregate
   and for each size of coarse aggregate shall be provided in the batching plant.

   iii. **Scales.** The scales for weighing aggregates and cement shall be of either the beam
type or the springless-dial type. They shall be accurate within 0.5 percent
throughout the range of use. When beam-type scales are used, provision, such as a
"tell-tale" dial, shall be made for indicating to the operator that the required load in
the weighing hopper is being approached. A device on weighing beams shall
indicate critical position clearly. Poises shall be designed to be secured in any
position and to prevent inadvertent change. The weigh beam and "tell-tale" device
shall be in full view of the operator while the hopper is charged, and he shall have
convenient access to all controls.

   a. Scales shall be tested as often as the Engineer may deem necessary to assure
their continued accuracy. The Contractor shall have on hand not less than ten
50-pound (22.5 kg) weights for frequent testing of all scales.
iv. Batching plants may be equipped to proportion aggregates and bulk cement by means of automatic weighing devices of an approved type.

B. Mixing.

1. General. Concrete may be mixed at the site of construction or at a central point, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

2. Mixers at Site of Construction. Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge level when the drum has been charged and release it at the end of the mixing period.

   i. The mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down one inch (1") (25mm) or more. The Contractor shall: 1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth; or 2) provide permanent marks on blade to show points of one inch (1") (25mm) wear from new condition. Drilled holes of one-fourth inch (1/4") (6.25mm) diameter near each end and at the midpoint of each blade are recommended.

C. Finishing Equipment.

1. Finishing Machine. The finishing machine shall be of an approved type.

2. Vibrators. Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute, and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators.

   i. When spud-type internal vibrators, either hand-operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.
D. **Concrete Saw.** When sawing joints is elected or specified, the Contractor shall provide soft-cut sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel at the required rate. The contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

E. **Forms.** Straight side forms shall be made of a metal having a thickness of not less than 7/32 inch (6mm) and shall be furnished in sections not less than ten feet (10') (3m) in length. Forms shall have a depth at least equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to not less than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of one hundred-foot (100') (33m) radius or less. Flexible or curved forms shall be of a design acceptable to the engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two-thirds (2/3) the height of the form.

1. Forms with battered top surfaces, and bent, twisted, or broken frames shall be removed from the work.

2. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the project is less than two thousand square yards (2,000 sq.yds) (1700 sq.m). The top face of the form shall not vary from a true plane more than one-eighth inch (1/8") (3mm) in ten feet (10') (3m), and the upstanding leg shall not vary more than one-fourth inch (1/4") (6.25mm). The forms shall contain provisions for locking the ends of abutting form sections together tightly, and secure setting.

**303.05 Preparation of Grade.**

After the base has been graded and compacted, in accordance with the provisions for the material specified, the grade shall be trimmed approximately to correct elevation.

**303.06 Setting Forms.**

A. **Base Support.** The foundations under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with granular material and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting, as necessary.

A. **Form Setting.** Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than three pins for each ten foot (10')
(3m) section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than one-fourth inch (1/4”) (6.25mm) at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

C. Grade and Alignment. The alignment and grade elevation of the forms shall be checked and corrections shall be made by the contractor immediately before the concrete is placed. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

D. Curbs and Gutters as Forms. In lieu of setting forms, the edge of a previously placed concrete gutter section may be used as a form.

303.07 Conditioning of Subgrade or Base Course.

A. Prior to setting forms, the subgrade shall be prepared in accordance with Division 200, Section 201, Division 400, Sections 401 and 402.

B. When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross section. Low areas may be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

C. The subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

303.08 Handling, Measuring, and Batching Materials.

A. The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Aggregates from different sources and of different gradings shall not be stockpiled together.

B. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least twelve (12) hours before being batched. Rail shipment requiring more than twelve (12) hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or nonuniform moisture content, storage, or stockpile periods in excess of twelve (12) hours may be required by the Engineer.
C. The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts set by the engineer in the job mix. Cement shall be measured by the sack or by weight. Separate scales and hoppers shall be used for weighing the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds (94#) (43kg) of bulk cement shall be considered one sack. Batches involving fractional sacks shall not be allowed, except when bulk cement is used.

D. When required by the contract, or when permitted, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved types.

E. Methods and equipment for adding air-entraining agent or other admixtures into the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixer with an accuracy of ±3 percent.

303.09 Mixing Concrete.

A. The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. Ready-mix concrete shall be mixed and delivered in accordance with requirements of AASHTO M-157.

B. When concrete is mixed at the site of the work or in a central mixing plant, the mixing time shall not be less than fifty (50) seconds nor more than ninety (90) seconds. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be completely removed before a succeeding batch is emptied therein.

C. The mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to ten percent (10%) above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

D. The batch shall be so charged into the drum that a portion of the mixing water shall enter 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 fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

E. Mixed concrete from the central-mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks having special bodies. The time elapsing from the time
water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed forty-five (45) minutes when the concrete is hauled in nonagitating trucks, nor ninety (90) minutes when hauled in truck mixers or truck agitators.

F. Retempering concrete by adding water or by other means will not be permitted, except that when concrete is delivered in transit mixers or agitators, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer, providing the following conditions are met:

1. Maximum allowable water-cement ratio is not exceeded;

2. Maximum allowable slump is not exceeded;

3. Maximum allowable mixing and agitating time (or drum revolutions) are not exceeded; and,

4. Concrete is remixed for at least half the minimum required mixing time or number of revolutions.

G. Concrete that does not meet the above provisions shall be rejected. Admixtures for increasing the workability or for accelerating the set will be permitted only when specifically provided for in the contract.

303.10 Limitations of Mixing.

A. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

B. Unless otherwise authorized, the temperature of the mixed concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40° F(4° C) and not resumed until an ascending air temperature in the shade away from artificial heat reaches 35° F(1.7° C).

C. When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible concurrence of overheated areas which might injure the materials.

D. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F(10° C) and not more than 90° F(32° C) at the time of placing it in the forms.

E. If the air temperature is 35° F(1.7° C) or less at the time of placing concrete, the Engineer may require the water or the aggregates or both to be heated to not less than 70° F(21° C)
nor more than 150° F (66° C). No concrete shall be placed on frozen subgrade, nor shall frozen aggregates be used in the concrete.

303.11 Placing Concrete.

A. The concrete shall be deposited on the grade in such manner as to require as little rehandling as possible. Unless truck mixers, truck agitators, or non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly-mixed concrete with boots or shoes coated with earth or foreign substances.

B. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained 80% of design strength.

C. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days.

D. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than fifteen (15) seconds in any one location.

E. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

F. Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

303.12 Testing.

A. The Contractor shall furnish the concrete necessary for testing and shall cooperate fully with the Engineer in obtaining the material for testing purposes. Unless otherwise provided, the concrete shall be sampled, specimens made, and compliance determined in accordance with the following:

<table>
<thead>
<tr>
<th>Test</th>
<th>Standard</th>
</tr>
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<tbody>
<tr>
<td>Slump</td>
<td>AASHTO T-119</td>
</tr>
<tr>
<td>Air content (gravel or stone)</td>
<td>AASHTO T-152</td>
</tr>
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<td>(Wyoming Modified)</td>
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</tbody>
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B. The beams will be cured in the field by the method specified for the pavement.

303.13 Strike-Off of Concrete and Placement of Reinforcement.

A. Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans or established by the engineer. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than thirty (30) minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed by mechanical or vibratory means in plastic concrete, after the concrete is spread.

B. Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which would impair bond of the steel with the concrete.

303.14 Joints.

A. Joints shall be constructed of the type and dimensions, and at the locations required by the Engineer.

1. Longitudinal Joint. Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints when shown on the plans. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.
i. Longitudinal formed joints shall consist of groove, or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the plans and while the concrete is in a plastic state. The groove, or cleft, shall be sealed with either a premoulded strip or poured material as required.

ii. The longitudinal sawed joints shall be installed so that their ends are in contact with the transverse joints, if any.

iii. Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the plans. Suitable guide line or devices shall be used to assure cutting the longitudinal joint as shown on the plans. The longitudinal joint shall be sawed before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned using both water and compressed air. All pieces of concrete and aggregate and residue left from the sawing shall be removed from the joint immediately. Care shall be taken so that the depth of cut is uniform. Sealing shall then proceed as soon as the joint is dry.

iv. Longitudinal joints may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete. The joint insert material shall be a strong, nonstretchable, three (3) mil thick, two-inch (2") (50mm) wide, polyester tape of such character, that when placed vertically in the concrete, it will not bond with the concrete and will form an effective weakened plane joint of two-inch (2") (50mm) minimum depth.

v. The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material as placed. The joint material shall be placed in such manner that the top of the strip is not above nor more than one-fourth inch (1/4") (6.25mm) below the finished surface of the concrete. After placement, the vertical axis of the joint material shall be within ten degrees (10°) of a plane normal to the surface of the pavement. Final alignment of the strip shall be uniformly parallel with the center line of the pavement and shall not vary more than one inch (1") (25mm) from the edge of a twelve foot (12') (3.5m) straightedge. The installation device shall be designed to consolidate the concrete about the joint material. After installation of the joint material, the concrete shall be free of segregation, rock pockets, or voids, and the finished concrete surface on each side of the joint shall be in the same plane.

1. Transverse Expansion Joints. The expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint
filler shall be furnished in lengths equal to the pavement width or equal to the width of one (1) lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

i. The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure performed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one-fourth inch (1/4") (6.25mm) in the horizontal alignment from a straight line. If joint fillers are assembled in section, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

3. Transverse Contraction Joint. Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the plans, shall include load transfer assemblies.

i. Transverse strip contraction joints shall be formed by installing a parting strip to be left in place.

ii. Formed grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

iii. Sawed construction joints shall be created by sawing grooves in the surface of the pavement of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw.

a. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually four (4) to twenty-four (24) hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing, and sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. All contraction joints in lanes and adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions exist which make it impracticable to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above.

b. When directed by the Engineer, random cracks shall be routed or sawed and filled with joint sealer. The sawed area shall be thoroughly cleaned using both water and compressed air. All pieces of concrete and aggregate and residue left from the sawing shall be removed from the joint immediately. Care shall be taken...
taken so that the depth of cut is uniform. Sealing shall then proceed as soon as the joint is dry.

iv. Transverse Formed Contraction Joints. These joints shall comply with the requirements for the longitudinal formed joint.

v. Transverse Construction Joints. Transverse construction joints shall be constructed when there is an interruption of more than thirty (30) minutes in the concrete operations. No transverse joint shall be constructed within five feet (5') (1.5m) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least five feet (5') (1.5m) long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

4. Load Transfer Devices. Dowels, when used, shall be held in position parallel to the surface and centerline of the slab by a metal device that is left in the pavement.

i. The portion of each dowel on only one side of the joint shall be painted with one (1) coat of lead or tar paint, and shall be thoroughly coated with an approved lubricant, to prevent the concrete from binding to that portion of the dowel. An approved metal dowel cap or sleeve shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly.

ii. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

303.15 Final Strike-Off, Consolidation, and Finishing.

A. Sequence. The sequence of operations shall be the strike-off and consolidation, floating, and removal of laitance, straight-edging, and final surface finish.

1. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

B. Finishing at Joints.

1. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also 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.

2. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage to or misalignment of joints. If uninterrupted operation of the finishing machine, to, over,
and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be lifted and set directly on top of the joint and the forward motion of the finishing machine shall be resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, the screed shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without the screeds being lifted, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

C. **Machine Finishing.** Unless otherwise permitted for small areas or for short periods of time due to equipment failure, all pavement concrete shall be vibrated. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the specifications.

D. **Hand Finishing.** Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.

2. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.

3. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

4. The screed for the surface shall be at least two feet (2') (50mm) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or other suitable material shod with metal.

5. Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

6. In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

E. **Floating.** After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated, by means of a longitudinal float, by the use of one of the following methods as specified or permitted:
1. **Hand Method.** The hand-operated longitudinal float shall be not less than twelve feet (12') (3.5m) in length and six inches (6") (150mm) in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centerline, and shall be passed gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half (1/2) the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.

2. **Mechanical Method.** The mechanical longitudinal float shall be of a design approved by the Engineer and shall be in good working condition. The tracks from which the float operates shall be securely adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the engineer on each transverse trip. The float shall pass over each area of pavement at least two (2) times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.

3. **Alternative Mechanical Method.** As an alternative to Item 2 above, the Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. This frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms.

4. If necessary, following one of the preceding methods of floating, long-handled floats having blades not less than five feet (5') (1.5m) in length and six inches (6") (150mm) in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge ten feet (10') (3m) or more in length. Successive drags shall be lapped one-half of the length of the blade.

F. **Straightedge Testing and Surface Correction.** After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a ten-foot straightedge. For this purpose the Contractor shall furnish and use an accurate ten-foot (10') (3m) straightedge swung from handles three feet (3') (1m) longer than one-half (1/2) the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other, as necessary. Advance along the road shall be in successive stages of not more than one-half (1/2) the length of the straightedge.
Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall be continued until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

G. Final Finish. The final finish will be specified on the plans as to the type of surface texture. The following types of surface textures may be specified:

1. **Type I - Transverse Tining.** The mainline finish shall be produced by mechanical equipment described as follows: The transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by the engineer in those areas where the mechanical equipment cannot be used.

   i. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at one-half inch (1/2") (12.5mm) to one inch (1") (25mm) intervals from center to center. The grooves shall be made perpendicular to the center line of the pavement and the resulting transverse grooves shall be .090 (2mm) to .125 (3mm) inches wide and shall be one eighth inch (1/8") (3mm) to three-sixteenths inch (3/16") (4.5mm) deep.

   ii. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical provided they produce a similar type of transverse groove.

2. **Type II - Longitudinal Tining.** The mainline finish shall be produced by mechanical equipment described as follows: The longitudinal grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by the engineer in those areas where the mechanical equipment cannot be used.

   i. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at one-half inch (1/2") (12.5mm) to one inch (1") (25mm) intervals from center to center. The grooves shall be made parallel to the center line of the pavement and the resulting longitudinal grooves shall be .090(2mm) to .125 (3mm) inches wide and shall be one eighth inch (1/8") (3 mm) to three-sixteenths (3/16") (4.5mm) inches deep. The mechanical equipment shall be operated from a bridge when the pavement is sixteen feet (16') (5m) or more in width.
ii. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical, provided they produce a similar type of longitudinal groove.

3. **Type III - Nylon or Artificial Grass Drag.** The pavement finish shall be produced by a nylon or artificial grass drag as approved by the Engineer. A uniform surface of gritty texture shall be produced by pulling the drag longitudinally. For a pavement width of sixteen feet (16') (5m) or more in width, the drag shall be mounted on a bridge which travels on the forms. The drag shall be at least three feet (3') (1m) wide and in full contact with the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new ones substituted.

4. **Type IV - Nylon or Bristle Broom.** The surface texture produced by a broom shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes lightly overlapping. The brooming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and shall have a minimum depth of approximately one-sixteenth inch (1/16") (1.5 mm) and a maximum depth of approximately one-eighth inch (1/8") (3mm). Brooming shall be completed before the concrete is in such condition that the surface will be 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. Mechanical brooming, in lieu of the manual brooming, will be permitted if satisfactory results can be obtained.

5. **Type V - Belt Finish (Paving with Rigid Forms).** When straightedging is complete and the water sheen has practically disappeared and just before the concrete becomes nonplastic, the surface shall be belted with a two-ply canvas belt not less than eight inches (8") (200mm) wide and at least three feet (3') (1m) longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the centerline.

6. **Type VI - Burlap Drag.** The drag shall be a seamless strip of damp burlap or cotton fabric which shall produce a uniform surface of a gritty nature after dragging it longitudinally along the full width of pavement. For pavement sixteen feet (16') (5m) or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric, at least three feet (3') (1m) wide, is in contact with the full width of pavement surface while the drag is used. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags shall be substituted.
i. When final longitudinal texturing has been completed by the burlap drag, the plastic pavement surface shall be textured by the designated type of texture and in a manner as approved by the Engineer. A belt finish need not be preceded by a burlap drag.

H. Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans. A well defined and continuous radius shall be produced, and a smooth, dense mortar finish shall be obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

1. At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. The rounding of the corner of the slab shall not be disturbed when the surface is broomed. All concrete on top of the joint filler shall be completely removed.

2. All joints shall be tested with a straightedge before the concrete has set, and correction shall be made if one side of the joint is higher than the other or if an edge is higher or lower than the adjacent slabs.

303.16. Surface Test.

A. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a ten-foot (10’) (3m) straightedge or other specified devices. Areas showing high spots of more than one-fourth inch (1/4”) (6.25mm) but not exceeding one-half inch (1/2”) (12.5mm) in ten feet (10’) (3m) shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of one-fourth inch (1/4”) (6.25mm) when tested with a ten-foot (10’) (3m) straightedge. Grinders shall be of the stacked head, vertical blade type that will not polish or smooth the surface but will provide a coefficient of friction approximately equal to that of the unground pavement. Grinding grooves shall be kept parallel with the direction of travel. Where the departure from correct cross section exceeds one-half inch (1/2”) (12.5mm), the pavement shall be removed and replaced by and at the expense of the Contractor.

B. Any area or section so removed shall be not less than five feet (5’) (1.5m) in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than five feet (5’) (1.5m) in length shall also be removed and replaced.

303.17 Curing.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured.
in accordance with one of the following methods. Failure to provide sufficient cover material of whatever kind the contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations.

The concrete shall not be left exposed for more than one-half (1/2) hour between stages of curing or during the curing period.

A. **Cotton or Burlap Mats.** The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for seventy-two (72) hours after the concrete has been placed, unless otherwise specified.

B. **Waterproofed Paper.** The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least eighteen inches (18") (450mm). The paper shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The paper shall be of such dimensions that each unit as laid will extend beyond the edges of the slab at twice the thickness of the pavement or shall be of pavement width and two foot (2') (600mm) strips of paper provided for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for seventy-two (72) hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

C. **White Pigmented Impervious Membrane.** The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with burlap or cotton mats, the curing compound may be applied upon removal of the mats.

1. The curing compound shall not be applied during rainfall.

2. Curing compound shall be applied under pressure at the rate of approximately one (1) gallon (3.785l) to one hundred fifty square feet (150 sq.ft) (140 sq.m) by mechanical sprayers. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During the application the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and on concrete surfaces exposed by the
removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed.

3. The curing compound shall be of such character that the film will harden within thirty (30) minutes after application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.

4. Upon removal of side forms, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.

C. White Polyethylene Sheeting. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least eighteen inches (18") (450mm). The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for seventy-two (72) hours after the concrete has been placed.

D. Curing in Cold Weather. When the average daily temperature is below 40° F. (4° C), curing shall consist of covering the newly laid pavement with not less than twelve inches (12") (300mm) of loose, dry hay or straw, or equivalent protective covering authorized by the Engineer, which shall be retained in place for ten (10) days.

1. When concrete is being placed and the air temperature may be expected to drop below 35° F. (1.7° C), a sufficient supply of insulated blanketing material shall be provided along the work, and any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The period of time such protection shall be maintained shall be not less than ten (10) days. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

303.18 Removing Forms.

Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least twelve (12) hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than ten feet (10') (3m) in length nor less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than five feet (5') (1.5m) in length shall also be removed and replaced.
303.19  Sealing Joints.

A. If the joints are to be sealed, they shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur.

B. The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed, and the pavement surface shall be cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint-sealing material shall not be placed when the air temperature in the shade is less than 50°F (10°C), unless approved by the Engineer.

303.20  Protection of Pavement.

A. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs and lights. He will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.

B. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protection materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than two inches (2") (50mm) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall be placing forms against the side of the pavement and covering the surface of the unhardened concrete with the protective covering.

C. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement shall be replaced.

303.21  Opening to Traffic.

The engineer will decide when the pavement shall be opened to traffic. The pavement shall not be opened to traffic until specimen beams have attained a flexural strength of five hundred and fifty...
pounds per square inch (550 psi) (3795kPa), when tested by the third-point method. If such tests are 
not conducted, the pavement shall not be opened to traffic until fourteen (14) days after the concrete 
was placed. Prior to being opened to traffic, the pavement shall be cleaned.

303.22 Concrete Pavement - Slipform Method.

Unless prohibited on the plans, pavement may be constructed without the use of fixed forms. When 
the slipform method is used, the following provisions shall apply:

A. Grade. After the grade or base has been placed and compacted to the required density, the 
grade and areas which are to support the paving machine shall be cut to the proper elevation 
by means of an approved fine-grading machine. The fine-grading machine shall be of 
sufficient weight, and shall be either self-propelled or towed by sufficient power to trim the 
compacted material without gouging or tearing the surface. The machine shall have cutting 
edges or surface shavers controlled from an independent control reference wire by means of 
an automatic control device. To avoid excessive depths of cut the machine may accomplish 
the fine grading by means of successive passes with each pass controlled from the 
independent reference line through the automatic control. If the density of the base is 
disturbed by the grading operations, it shall be corrected by additional compaction before 
concrete is placed. The grade shall be constructed sufficiently in advance of the placing of 
the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked 
and corrected immediately ahead of the placing of the concrete.

B. Placing Concrete. The concrete shall be placed with an approved slipform paver designed to 
spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass 
of the machine in such manner that a minimum of hand finish will be necessary to provide a 
dense and homogenous pavement in conformance with the plans and specifications. The 
machine shall vibrate the concrete for the full width and depth of the strip of pavement being 
placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the 
concrete, or with a vibrating screed or pan operating on the surface of the concrete. The 
sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The 
forms shall trail behind the paver for such a distance that no appreciable slumping of the 
concrete will occur.

1. The concrete shall be held at a uniform consistency, having a slump of not more than two 
   inches (2") (50mm). The slipform paver shall be operated with as nearly a continuous 
   forward movement as possible, and all operations of mixing, delivering, and spreading 
   concrete shall be so coordinated as to provide uniform progress with stopping and 
   starting of the paver held to a minimum. If, for any reason, it is necessary to stop the 
   forward movement of the paver, the vibratory and tamping elements shall also be stopped 
   immediately. No tractive force shall be applied to the machine, except that which is 
   controlled from the machine.
DIVISION 300

SECTION 304

ASPHALTIC CONCRETE PAVEMENT

304.01 Description.

The work specified under this section shall consist of one or more courses of bituminous mixture constructed on a prepared foundation and in reasonably close conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans or established by the Engineer. This article also addresses asphaltic concrete pavement repairs performed as part of the installation of some appurtenance.

304.02 Materials.

A. **General.** The asphaltic pavement shall be hot mixed at a central plant. It shall consist of mineral aggregates, uniformly mixed with asphalt cement and laid upon the prepared base to the finished thickness shown on the typical cross-section on the plans or as directed by the Engineer. The composition of the combined mineral aggregate shall be crushed gravel.

B. **Crushed Gravel Gradation.** Crushed gravel shall consist of clean, hard, durable, stone particles which have been crushed, screened, and otherwise processed to meet the following requirements. The thickness and grading type shall be as specified in the special provisions.

**TABLE - GRADATION REQUIREMENTS**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>3/4&quot; (20mm) Max.</th>
<th>1/2&quot; (12.5mm) Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading A</td>
<td>Grading C</td>
</tr>
<tr>
<td>1&quot; (25mm)</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>3/4&quot;(20mm)</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>1/2&quot;(12.5mm)</td>
<td>60-85</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8&quot;(9.5mm)</td>
<td>-</td>
<td>60-85</td>
</tr>
<tr>
<td>#4 (4.75mm)</td>
<td>40-60</td>
<td>40-60</td>
</tr>
<tr>
<td>#8 (2.36mm)</td>
<td>25-45</td>
<td>25-45</td>
</tr>
<tr>
<td>#30 (600μm)</td>
<td>10-30</td>
<td>10-30</td>
</tr>
<tr>
<td>#200 (75μm)</td>
<td>2-8</td>
<td>2-8</td>
</tr>
</tbody>
</table>

C. **General.** Aggregate shall be composed of coarse and fine aggregates combined in the proper proportions to meet the grading requirements shown above. Aggregates shall be composed of clean, tough, durable fragments, free from an excess of flat, elongated, soft, or disintegrated pieces and free from fragments coated with dirt or other objectionable matter.

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D. Coarse Aggregate. Coarse aggregate shall be crushed stone or crushed gravel of such gradation that when combined with other required aggregate fractions and fillers in proper proportion, the resultant mixture shall meet the gradation required under the composition of mixture for the specific type under contract. The crushed aggregate shall have a percentage of wear of not more than 40 when tested in accordance with AASHTO T-96. The sodium sulfate soundness loss shall not exceed 12% in accordance with AASHTO T-104 and the plasticity shall not exceed three (3).

E. Fine Aggregate. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75 µm) sieve shall not be greater than two-thirds (2/3) of the fraction passing the No. 40 (425 µm) sieve. The fraction passing the No. 40 (425 µm) sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than three (3), except that when the plasticity index is non-plastic (NP), the liquid limit shall be not more than 30.

1. When Type II pavement is specified, not less than 50% of the materials by weight, retained on the No. 4 (4.75 mm) sieve, shall have at least one fractured face, unless a different percentage of fractured faces is shown on the plans.

2. When Type III pavement is specified, not less than 50% of the materials by weight, retained on the No. 4 (4.75 mm) sieve, shall have at least one fractured face unless otherwise shown on the plans. During crushing operations the coarse aggregate, the pit run minus No. 4 (4.75 mm) fine aggregate, and the crushed minus No. 4 (4.75 mm) fine aggregate, shall be stockpiled in separate piles.

3. Crushed gravel shall show no signs of detrimental stripping when tested in accordance with ASTM D1664 using asphalt taken from the plant. This test shall be performed at the plant owner's expense by an approved testing laboratory once every week of operation. Test results are to be submitted immediately by the testing lab to the City Engineer.

4. Admixtures and treating methods shall be subject to the special approval of the Engineer. Samples of the proposed admixtures shall be submitted to the Engineer at least two (2) weeks prior to use. Special attention will be given to the thermal stability of admixtures.

F. Asphalt Cement. The asphalt cement shall be PG 58-28, PG 64-22, or PG 64-28. The grade of asphalt cement shall meet the requirements for the grade and type as stated in the AASHTO Provisional Standards 1993 and AASHTO documents PP5, PP6, PPX, M20, and M226. The type and grade of bituminous material may be changed one step by the Engineer during construction, at no change in unit price. The amount of asphalt cement in the submitted and approved mix formula for Grading "A" and Grading "C", shall be established by Marshall Design Criteria. Initial guideline for the amount of asphalt cement in Grading "A" is 4.5-5.5%, and in Grading “C” is 5-6% by weight.
1. Certificates of compliance for each consignment of asphalt cement shall be furnished by the Contractor to the Engineer in accordance with the requirements of Division 400, Section 403.06 of the specifications.

**304.03 Paving Plant Requirements.**

A. General Requirements.

1. **Uniformity.** The plant shall be so designed and operated as to produce a job mixture whose permissible variance from the mix design shall be as follows:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount passing on the No. 4 (4.75mm) sieve and larger</td>
<td>+7%</td>
</tr>
<tr>
<td>Amount passing on the No. 8 (2.36mm) to No. 100 (150μm) sieves</td>
<td>+5%</td>
</tr>
<tr>
<td>Amount passing on the No. 200 (75μm) sieve</td>
<td>+3%</td>
</tr>
<tr>
<td>Asphalt Cement</td>
<td>±.5%</td>
</tr>
</tbody>
</table>

   i. The range of tolerance shall not exceed the maximum value listed in gradation or asphalt cement requirements.

   ii. The mixture shall have a density, when thoroughly compressed, of not less than 97% of field sampled laboratory Marshall density.

2. **Paving Plant Inspection.** For verification of weights or proportions and character of materials, and determination of temperatures used in the preparation of mixture, the Engineer, or his authorized representatives, shall have access at any time to all parts of the paving plant.

3. **Composition of Mixtures.** Mixing temperatures for bituminous mixes shall be determined by the submitted and approved mix design.

<table>
<thead>
<tr>
<th>Grade of Material</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 64-22</td>
<td>ALL TYPES OF CONSTRUCTION</td>
</tr>
</tbody>
</table>

B. **Asphaltic Pavement Mixture Design Criteria.** The following Marshall Design Criteria shall be used to determine optimum asphalt content:

1. **No. of Compaction Blows Each End of Specimen** - **50**.
304.04 Construction.

A. General Conditions.

1. Proofrolling. Prior to the placing of any hard surfacing material upon the subgrade/subbase/base, such subgrade/subbase/base shall be proofrolled under the observation of a representative of the City Engineer's Office and approval obtained. The proofrolling shall be done by a pneumatic tired roller with tires having a ground contact pressure of 85-90 p.s.i. (585-621 kPa). The entire area upon which hard surfacing is to be placed must be rolled. When proofrolling shows an area to be unstable, such area shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material. If paving operations have not begun within twenty-four (24) hours after approval, a repeat of the proofrolling may be required.

2. Weather Limitations. Bituminous plant mix shall not be placed on any wet surface or when the atmospheric temperatures are less than those specified in the following table; or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

<table>
<thead>
<tr>
<th>Compacted Thickness</th>
<th>Surface Course</th>
<th>Subsurface Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1&quot; (25mm)</td>
<td>60° F (15.5°C)</td>
<td>55° F (13°C)</td>
</tr>
<tr>
<td>1&quot; to 2&quot;, (25-50mm) inclusive</td>
<td>40° F (4.5°C)</td>
<td>35° F (1.7°C)</td>
</tr>
<tr>
<td>More than 2&quot; (50mm) to and including 4&quot; (100mm)</td>
<td>35° F (1.7°C)</td>
<td>35° F (1.7°C)</td>
</tr>
<tr>
<td>More than 4&quot; (100mm)</td>
<td>N/A</td>
<td>25° F (-4°C)</td>
</tr>
</tbody>
</table>

i. The meanings of the terms "surface course" and "subsurface course" applies to this subsection only, and shall be as follows:

a. Any plant mix pavement overlaid with surface course on the same contract is considered a subsurface course.

b. Plant mix bituminous base is considered a subsurface course.

c. Spot leveling or the bottom lift of a leveling course may be placed at 35° F (1.7°C) if additional courses are placed on the same contract.
d. Surface course shall be Grading "C" aggregate.

e. Subsurface course shall be Grading "A" aggregate.

B. Transportation of Mixture. The mixture shall be transported from the paving plant to the work in vehicles equipped with tight metal compartments previously cleaned of all foreign materials. When directed by the Engineer, the compartments shall be suitably insulated and each load shall be covered with canvas or other suitable materials of sufficient size to protect it from weather conditions. The inside surface must be lightly lubricated with a non-stick lubricant just before loading, but excessive lubricant will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight.

C. Placing Asphalt Mixture. The mixture shall be delivered on the work site at a temperature plus or minus 15° F. (-9° C) of the mixing temperature, but in no case shall the temperature be below 240° F. (156° C). Final rolling and density of the bituminous surface, subsurface, or leveling courses must be obtained prior to the mixture reaching a minimum temperature of 180° F (82° C).

1. Unless otherwise permitted by the Engineer, the mixture shall be spread by means of a mechanical self-powered paver, capable of spreading the mixture true to the line, grade, and crown shown on plans. Hand-placing and spreading will be permitted in irregular areas where it is impractical to use a paving machine.

2. Pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. The mixture shall be dumped in the center of the hoppers and care exercised to avoid overloading and spilling over the mixer upon the base. Pavers shall operate, when laying mixtures, at such speed for a consistent and uniform laying of the mixture as may be decided by the Engineer.

3. Pavers shall be equipped with a quick and efficient steering device and shall have forward and reverse traveling speeds of not less than one hundred feet (100') (33m) per minute and a tamping device capable of delivering at least 500 blows per minute.

4. Unless operating on fixed side forms, pavers shall employ mechanical devices such as equalizing runners, straight-edge runners, evener arms, or other compensating devices to adjust the grade and confine the edges of the mixtures to true lines without the use of stationary side forms. The pavers shall be capable of spreading the mixtures, without segregation, in thickness of from one-half inch (1/2") (12.5mm) to three inches (3") (75mm) and in widths of eight feet (8') (2.5m) to fourteen feet (14') (4.5m) adjustable in steps of one foot (1') (.3m) or less. They shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips of courses of the same thickness.
5. Pavers shall be equipped to automatically control the laying of the mixture to specified transverse slope and established longitudinal grade. The paver control system shall be automatically actuated from an independent line and grade control reference through a system of mechanical sensors and sensor-directed devices which shall maintain the paver screed at the proper transverse slope and height to establish the top surface of the compacted mixture at specified slope and grade.

6. The screed or "strike-off" assembly shall produce the specified finished surface without tearing, shoving, or gouging, and which produces a finished surface of the evenness and texture specified. The screed shall be adjustable as to level and shall have an indicating level attached and shall be vibrating.

7. Immediately after any course is screeded, and before roller compaction is started, the surface shall be checked, and all inequalities adjusted. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.

8. The Contractor shall provide a competent worker who is capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given by the worker to the straight-edging of each course immediately following the initial rolling.

9. In narrow, deep, or irregular sections, intersections, turnouts, or driveways where it is impractical to spread and place asphalt mixes by machine methods, the Contractor may use approved spreading equipment or acceptable hand methods as directed by the Engineer. Excessive loose rock will be removed from surface prior to rolling the patch.

10. When the mixture is to be spread by hand, upon arrival on the work it shall be dumped outside the area on which it is to be spread, or shoveled directly from the truck to the area on which it is to be spread. Immediately thereafter it shall be distributed into place by means of hot shovels and spread with hot rakes in a loose layer of uniform density and correct depth. Tines of the rakes shall be not less than one-half inch (1/2") (12.5mm) longer than the loose depth of mixture and spaces between tines shall be not less than the maximum diameter of aggregate particle except that in no case should the spaces be less than one inch (1") (25mm). Loads shall not be dumped any faster than they can be properly handled by the shovelers. Lutes may be used with permission of the Engineer.

11. The shovelers shall not distribute the dumped load faster than it can be properly handled by the rakers.

12. The rakers will not be permitted to stand in the hot mixture while raking it, except where necessary to correct errors in the first raking. The raking must be carefully and skillfully done in such a manner that after the first passage of the roller over the raked mixture, a minimum amount of back patching will be required.
13. The placing of the mixture shall be as continuous as possible. The roller shall pass over the unprotected edge of the freshly laid mixture only when the laying of this course is to be discontinued for such intervals of time as to permit the mixture to become chilled.

D. Joints. Transverse construction joints shall be made in a careful manner. The edge of the previously laid course shall be cut back as far as is necessary to eliminate irregularities incidental to finishing and rolling. After laying the finished mixture adjacent to a transverse construction joint, a skilled laborer shall follow up each rolling with a straightedge and corrective measures to insure a smooth riding surface. The laborer shall be equipped with hot smoothing irons, tampers, and other devices for use in truing up the pavement surface adjacent to the joint.

1. Longitudinal joints against both hot and cold material shall be made with equal care. Mixtures spread and compacted (or partially compacted) by the machine shall not be disturbed by a rake in dressing the joint, unless one side is too high, nor shall surplus mixture be spread or scattered back of the machine when not needed to build up low spots. When spreading next to a warm or cold edge of a previously laid section of surfacing, the machine shall be adjusted to leave a "bead" of material, roughly one inch (1") (25mm) by one inch (1") (25mm), which shall be rolled in to compensate for uneven density at the joint. If one side of the joint is cold, the "bead" shall be moved back of the rake to the warm side of the joint but otherwise the machine-laid mixture shall not be disturbed.

2. In making the joint along any adjoining edge such as curb, gutter, or an adjoining pavement, and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open, and provide a small "bead" of extra material. This joint shall be properly "set-up" with the back of the rake at proper height and bevel to receive the maximum compression under rolling. The work of "setting-up" this joint shall always be performed by competent workmen, who are capable of making a correct, clean, and neat joint.

E. Bonds Between Existing and New Asphalt.

1. In order to obtain a good bond between existing and new asphalt pavements, all areas where the existing pavement is cut for the installation of an appurtenance or structure the Contractor shall saw cut the full depth of the existing asphalt pavement a minimum of twelve inches (12") (300mm) beyond the excavation. This entire edge will be properly coated with tack oil prior to the installation of the new asphalt pavement. The new pavement section will be applied in two (2) lifts. In addition, as directed by the Engineer, after the first lift is applied, the edge of the old asphalt pavement shall be milled down to the level of the first lift of the new pavement section or a minimum of one and one-half (1½”) (37.5mm) from the surface. The milling shall extend at least
twelve (12") (300mm) beyond the saw cut. The milled surface shall be thoroughly cleaned and have tack oil applied to it and coated to cover the entire edge before applying the second lift. The second lift will then be applied overlapping the milled surface and the new first lift of the new pavement. If the second lift cannot be applied immediately after compaction of the first, the first lift shall have tack applied to its surface before the application of the second.

F. Compaction of the Mixture. As soon as the mixture will carry the compaction equipment without undue shoving or displacement, it shall be compacted with self-propelled rollers. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

Recommended criteria:

1. Three-axle tandems, two-axle tandems, and three-wheeled rollers used for breakdown rolling shall be of such weight that the compression load on the drive wheels is at least three hundred twenty five pounds per inch (325#/in) (58kg/cm) of tire width.

2. Vibratory rollers used for breakdown or intermediate rolling having a compactive effort of not less than a dynamic force of twenty one thousand pounds (21,000#)(9525kg) may be used only with the written consent of the City Engineer, and should not be used on lifts of two inches (2") (50mm) or less.

3. Two-axle tandem rollers used for intermediate and finish rolling shall weigh not less than seven tons (7 t) (6350kg).

4. Pneumatic-tired rollers used for intermediate rolling shall be the oscillating type having a width of not less than four feet (4') (1.2m) and equipped with pneumatic tires of equal size and diameter, having treads satisfactory to the Engineer. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to ninety pounds per square inch (90 psi) (621 kPa) or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five pounds per square inch (5 psi) (35 kPa) from the designated pressure. Pneumatic-tired rollers shall be so constructed that the total weight of the roller can be varied to produce an operating weight per tire of not less than two thousand pounds (2,000#) (900kg). The total operating weight of the roller shall be varied as directed by the Engineer.

   i. Other rollers may be used subject to prior approval by the Engineer.

5. All rollers must be maintained in good mechanical condition, and those that cannot be driven along a straight path or operated without jerking, shall not be used. No leakage of petroleum products from any roller shall be allowed to come in contact with pavement being constructed, nor shall any roller be permitted to stand motionless on any
portion of the work. The surfaces of all roller wheels shall be misted with sufficient water to prevent the pickup of bituminous materials, but under no circumstances shall the quantity of water used be detrimental to the surface of the pavement being rolled. Water shall not be applied directly in any manner to the asphalt surface.

6. As soon as the layer of asphalt concrete has been placed, it shall be thoroughly compacted by rolling. Except when compacting lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced along the lower edge of the area to be rolled and continued until the edge is thoroughly compacted, after which the roller shall be gradually advanced to the crown point, both sides being rolled in like manner. Rolling shall be continued until the pavement layer has become thoroughly compacted throughout and is true to grade and cross-section.

7. For lifts greater than four inches (4") (100mm) in compacted thickness, rolling shall be commenced in the middle of the mat, after which the roller shall be gradually advanced to both edges. The roller should be advanced to a supported edge first, if applicable. Rolling of an unsupported edge should be delayed as long as possible, provided the required densities are obtained after the completion of the finishing rolling.

8. The finish rolling of the surface course shall be done with a tandem steel-wheeled roller until all roller marks are eliminated.

9. Along curbs, headers, manholes, and similar structures, and at all places not accessible to the roller, thorough compaction must be secured by means of hot tampers and irons. At all contacts of this character, the joints between these structures and the surface mixture must be effectively sealed with a bituminous tack coat.

10. After final compression, the surface course shall conform with the following requirements:

i. It shall be smooth and true to the established crown and grade. It shall have the average thickness specified and shall at no point vary more than one-fourth inch (1/4")(6.25mm) from the thickness shown on the typical cross-sections on the plans. Any low or defective places shall immediately be remedied by cutting out the course at such spots and replacing it with fresh, hot mixture which shall be immediately compacted to conform with the surrounding areas and shall be thoroughly bonded to it. The surface of the finished pavement shall be free from depressions exceeding one-fourth inch (1/4")(6.25mm) as measured with a ten foot (10') (3m) straight edge in any direction.

11. At no point shall the density of the binder and surface course be less than 97% of maximum Marshall density. (See Division 400, Section 402.03.)

E. Construction Testing and Sampling. All testing and sampling shall be done in accordance with the latest A.A.S.H.T.O. methods unless otherwise specified. Test results shall be
forwarded immediately by the testing lab to the City Engineer and general Contractor. The frequency of all required testing may be increased or decreased at any time deemed necessary by the City Engineer. The following tests shall be required during construction.

1. **Asphalt Content and Gradation.** One asphalt content and gradation test shall be made per each four hundred tons (400 t) (363 metric t) or portion thereof of asphaltic mixture placed per day. These tests shall be performed on samples taken prior to screeding. The percentage of asphalt content may be determined by Ignition Oven or by Extraction Method (ASTM D 2172, D 6307, ASHTO T164).

2. **Marshall Series.** A complete Marshall test series shall be performed each week of paving operations when placing more than four hundred tons (400 t) (363 metric t).

3. **Density Tests.** At least one (1) density test for each four hundred tons (400) (363 metric t) or part thereof shall be performed for each two hundred feet (200’) (61m) of paving strip.

4. **Preconstruction Test and Sampling.** All sampling and testing of materials shall be done in accordance with the latest A.A.S.H.T.O. methods unless otherwise specified. At least three (3) weeks in advance of the beginning of asphaltic paving work, the Contractor shall:
   
   i. Submit suitable samples of all materials including asphalt cement to an approved materials testing laboratory for mixture design, and to determine compliance of materials to these specifications;
   
   ii. Or shall submit certification that the materials to be used are in conformance with these specifications and that the mixture design for use with these materials is approved and on file with the City Engineer.

5. The Contractor shall be responsible for all preconstruction tests and sampling, Marshall series testing, and all asphalt content and gradation testing. The Contractor shall select and pay for a certified testing firm, acceptable to the Owner and Engineer.

6. Unless specified by the contract documents or Standard Specifications the Owner/Engineer will be responsible for all density/moisture testing. If the initial test fails to meet minimum requirements, the Contractor shall pay for any and all additional tests until the minimum density/moisture standards are met.

**H. Warranty or Inspection of Asphaltic Concrete Pavement.** After completion of the asphalt and concrete work and prior to the end of the specified warranty period, the City will inspect all asphalt and concrete areas installed on this project. At the time of the inspection, all areas of asphalt where there exists a one quarter inch (1/4”) (6 mm) separation between the new asphalt and the existing asphalt or the new asphalt and the new concrete, the Contractor will be required to crack seal these locations following City specifications. The sealant shall conform to ASSHTO M 301 or
modified ASTM D 3405. Any pavement found to have settled more than one-quarter inch (1/4”) (6mm) shall be repaired as to the engineer’s recommendations.

“LEFT BLANK ON PURPOSE”
DIVISION 400

SECTION 402

PAVEMENT BASE COURSE

402.01 Description.

The work covered by this Section shall consist of furnishing, placing, watering, shaping, and compacting a course or courses of crushed gravel to provide a firm and stable foundation for subsequent construction. The base course shall be constructed on a previously constructed subbase or subgrade in accordance with the requirements of these specifications and in conformity with the lines, grades, quantity requirements, and the typical cross-sections shown on the plans.

402.02 Materials.

A. Crushed Gravel. The crushed gravel for base course shall consist of clean, hard, durable particles which have been crushed to the following gradations:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot; (37.5mm)</td>
<td>100</td>
</tr>
<tr>
<td>1&quot; (25mm)</td>
<td>90-100 100</td>
</tr>
<tr>
<td>1/2&quot; (12.5mm)</td>
<td>60-85 95-100</td>
</tr>
<tr>
<td>#4 (4.75mm)</td>
<td>45-65 45-65</td>
</tr>
<tr>
<td>#8 (2.36mm)</td>
<td>33-53 33-53</td>
</tr>
<tr>
<td>#200 (75um)</td>
<td>3-12 3-12</td>
</tr>
</tbody>
</table>

1. The above is equivalent to Wyoming Highway Department grading "W" or grading "H" base course. The type of base course to be applied shall be specified in the special provisions.

2. Coarse aggregate shall consist of hard, durable particles, or fragments of stone or gravel. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50%.

3. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75um) sieve shall not be greater than two-thirds (2/3) of the No. 40 (425um) sieve. The fraction passing the No. 40 (425um) sieve shall have a liquid limit not greater than twenty-five (25) and a plasticity index not greater than six (6) except that, when the plasticity index is non-plastic, the liquid limit shall not be more than thirty (30).
4. Of the particles retained on a No. 4 (425\(\mu\)m) sieve, at least 35\% by weight shall have one (1) or more broken faces.

B. Preconstruction Testing. All testing and sampling shall be done in accordance with latest ASTM methods, unless otherwise specified. At least two (2) weeks in advance of the beginning of base work, the Contractor shall:

1. Submit suitable samples of the base material to an approved materials testing laboratory for tests to determine the compliance of the proposed subbase material with these Specifications;

2. Or shall submit certification that the materials to be used are in conformance with these Specifications.

C. Construction Testing. During construction the supplier/Contractor shall have performed by an approved testing laboratory one (1) gradation test including liquid limit and plasticity index per each five thousand tons (5,000t) (4500 metric t) or portion thereof, of base material.

1. The results of such tests shall be submitted by the lab to the Engineer, Contractor, and owner.

402.03 Mixing.

A. The crushing plant shall be equipped with rolls, or any combination of rolls, jaws, or other crushing devices, which will produce the required material. Care shall be exercised in the operation of loading, hauling, and distributing the crushed material to avoid segregation of the coarse and fine particles of the total material. If segregation occurs, the method of spreading and placing shall be modified so that placement is made to the satisfaction of the Engineer. The base course shall be placed on the previously prepared subbase or base course in the proper quantities to conform to the typical cross-section shown on the plans. The crushed material shall then be windrowed and watered as directed by the Engineer and mixed until a uniform mixture is obtained.

1. The base course thickness specified by the plans is absolute minimum thickness. Where the subbase has been left low, the Contractor may, at his option, use base course material as covered in this section of specifications to bring the subbase up to the grade specified.

2. The Contractor shall mix the aggregate, water, and commercial additive where required, by the stationary plant methods unless otherwise shown on the plan or approved by the Engineer. The moisture content of the material at the time of compaction shall be within +2 or -4 percentage points of optimum.
B. **Stationary Plant Method.** The aggregate and water shall be mixed in an approved pugmill mixer. Water shall be added during the mixing operation in the amount necessary to maintain the required moisture content for compacting.

1. The mixer shall be capable of uniformly distributing the aggregate, additives, and water throughout the mixture without evidence of overwet or dry pockets of material when the equipment is operated at the Contractor's desired capacity.

2. After mixing, the material shall be transported to the job site while it contains the proper moisture content, and shall be placed on the roadbed by means of an approved aggregate spreader.

3. The spreader shall be capable of spreading the material for a minimum width of ten feet (10') (3m) when used to full capacity to a uniform thickness.

C. **Travel Plant Method.** After the material for each layer has been placed through an aggregate spreader, window sizing device or aggregate hopper, the material shall be uniformly mixed by a traveling mixing plant. During mixing, water shall be added in an amount sufficient to maintain the required moisture content for compacting.

D. **Road Mix Method.** After material for each layer of the course has been placed, the materials shall be mixed while in the range of +2 or -4 percentage points of optimum moisture content, by means of motor graders or other approved equipment until the mixture is uniform throughout.

E. **Stockpile Method.** Commercial additives, if required, will be introduced into the aggregate during stockpiling operations. Water will be introduced by pre-wetting the stockpile of aggregate and additive. Additional water may have to be introduced during the placing of the aggregate courses.

402.04 Shaping and Compaction.

A. After the base course material has been placed and uniformly spread over the prepared subbase, compaction shall be accomplished by means of multiple-wheel, pneumatic-tired rollers, tandem or three-wheel steel rollers and/or vibratory compactors, or any other method approved by the Engineer. If additional water is needed to facilitate compaction and bonding of materials, it shall be applied at the direction of the Engineer. Rolling shall be continued until the entire base course has been compacted to the required density and moisture content.

1. The finished base surface shall be smooth and free of ruts and irregularities and true to grade and crown and thickness as shown by the plans or directed by the Engineer.

2. Each layer shall be compacted to a density of not less than 95% of maximum density and a moisture content of plus or minus 2% of optimum moisture, as determined in Section 402.
accordance with ASTM D698, unless otherwise called for on the plans. Compactions or field-in-place densities will be determined by sand cones or nuclear density meters. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture and surface is produced and the aggregates firmly keyed. Water shall be uniformly applied over the materials during compaction in the amount necessary for proper consolidation.

3. If the required compacted depth of subbase course exceeds six inches (6”)(150mm), the course shall be constructed in two or more layers of approximately equal thicknesses. The maximum compacted thickness of any one layer shall not exceed six inches (6”)(150mm). When vibrating or other approved types of special compacting equipment are used, the depth of a single layer of the course may be increased upon approval by the Engineer.

402.05 Quality Control Testing.

A. One density and moisture test shall be performed for every two thousand square yards (2,000 sq.yds) (1675 sq.m) of base course placed.

B. Gradation tests, including liquid limit and plasticity index shall be performed for every two thousand square yards (2,000 sq.yds) (1,675 sq.m.) placed, or portion thereof.

C. The Contractor/Supplier shall select and pay for a certified testing firm, acceptable to the Owner and Engineer to complete all gradation, liquid limit and plasticity index testing requirements, prior to and during construction. The lab shall forward copies of the results of such tests to the Engineer, Contractor, and/or Owner.
DIVISION 400

SECTION 403

BITUMINOUS PRIME COAT

403.01 Description.

This Section covers work necessary to prepare and treat an existing surface with bituminous material, if required, in accordance with these specifications.

403.02 Surface Preparation.

Prior to placing the bituminous prime coat, the base course shall be smooth, free from ruts, irregularities, and true to line and grade. All base courses shall be approved by the Engineer before the prime coat is placed. The base surface shall be cleaned to remove all loose or foreign material. The base course surface shall be moderately moist but shall not contain any free or ponded water.

403.03 Materials.

The asphaltic oil for prime coat shall be MC-70 or as specified in the contract documents, and shall meet the requirements of A.A.S.H.T.O. Standard Specification M-82, Table 1.

403.04 Weather Limitations.

Unless otherwise specifically directed by the Engineer no prime coat shall be placed when the atmospheric temperature is less than 50° F. (10° C) ambient, or when in the opinion of the Engineer, excessive wind or other atmospheric conditions will not permit satisfactory placement of the prime coat.

403.05 Application.

A. The prime coat shall be placed by means of an approved pressure distributor. The distributor shall be in good mechanical condition and shall be capable of uniformly distributing the prime coat throughout a reasonable range of widths, pressures, temperatures, and application rates. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices, and an accurate thermometer for reading temperatures of tank contents. The prime coat shall be applied at a rate of not less than 0.20 gals./sq. yd. (0.9l/sq.m) nor more than 0.50 gals./sq. yd (2.3l/sq.m) as directed by the engineer. Temperature at application shall be between 90° F. (32° C) and 180° F (82° C). The prime coat shall be carefully and uniformly applied, particularly around curbs, sidewalks, and other structures, and if excessive amounts of asphaltic oil are sprayed on the curbs, sidewalks, and other structures, they shall be cleaned as directed by the Engineer at the Contractor's expense. Excessive lapping of abutting applications will not be permitted. Should excessive lapping occur, the
prime coat in the lapped portion shall be removed and replaced as directed by the Engineer at
the Contractor's expense.

B. All spots missed by the distributor or areas which are inaccessible to the distributor shall be
handsprayed. Particular attention shall be given to handspraying operations to avoid the
application of excessive amounts of asphaltic oil.

C. The primed surface shall be allowed to cure for at least twenty-four (24) hours before placing
any bituminous pavement. The primed surface shall be maintained by the Contractor until
the bituminous pavement is placed. Any damaged areas shall be repaired as directed by the
Engineer and at the Contractor's expense. All vertical contact surfaces such as concrete
gutters, manholes, drainage structures, curbs, and so forth shall be primed by painting with
hot asphaltic cement of the same grade being used in the asphaltic pavement just prior to
placing the asphaltic pavement.

403.06 Quality Control.

A test report shall be obtained from the vendor by the Contractor at the time of shipment of each
consignment of asphaltic material. This test report shall be submitted to the Engineer for approval
prior to application or use of any asphaltic material in the work. The test report shall show loading
temperature, quantity in weight, quantity in gallons at 60° F (15.5° C), viscosity, A.P.I. or specific
gravity at 60° F (15.5° C), characteristics of residue and distillation ends of the material contained in
the consignment, and percent and type of additive included when specified.
404.01 Description.

This work described in this Section shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material. Application of tack coat material shall be as specified in the contract documents.

404.02 Surface Preparation.

Prior to placement of the bituminous tack coat, the pavement surface shall be clean, dry, and free of all loose and foreign material. All pavement surface shall be approved by the Engineer before the tack coat is placed.

404.03 Materials.

The bituminous oil for tack coat shall meet the requirements of A.A.S.H.T.O. Specification M81, Table 1, or emulsified asphalt, SS-1, or SS-1h diluted approximately one to one with water and meeting the requirements of A.A.S.H.T.O. Specification M-140.

404.04 Weather Limitations.

Unless otherwise specifically directed by the Engineer, no tack coat shall be placed when the ambient air is below 40°F (4.4°C), or when, in the opinion of the Engineer, excessive wind or other atmospheric conditions will not permit satisfactory placement of the tack coat.

404.05 Placing of the Tack Coat.

A. The tack coat shall be placed by means of an approved pressure distributor. The distributor shall be in good mechanical condition and shall be capable of uniformly distributing the tack coat throughout a reasonable range of widths, pressures, temperatures, and application rates. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices, and an accurate thermometer for reading temperatures of tank contents. The tack coat shall be applied at a rate of .06-.1 gals./sq. yd (.27 - .45 liters/sq.m). Prior to placement SS-1 and SS-1h shall be heated to 75°-130°F (24 - 55°C). Care should be taken not to exceed the upper limits of these ranges.

B. The tack coat shall be carefully and uniformly applied, particularly around curbs, sidewalks, and other structures, and if excessive amounts of bituminous oil are sprayed on the curbs, sidewalks, and other structures, they shall be cleaned as directed by the Engineer at the
expense of the Contractor. Excessive lapping of abutting applications will not be permitted. Should excessive lapping occur, the tack coat in the lapped portion shall be removed and replaced as directed by the Engineer at the Contractor's expense.

C. All spots missed by the distributor or areas which are inaccessible to the distributor shall be handsprayed. Particular attention shall be given to handspraying operations to avoid the application of excessive amounts of bituminous oil.

D. The tacked surface shall be allowed to cure before placing any asphaltic concrete. The tacked surface shall be maintained by the Contractor until the asphaltic concrete is placed. Any damaged areas shall be repaired as directed by the Engineer and at the Contractor's expense. All vertical contact surfaces such as concrete gutters, manholes, drainage structures, curbs, and so forth, shall be tacked by painting with a hot asphaltic cement of the grade used in the asphaltic pavement just prior to placing the asphaltic pavement.

E. When the first course of asphaltic concrete is to be immediately covered by the second course of asphaltic concrete, the tack coat may not be required. When the first coat of asphaltic concrete is subjected to traffic, rain, blowing dust, and other unfavorable conditions, the tack coat shall be applied.

404.06 Test Reports.

Certificates of compliance for the bituminous tack coat material shall be supplied by the Contractor and furnished to the Engineer for each consignment of asphaltic material as provided Division 400, Section 403.06 of theseSpecifications.
DIVISION 600

SECTION 602

STORM SEWERS AND CULVERTS

602.01 Description.

This section covers storm sewer and culvert materials, excavation, trenching, and backfilling for storm sewers and appurtenances. Work shall consist of removal of all material of whatever description that may be encountered; removal and disposal of debris; handling and storage of materials; all necessary bracing, shoring, and protection; pumping and dewatering as necessary; all backfill preparation of subgrades; and, final grading, dressing, and surface restoration cleanup of the site.

602.02 Submittals.

Before the fabrication of the pipe and manholes is started, the contractor shall submit for review, drawings showing the pipe lengths, complete laying schedule, joint details, special sections, and other additional details, such as fittings. All pipe and manholes furnished shall be fabricated in accordance with the reviewed drawings. Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City prior to construction.

602.03 Materials.

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

A. Storm Sewer Pipe and Culverts.

1. Concrete Pipe. Reinforced concrete pipe (RCP) shall conform to the requirements of ASTM C76, latest revision, as modified in this Section. Non-reinforced concrete pipe shall meet the requirements of ASTM C14 for sizes twelve-inch to thirty-inch (12” to 30”). Horizontal elliptical reinforced concrete pipe (HERCP) shall conform to the requirements of ASTM C-507, latest edition. Precast concrete box culverts shall conform to the requirements of ASTM C-1433, latest revision. Reinforced concrete pipe items and concrete box culvert items shall be manufactured in a plant that is certified by the American Concrete Pipe Association.

Minimum wall thickness’ shall be “Wall B” in referenced specifications C76 and C14 of ASTM. Except for special pieces, each joint shall be at least seven and one-half feet (7'6") (2.3m) in length. The class of pipe required shall be shown on the drawings. The cement used in manufacturing reinforced concrete pipe shall be Type II, modified low C3A (less than 5%) or Type V. Lifting holes will not be permitted in
any of the pipe, except elliptical pipe and box sections. Non reinforced concrete pipe must meet the same D-load requirements as reinforced concrete pipe. The Engineer may specify bedding type and fill height requirements.

Joints for the reinforced concrete pipe shall be either tongue and groove or bell and spigot. Unless deleted elsewhere in the specifications, a butyl mastic joint sealant will be installed in each joint. The sealant will be in rope or trowel-applied form, made specifically for permanently sealing joints in concrete pipe, must adhere tightly to the pipe surface, and must form a tight flexible joint. The sealant shall be installed as directed by the pipe manufacturer.

In addition to the certifications and bearing test results, the contractor shall furnish the Owner with mill test reports for all cement used to manufacture proposed pipe. The owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

2. Polyvinyl Chloride Pipe. Polyvinyl chloride (PVC) pipe shall conform to ASTM D-3034, SDR 35 for four inch (4") (100mm) through fifteen inch (15") (375mm) diameter, and ASTM F679 for eighteen-inch (18") (450mm) through twenty-seven inch (27") (675mm) diameter. The pipe shall have bell and spigot joints with an approved gasketed joint. Inert materials, such as limestone, shall not exceed ten (10) parts per one hundred (100) of the resin.

   a. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with PVC pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

3. Corrugated Steel Pipe. Corrugated steel pipe (CSP), band couplers, and fittings, shall be manufactured in accordance with AASHTO M-36, latest edition, as revised in these specifications. All seams shall be joined in a manner that develops the full strength of the pipe and shall not affect the shape or nominal diameter of the pipe. The wall thickness of the steel shall be specified in the Special Provisions.

   a. The materials used to coat the steel sheets shall be specified in the Special Provisions and may be one or more of the following types:

      i. Zinc-coated (galvanized) steel sheets for annular pipe shall be coated in accordance with AASHTO M-218.

      ii. Aluminum coated (Type 2) steel sheets shall be coated by the hot dip process in accordance with AASHTO M-274, M-36, and M-274.
iii. Precoated (Polymeric) galvanized steel sheets shall be coated in accordance with AASHTO M-246 and M-245. The precoated sheets shall be Type C with a polymeric coating in a thickness of 0.010 inch (3mm) minimum on each side and edge of the sheets.

b. After the fabrication of the pipe, the manufacturer will coat the cut ends of each section of pipe with the specified coating before shipping. Exposed uncoated metal at the ends of the pipe may be reason for rejection of the pipe.

c. The CSP shall be joined together with coupling bands manufactured in accordance with AASHTO M-36. If coatings of the CSP are specified, the couplings shall be coated with the same materials. Unless otherwise specified, the couplings shall make a watertight joint.

d. All pipe shall be inspected when delivered to the job site and prior to the unloading of the pipe. Any pipe damaged during shipping and/or handling will be rejected and will not be installed. If the exterior bituminous coating is damaged during installation, the contractor shall repair the coating using approved methods and materials. If the concrete lining is damaged during installation, the contractor shall remove and replace the damaged pipe at no expense to the owner.

e. The pipe supplier shall prepare and supply the contractor with a pipe-laying schedule, and the Contractor's supervisor and superintendent and the owner's representative shall have these laying schedules available on the job site.

f. Connections for the laterals and catch basin leads may be shop fabricated or made in the field. In some instances, field connections shall be required. All field connections shall be saw cut using a saber type saw and templates made for such use. Flame cutting shall not be allowed. After field cuts have been made, the exposed metal shall be coated with the specified coating. Coating materials shall be supplied by the pipe manufacturer. The connection shall be completed according to the manufacturer's recommendations.

g. Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the "Handbook of Steel Drainage and Highway Construction Projects", published by the American Iron and Steel Institute.

i. All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.
ii. The bedding material shall be placed evenly on both sides of the pipe to a point twelve inches (12”) above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored, or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.

iii. Removal of Trench Protection: Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point one foot (1’) above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for “flexible conduits” and create excessive lateral soils pressures and pipe deflections.

iv. Protection of Conduit During Construction: Maximum supporting strength in flexible conduits does not develop until the fill consolidates. Therefore, excessive concentrated loads or heavy equipment on top of or along side of the pipe shall be avoided.

B. Manholes.

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer’s certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.

   a. All manholes shall be constructed with concentric precast sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the standard specifications for precast reinforced concrete manhole sections, ASTM designation C478. The minimum internal diameter for storm manholes shall be forty-eight inches (48”) (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with RAM-NEK material, or approved rubber gasket at each joint. The RAM-NEK and primer must be used in accordance with the manufacturer’s instructions. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM designation C-443. All lifting holes must
be grouted. All cement for manholes shall be Type V Portland cement or modified Type II with equal sulfate resistant characteristics.

b. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C-478. Manholes with the base monolithically poured with the bottom barrel are also acceptable and preferred.

c. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the incoming pipelines, incorporating a finished flow depth of 0.8 to 1.0 diameter of the largest pipe. The completed precast invert shall include an alignment bench for each pipe, and provide for uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be “a-lok tru contour”, or approved equal.

d. The manhole ring and cover shall be centered over the connection at the centerline of flow.

e. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.

C. Catch Basins.

1. All catch basins, inlet boxes, and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Catch basins (storm inlets) shall be cast-in-place or precast concrete with dimensions as shown on the drawings or standard details.

a. Precast concrete catch basins shall comply with all the requirements of ASTM C858 and C857. Cast-in-place concrete basins shall be constructed of materials in accordance with Division 300, Section 301, Portland Cement Concrete.

b. The Contractor may elect to install pre-cast or cast-in-place catch basins.
D. Castings

1. Manhole frames and covers, and catch basins frames and grates shall meet the requirements of this Section unless specified otherwise in the Special Provisions or drawings.

2. Manhole frames and covers shall be six-inch (6”) (150mm) heavy duty Neenah R 1726-A, D&L Supply A-1043, or approved equal. Heavy-duty manhole ring and cover shall have a minimum ring depth of six inches (6”) (150MM).

3. Acceptable grates shall be determined by the design, hydraulic efficiency, and placement required. Additionally, grates must be suitable for use in areas where it is possible for handicap persons and pedestrians to be present. The adoption of the Americans with Disabilities Act (ADA), the prominence of narrow-tired bicycles and concern for pedestrian safety dictates the design considerations of storm water installations.

Grate selection criteria should include a combination of capacity, and functionality for the specific location. Directional and/or vane grates are not recommended at the low points of vertical curves, and shall be used only when approved by the Engineer.

Catch basin frames and curb box shall be Neenah R-3067, D&L Supply I-3517, or equivalent. I-3516 is recommended for use in the lowpoint of vertical curves.

Grates shall be certified by the manufacturer as bicycle friendly, and the certification shall be submitted to the City of Casper prior to installation.

4. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word “storm sewer” clearly cast on its surface.

When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F, D &L E-1043, or approved equal shall be used.

5. Flared end sections for culverts shall be manufactured of the same material as the culvert. End sections shall be fitted for a trash rack on both upstream and downstream ends, or as directed by the Engineer.

E. Granular Materials.

1. Granular materials furnished for foundation, bedding, encasement or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.
2. Granular materials furnished for use in foundation, bedding, or encasement recommended for use in construction are:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Foundation</th>
<th>Bedding and Encasement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (25mm)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>¾ inch (20mm)</td>
<td>85-100</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8 inch (9.5mm)</td>
<td>30-60</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 4 (4.75mm)</td>
<td>0-10</td>
<td>35-100</td>
</tr>
<tr>
<td>No. 200 (0.075mm)</td>
<td>0-10</td>
<td>0</td>
</tr>
</tbody>
</table>

3. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHO T-89 and T-90. Other gradations may be used if written approval is obtained from the City.

4. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.

5. Granular materials provided for Foundation, Bedding, or Encasement use, shall be classified as to use in accordance with the following:

a. Granular Foundation: placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.

b. Granular Bedding: placed from four inches (4") (100mm) below the pipe to the pipe midpoint, to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.

c. Granular Encasement: placed below an elevation one foot (1’) (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill.

6. Granular encasement and bedding material shall meet the gradation requirements listed in Section 602.03.E.2. Other gradations may be used if written approval is obtained from the City Engineer. Gradations should meet the requirements of ASTM 2321. Guidelines for the maximum particle size for encasement material in relation to pipe type and diameter are shown below:

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<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Nominal Diameter</th>
<th>Maximum Particle Size Inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC, Other Plastic</td>
<td>15” and greater</td>
<td>3/4 (20)</td>
</tr>
<tr>
<td>PVC, Other Plastic</td>
<td>Less than 15”</td>
<td>½ (12.5)</td>
</tr>
<tr>
<td>Concrete</td>
<td>6.1 - 12.0 (155 - 300)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>Concrete</td>
<td>12.1 (307) and greater</td>
<td>1 (25)</td>
</tr>
<tr>
<td>CMP</td>
<td>6.1 - 12.0 (155 - 300)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>CMP</td>
<td>12.1 (307) and greater</td>
<td>1 (25)</td>
</tr>
</tbody>
</table>

7. Select Backfill

Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3”) (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3”) (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as the bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

8. Structural Fill Material

Structural fill shall consist of excavated or imported material, free of organic or deleterious material and particles larger than three inches (3”) (75mm) in maximum dimension. Structural fill shall be well graded from coarse gravel to fine sand with less than 10% passing the No. 200 sieve. Structural fill material shall be within +2% of optimum moisture content when placed as determined by Proctor, and shall not exhibit pumping (horizontal or vertical displacement) after completion.

9. Groundwater Barriers

Low permeability groundwater barriers shall be used in areas designated by the City Engineer. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used.

602.04 Execution.

A. Excavation for Pipe and Related Structures (General).

1. Complete all excavation regardless of the material encountered. If structures, utilities, or other objects are encountered that may be necessary for continued facility operation or may need preservation, immediately notify the Engineer and protect said object.
2. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc., from the appropriate authority.

   a. Where trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphal tic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations, when possible.

3. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12”) (300 mm), whichever is less.

4. The disturbed area from construction shall be confined within the construction limits.

   a. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Standards and the trench drained so that workers can work safely and efficiently. It is essential that the discharge of pumps when required, be laid to approved natural drainage channels or storm sewers. Wyoming State Engineer groundwater permits and Department of Environmental Quality discharge permits shall be required for dewatering.

5. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.

6. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2’) (600 mm) or more from the edge of the trench in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction, Chapter XVI, Section 2.i.(1). Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.

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a. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

b. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.

7. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled.

a. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.

8. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added (four inches (4”) (100mm) minimum) to provide uniform bearing and support for each section of pipe at every point along its length. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor’s expense. All bedding material added shall be moistened and compacted to the satisfaction of the City Engineer. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.

a. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.

b. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the City Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the City Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.

c. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.

9. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6”) (150mm) below the outside barrel of pipe and allow a clear width.

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of six inches (6") (150mm) on each side of the pipe. The space between the bottom of the trench in bedrock or rocky areas and the bottom of the pipe shall be backfilled with suitable granular material in three-inch (3") (75mm) uncompacted layers and thoroughly tamped before pipe is installed.

10. Blasting the excavation to remove rock, clay, or hardpan will not proceed until the Contractor has notified the City Engineer of the necessity to do so and obtained written approval. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall fix the hours of blasting. The Contractor at his expense shall repair any damage caused by blasting. The Contractor’s methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and the necessary permits shall be obtained.

11. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1’) (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be wider than the pipe diameter plus three feet (3’) (900mm).

12. Where the trench is not located near existing utilities, buildings, or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench shall be sloped to protect the workers working within them in accordance with Wyoming Occupational Health and Safety Rules and Regulations for Construction. However, the trench must stay within the construction limits.

13. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.

14. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.

15. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.

a. Sheeting or bracing may be left in place in the trench at the discretion of the City Engineer. Any sheeting or bracing left in place shall be cut off approximately three
feet (3’) (900mm) above the top of the pipe or two feet (2’) (.6m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the “Record Drawings” (See Sec. 602.115 of these specifications).

16. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.

B. PCE Testing Requirements

1. Where groundwater contamination is known or suspected, the Contractor shall provide PCE air and water testing services. These services will be required on all excavations where dewatering activities are required and where PCE groundwater contamination is known or suspected. The Contractor shall provide said testing as performed by a certified testing laboratory, and by certified testing methods, and subject to approval of Engineer and City.

2. The Contractor shall provide testing services for the following air and groundwater contamination sampling requirements. All results shall be submitted to Engineer and City.

   a. Air Sampling. One instantaneous test per fifty feet (50’) (16m) of trench shall be taken as the excavation progresses. Results are to be obtained by detector tube test or Organic Vapor Analyzer, or other similar device. These devices must be capable of detecting air quality parameters within the maximum time weighted average (TWA) detection limits for an eight (8) hour period as set by OSHA.

   b. Should air sampling test results yield concentrations higher than those set by Wyoming Occupational Health and Safety Commission, contractor is to immediately notify the Engineer, Owner, City, and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the Contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.

   c. One (1) groundwater PCE contamination analysis shall be taken per stationary excavation site, and two tests per pipeline, same as above. Detection limits for water testing shall be 0.50 micrograms per liter (ppb).

   d. Should water sampling test results yield concentrations higher than those set forth by the EPA Manual Guidance of the Undevelopment and Implementation of Local
Discharge Limitations Under the Pretreatment Program, Dec. 1987, the contractor is immediately to notify the Engineer, Owner, and DEQ to help coordinate a course of action.

C. Volatile Organic Compound Sampling

1. For those sites with known or suspected soil contamination, the contractor shall provide for ongoing volatile organic compound (VOC) monitoring of the air (similar to that described for PCE air monitoring) in the breathing zone of the trench and associated working areas. Monitoring shall be performed using an organic vapor analyzer (OVA) or other similar device capable of detecting air quality parameters within the maximum time weighted average detection limits for an eight-hour period as set by OSHA. All VOC monitoring shall be performed by a trained and competent environmental testing service, subject to prior approval of the Engineer, City, and Owner.

2. If and when the VOC level for any breathing zone test exceeds 5.0 milligrams per liter (ppm), the contractor shall immediately notify the Engineer, Owner, City and DEQ and take the appropriate precautions to inform and protect workers and the public from the contaminant. There are several possible methods for protecting against the contamination some of which include natural trench ventilation, mechanical ventilation, protective clothing and breathing apparatus for workers and combinations of the above. These protective actions shall be the sole responsibility of the contractor and he shall use workers, equipment, and methods approved by OSHA for the types of soil contaminants encountered.

3. The necessary ventilation and protective equipment will be expected to be readily available when the need arises, if VOC (and PCE) contamination is encountered. The cost of any interruptions or reduction in work efficiency resulting from VOC contaminated soils (and PCE) shall be born solely by the Contractor.

D. Dewatering, if required by site conditions, shall be provided by the Contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12”) (300mm) or more below the bottom of the excavation.

2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
3. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

4. In areas where dewatering is required, the Contractor will comply with the following requirements.

   a. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Wyoming Department of Environmental Quality (DEQ). Before starting any construction, the Contractor shall submit an application to discharge to the DEQ along with this proposed dewatering plan for review. The application shall be submitted on “National Pollutant Discharge Elimination System, Application to Discharge from a Construction Project, Short Form E”. If the dewatering plan is revised during construction, a revised plan will be immediately sent to the DEQ by Contractor.

   b. If there is any evidence of hydrocarbon or other contamination of the discharge water the discharge shall immediately cease and the DEQ shall be notified immediately. The Contractor will then comply with DEQ conditions.

   c. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

F. Disposal of Excess Material

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.

2. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

602.05 Pipe Installation

A. The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade. Reasonable care shall be exercised in handling and laying the pipe and fittings. The interior of all pipe and fitting shall be kept
free from dirt and foreign matter at all times, and cleaned out thoroughly before being lowered into the trench. Under no circumstances shall materials be dropped or thrown into the trench.

B. Materials shall be placed where they will not be subject to injury from vehicles or equipment. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor trench will be damaged or disturbed. Pipe shall be lowered into the trench with rope slings, gin poles, dragline, or trench in such manner as to lay the pipe carefully into place and shall be lowered and laid with the bell end upgrade. Holes shall be dug under the bells so that pipe is unsupported at the pipe connection. The laying of pipe in the finished trench shall be started at the lowest point and laid upgrade. The Contractor shall clean and remove all sand, gravel, concrete, and cement grout that has entered the lines in the process of construction.

C. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the Engineer, shall be removed and replaced by the contractor at no additional cost to the owner. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.

D. The Contractor shall keep the pipe, manholes, catch basins, and other structures free from deposits of mud, sand, gravel, or other foreign matter, and in good working condition until the construction is completed and accepted. Upon completion of each line between manholes, a clear and unobstructed view of the whole bore of a pipe shall be obtained between manholes by use of a light or subreflector. If such view is not apparent an air-filled rubber ball, approved by the Engineer, having a diameter one-inch (1\''\) (25mm) less than the tile to be tested, shall be flushed through the line between manholes. Any obstruction found in any line shall be removed by the contractor without cost to the owner. Any methods used by the contractor to remove deposits of mud, sand, gravel, or other foreign matter from the line shall be approved by the Engineer. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.

E. Pipe shall not be laid on frozen ground, or when trench conditions are unsuitable for such work.

F. The upgrade end of pipelines not terminating in a structure shall be plugged with a cap or plug approved by the Engineer.

G. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying and, should any over-excavation exceeding two inches (2\") (50mm) be encountered, the material added shall be moistened (95% of Standard Proctor) and compacted to the density of the existing subgrade or foundation material shall be added at the Contractor's expense.
H. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary so that maximum support on undisturbed ground or pipe zone material will be provided for the pipe. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material, compacted in maximum six inch (6") (150MM) layers to completely fill all space under and adjacent to pipe.

I. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work, except by written permission of the Engineer. The Contractor shall make all connections of pipe to the manholes which have previously been constructed.

J. The Contractor shall connect all existing storm inlets and sewers to the new storm sewer as shown on the drawings. These connections shall be made as the storm sewer construction progresses which will require that each section of the new sewer be fully completed and ready for operation as the construction advances.

1. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris, by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipeline to prevent flotation of the pipeline. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed at the Contractor's expense.

K. Installation for pipelines using flow fill shall be as follows:

1. The mix design for flow fill shall meet the requirements of Division 200, Section 205.05, Control Density backfill mixture requirements.

2. Assembly must be done under dry conditions with all joints completely cleaned of dirt and contaminants. Pipe ends and joints shall be kept covered until connection with next pipe segment or fitting. All joints shall be lubricated in accordance with the manufacturer’s recommendations and assembled by pushing the spigot into the bell until the reference mark on the pipe barrel is flush with the end of the bell.

3. The pipe to be embedded in flow-fill can be laid on a four- to six- inch (4”– 6") (100 – 150 mm) bed of washed gravel that has been excavated for the bells so that the pipe is uniformly supported along its entire length, or the pipe can be set on four inch (4") (100mm) high blocks spaced no further than every ten feet (10') (3m). The flow-fill or washed gravel must bear on undisturbed trench bottom. If necessary, Contractor shall stake the pipe to prevent lateral movement or floating during the placement of the flow-fill. The flow-fill must be placed carefully under and around the pipe and

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extend from undisturbed trench sidewall to sidewall. Placement may be by chute, bucket, or other means to assure that the line and grade of the pipe or pipes is maintained. The flow-fill must extend to at least two inches (2”) (50mm) above the top of the pipe.

L. Installation for pipeline crossings using flow fill shall be as follows:

1. Whenever possible, the pipes should be laid so there are no joints or taps within nine feet (9’) (2.7m) of the crossing. The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches (2”) (50mm) above the top of the upper pipe and extend from one side of the trench to the other. Pipes crossing one another can be separated by as little as four inches (4”) (100mm) when embedded in flow-fill. The flow of flow-fill must be wide enough to ensure the structural integrity of the installation. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of this specification.

2. All sewer services crossing over water mains must be encased in flow-fill in accordance with the provisions of the above specifications.

3. There shall also be a concrete flow-fill barrier between City lines and high pressure petroleum lines.

602.055 Installation of Manholes

A. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:

1. Six inches (6”) (150mm) minimum layer of well-compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.

2. Three inches (3”) (75 mm) of concrete poured on undisturbed soil.

B. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.

C. The Contractor shall provide a minimum of two inches (2”) (50mm) and a maximum of twelve inches (12”) (300mm) in two-inch (2”) (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight in accordance to Drawing 602-2. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.

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1. The minimum two-inch (2") (50 mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.

2. If the number of adjusting rings exceeds the maximum twelve inches (12") (300 mm), the manhole shall be reexcavated and a manhole barrel section installed.

D. Manholes shall be set as shown on drawing 601/5 and 601/2. All lifting holes must be grouted in after placement.

E. When manholes are to be constructed in new streets, manhole rings shall be set to the final grade before the street-wearing course is placed. Riser rings shall not be used to make adjustments for new construction. In gravel or unpaved roads, the manhole ring shall be kept four to six inches (4”-6”) (100mm-150mm) below the road surface.

F. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of storm water. The invert forming system shall be “A-Lok Tru Contour”, or approved equal.

1. Floor troughs shall be furnished for all storm sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.

602.06 Trench Backfilling.

A. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.

1. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompressing will be at the Contractor’s expense regardless of the condition of the pipe and/or the materials under question.

2. The Contractor shall completely backfill all excavations before stopping work at the end each day. Open excavations (fenced or unfenced) shall not be allowed overnight or on weekends at any site after work has stopped for the day unless approved by the City.
B. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City’s opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000’) (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.

C. Bedding Material. Bedding material shall be placed as shown on the typical trench detail. Spread and surface grade bedding material to provide continuous and uniform support beneath pipe at all points between bell holes or pipe joints. Particular attention shall be given to the area from the base of the pipe or culvert to the centerline to ensure firm, uniform, and continuous support is obtained and to prevent any lateral movement upon subsequent backfilling or under service conditions. Bedding material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Bedding material shall be moisture conditioned to +2% to –4% of optimum and compacted to 90% maximum density, as determined by ASTM D698. Pipe zone material shall be placed manually with shovels, and tamped in maximum 6” lifts and evenly placing the material on both sides of the pipe. Material shall not be dropped directly onto pipes or culverts when using loaders or backhoes. Bedding material shall not exhibit pumping (horizontal or vertical displacement) after compaction. Encasement material will then be placed around and over the top of the pipe, but need not be hand placed.

D. Trench Backfill above the Encasement Zone. Trench backfill above the encasement zone may consist of excavated material or select backfill material. Excavated material shall be used unless its gradation does not meet the requirements of select backfill material. Backfill material shall be pushed onto the slope of the excavated trench and allowed to slide down into the trench. Backfill material shall not be permitted to free fall into the trench until at least two feet (2’) (600mm) of cover is over the pipe or culvert. Moisture conditioning may be provided by water trucks or hoses. Excavated or select backfill material shall not exhibit pumping (horizontal or vertical displacement) after compaction.

E. Backfilling shall be done in lifts of uniform layers which will produce the required compaction. Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.

F. Groundwater barriers shall be placed at maximum three hundred feet (300’) (90m) intervals or where directed by the Engineer. These shall be provided to interrupt the passage of water through the foundation, bedding, encasement, and select backfill material. The barriers shall be compacted to 95% of maximum density (Standard Proctor) the full depth of the granular material, the full trench width and a minimum of three feet (3’) (900mm) long.

G. In-place densities of compacted backfill material shall be determined by the Engineer using either ASTM standard test method D1556-82 (Sandcone) or ASTM standard test method Section 602, Page 19 of 24
D2922-81 (nuclear). The minimum and maximum dry density for non-cohesive materials such as clean sands and gravel shall be determined by ASTM D4253 and D4254. The maximum dry density for cohesive backfill materials, such as clays, silts, etc., shall be determined by ASTM D698.

1. Backfill above the encasement zone shall be compacted to the minimum densities and moisture conditions listed below. The densities listed below may only be modified through a geotechnical report.

<table>
<thead>
<tr>
<th>Area</th>
<th>Cohesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streets, highway, alleys</td>
<td>95%, ±2%</td>
</tr>
<tr>
<td>Sidewalks, curbs, and driveway</td>
<td>95%, ±2%</td>
</tr>
<tr>
<td>Lawns and cultivated areas</td>
<td>90%, ±2%</td>
</tr>
</tbody>
</table>

H. Care of Utilities. In excavating and backfilling for pipelines or structures, extreme care must be taken so as to not mar or injure any gas, telephone, sewer, water, power, or television lines. The utility owner shall be notified that the relocation is necessary and shall be given adequate time to provide for the relocation. See Division 100, Section 101.06 for more detail on utility locates.

I. When the trench excavation for the sewer main and appurtenances is within the rights-of way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.

J. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.

K. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compacting and grading and on all detours and bypasses.

L. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.
M. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

602.07 Installation of Structures.

A. Structures shall be set on a six-inch (6") (150mm) layer of foundation material when directed by the Engineer. The surface shall be accurately graded to provide uniform bearing for the structure.

B. Catch basins shall be constructed at the locations shown on the drawings and approved by the Engineer. The size and type of catch basins shall be shown on the drawings or in the Standard Details of the Specifications. Catch basin frames shall be set accurately to grade. Concrete grout shall then be placed around and beneath the frame to hold the grate securely in place.

C. Manhole castings shall be installed one-fourth inch (1/4") (6.25mm) to one-half inch (1/2") (12.5mm) below the surface of the existing pavement. Where the structure is in unpaved streets, the manhole casting shall be set to the future street elevation. The casting shall be constructed as shown in the Standard Details. The contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight. The bearing surface around the perimeter of the frame shall be grouted to a height within two inches (2") (50mm) from the existing street surface, and to a width of twelve inches (12") (300mm) greater than the manhole ring, and a depth of six inches (6") (150mm) below the bottom adjusting rings or one foot (1') (300MM), whichever is greater. The manhole frame shall then be tacked and asphaltic concrete pavement shall be placed for the final two inches (2") (50mm).

602.08 Structure Backfilling.

A. Structure backfilling shall cover manholes, catch basins, junction boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of structural fill material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure. Special attention shall be given to the compaction operation around structures to ensure uniform compaction.

B. Do not place fill when the surface to be filled is snow covered or frozen. Do not place frozen fill.

C. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and
trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.

D. Place fill material in eight inch (8”) (200mm) maximum lifts and compact to at least 95% density for cohesive soils. The moisture content shall be +2% to –2% of optimum.

602.09 Cleanup.

A. Construction cleanup and all backfill operations shall directly follow the storm sewer installation. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.

B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

1. See Division 100, Section 101 for additional cleanup requirements.

602.10 Quality Control.

A. Light Test. After the trench has been backfilled, a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the plans, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at his own expense.

B. Leakage Test. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels, or bells, etc.) will not be allowed.

C. Gradation Test.

1. Bedding Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.

2. Foundation Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.

3. Structural Fill Material. One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd³) (750m³) placed of each material.
4. **Select Backfill Material.** One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd$^3$) (750 m$^3$) placed of each material.

5. **Encasement Backfill Material.** One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd$^3$) (750 m$^3$) placed of each material.

6. All gradation tests shall be the responsibility of the Contractor using a certified approved testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.

D. **Density Test.**

1. **Encasement Zone Material.** One test for each five hundred lineal feet (500’) (150m) pipe installed.

2. **Bedding Zone Material.** One test for each five hundred lineal feet (500’) (150m) pipe installed.

3. **Trench, Select Backfill Material, and/or Structural Fill Material.** One standard proctor test ASTM D698 or one relative density test, (ASTM D4253 and D4254) for each type of material for every two foot (2’) (600mm) of trench depth above the pipe zone per every one hundred lineal feet (100’) (30m) pipe installed. The Engineer may elect to take one test for each one thousand cubic yards (1000yd$^3$) (750m$^3$) or a portion thereof.

4. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Owner/Engineer. The Contractor shall cooperate with the Engineer or testing agency. If the initial moisture/density tests fail, the Contractor will be responsible for all costs associated with retests, until a passing moisture/density test is completed.

E. **Deflection Test** – Mandrel testing for flexible conduit may be determined by the Engineer.

602.105 Final Acceptance and Record Drawings.

A. “Record Drawings” shall be submitted to the City prior to preliminary acceptance of the construction project. “Record Drawings” shall include, in addition to construction drawings and details, “as built” information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.
B. Final Acceptance

1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbwalk is completed.

2. Before final acceptance of any sanitary sewer, the following inspections shall be made:
   a. All lines clean and flushed
   b. Manholes up to proper grade in a proper condition

3. All punch list items must be completed prior to final acceptance.

4. The warranty period shall not start until final acceptance is obtained and a complete set of “Record Drawings” is submitted to the City.

602.11 Standard Detail Sections

602/1 Typical Street Cut Section Asphalt Surfacing
602/2 Standard Manhole Frame and Cover Grade Adjustment Detail
602/3 Standard Straight Manhole for Depths of 6’0” or Less
602/4 Standard Catch Basin Detail
602/5 Standard Storm Sewer Manhole Detail for Manhole Depth ≥ 6’ Invert to Rim
602/6 Standard Trash Guard Detail
DIVISION 620

SECTION 621

GEOTEXTILES FABRICS AND MEMBRANES

621.01 Description

This section covers furnishing and placing geotextile as shown on the plans or directed, in accordance with these specifications. The geotextile usage will determine the applicable specifications and the corresponding pay item.

621.02 Materials

The geotextile shall consist only of woven or non-woven, long-chain polymeric filaments or yarns such as polyethylene, polyester, polyamide, or polyvinylidene chloride formed into a stable network such that the filaments or yarns retain their relative positions to each other. The geotextile shall conform to the requirements of section 620, as applicable for the specified use.

621.03 Equipment

Equipment loads when placing and compacting the material placed over the geotextile shall comply with the following:

a. Maximum wheel load shall be 9,945 pounds (4500 kg), or as specified.

b. Maximum contact pressure shall be 60 psi (400kPa). The contact pressure is calculated from the applied wheel load in newtons and the resulting contact area in square meters.

c. Rutting in excess of three inches (3") (75mm) will not be allowed. Equipment loads are to be lightened if this occurs. Ruts shall be repaired by filling the ruts with additional material.

621.04 Construction Requirements.

The geotextile shall be lapped a minimum of two feet (2’) (0.6m) at ends and sides of adjoining sheets unless shown otherwise on the plans. Geotextile that is joined by sewing shall have strength properties at the seam equal to the specified strength requirements of the geotextile. All seams shall be exposed for ease of inspection. High-strength polyester, polypropylene or kevlar thread shall be used for sewn seams. Nylon threads shall not be used. Overlapping J seams and double sewing are required for field seams. The requirements for overlapping of seams shall be two feet (2’) (0.6m) minimum or as specified on the plans.

Gravel, base course, sand, or other specified material shall be placed on the geotextile so that it is not torn, punctured, or shifted. Maximum pile heights of materials shall be limited to prevent geotextile distortion. Any geotextile that is torn or punctured shall be repaired. The repair shall
consist of a patch of the same type of geotextile placed over the ruptured area and overlapped a minimum of three feet (3') (1m) from the edge of any part of the rupture, or a sewn patch with the same requirements for seam strength as that of the geotextile being repaired.

Pegs or pins, as approved by the Engineer, may be used to hold the geotextile for embankment erosion control in place until the specified cover material has been placed. Pegs or pins shall not be used for other types of geotextile installations without approval of the Engineer. If such approval is given, pegs or pins shall be used only at locations that are not detrimental to the finished product.

When geotextile is used for foundation stabilization, the following criteria shall govern:

a. The cover material shall be placed over the geotextile in 1-foot (0.3m)+/- lifts.

b. Equipment shall not be operated directly on the geotextile. The minimum left thickness shall be maintained at all times.

c. The cover material shall be compacted with a roller or other equipment as approved by the Engineer.

d. Prior to the installation of geotextile, the subgrade shall be leveled and smoothed to remove ruts, depressions, or humps, which exceed four inches (4") (100mm). The surface also shall be free of rocks, stumps, roots, brush, limbs, or other objects that might tear or puncture the geotextile or result in geotextile wear.

During periods of shipment and storage, the geotextile shall be enclosed in heavy duty wrapping to protect it from direct sunlight, ultraviolet rays, temperatures greater than 140°F (60°C), mud, dirt, dust, and debris. Any geotextile left unprotected shall be removed from the project.

The product name, type of material and the lot or batch identification shall be clearly labeled on each roll.

Except for geotextile used for erosion control and silt fence, the cover material shall be placed over the fabric within five (5) days.

Test results, with a certification by the manufacturer showing the geotextile performance in regard to the material requirements of this specification, shall be submitted to the Engineer. At least two weeks before the use of any geotextile, a sample six feet (6’) (2 m) in length by the full width of the roll shall be submitted to the Engineer. The sample shall be labeled with the product name, machine direction, the lot and batch number, date of sampling, project number, and certification of compliance with the material specifications. If sewing is specified, a seam sample also shall be submitted to the Engineer. The sample sewn section shall be six feet (6’) (2 m) by three feet (3’) (1 m) with the seam in the center and parallel to the six feet (6’) (2 m) length.
621.05 Method of Measurement.

The Engineer will measure Geotextile by the square yard of surface area covered. No measurement will be made for overlaps. Pins, pegs, sewn seams, or other items necessary for the placement of the geotextile will be subsidiary to the pay item.
DIVISION 620
SECTION 623
PAVING FABRIC

623.01 Description

This section describes furnishing and placing asphalt sealant and fabric as a stress relieving membrane within the pavement structure. This applies to fabric membranes used for full coverage of the pavement, or as strips over transverse and longitudinal pavement joints.

623.02 Materials

The asphalt cement shall meet the manufacturer’s specifications and as directed by the Engineer. The paving fabric shall meet the requirements of this specification and as directed in the plans and specifications.

623.03 Equipment

The distributor shall meet the requirements as specified in 404.05. The distributor shall have a single nozzle hand spray with a positive shut-off valve.

Mechanical or manual laydown equipment shall be used for laying the fabric smoothly and evenly.

A pneumatic roller may be used if required.

623.04 Construction Requirements

Air and pavement temperature shall be 50° F (10°C) and rising. Only one paving fabric product shall be furnished for use on the project.

623.05 Fabric Storing

Fabric rolls shall be wrapped for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes.

Fabric rolls shall be stored and protected from the weather. If stored outdoors, the rolls shall be elevated and protected with a waterproof cover.
623.06 Surfacing Preparation.

The fabric shall be placed on a clean surface free of dirt, water, vegetation, and other debris.

623.07 Application of Asphalt Sealant.

The asphaltic sealant shall be uniformly applied to the prepared dry pavement surface at the rate and to the width indicated in the contract documents. Application of the asphaltic sealant shall be by distributor spray bar, with hand spraying kept to a minimum. For asphalt cements, the minimum application temperature shall be 290°F (140°C), and the distributor tank temperatures shall not exceed 325 °F (160°C).

The width of the asphaltic sealant application shall be the fabric width plus six inches (6”) (150mm). The asphaltic sealant shall not be applied any farther in advance of the fabric placement than the distance that can be maintained free of traffic. Excess asphaltic sealant shall not be applied.

Asphalt spills shall be cleaned from the road surface to avoid flushing and fabric movement.

623.08 Fabric Placement.

The paving fabric shall be placed immediately in advance of the plant mix bituminous pavement so the paving fabric membrane is not exposed to traffic. Temporary traffic control, including flagging, shall be provided by and at no additional cost to the City of Casper to protect the fabric from exposure to traffic.

The fabric shall be placed into the asphaltic sealant with a minimum of wrinkling before the asphalt sealant has cooled and lost tackiness. Wrinkles or folds in excess of one inch (1”) (25mm) shall be slit and laid flat.

Brooming shall be used to maximize fabric contact with the pavement surface. A pneumatic roller shall be used when ambient temperature is lower than 60° F (15°C) or the wind speed in greater than 20 mph (30 km/h).

Stiff bristle brooms or squeegees to smooth the fabric, scissors or blades to cut the fabric, and brushes for applying the asphalt sealant at fabric overlaps shall be provided.

Overlap of fabric joints shall be sufficient to ensure full closure of the joint and shall not exceed six inches (6”) (150mm). Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. A second application of asphalt sealant to fabric overlaps will be required if additional asphaltic sealant is needed to ensure proper bonding of the double fabric layer. The City of Casper may require a representative of the fabric manufacturer to be on the project during the beginning of placement of the fabric.
Paving equipment and hauling units shall be operated so that braking, turning movements, and reversing direction of travel do not cause wrinkling, folding, or displacement of the fabric. Damaged fabric shall be replaced without additional payment.

Only emergency and construction traffic will be allowed on the fabric.

**623.09 Hot Plant Mix Overlay**

The temperature of the mix shall not exceed 325°F (160°C). In the event the asphalt bleeds through the fabric causing construction problems before the overlay is placed, the areas shall be blotted by spreading washed sand or hot mix.

**623.10 Method of Measurement**

The Engineer will measure paving fabric by the square yard (square meter) of surface area, complete, in place, with no allowance for overlaps. The fabric unit price will be full compensation for preparation of the application surface, application of asphalt cement, furnishing and placing the fabric, furnishing and placement of sand or broadcast hot-mix material, when required, and all labor, equipment, tools, and incidentals necessary to complete the fabric placement.

The Engineer will measure and document the asphalt cement (sealant) as provided for per the contract. The measurement will not include quantities of asphalt cement applied in excess of the application rate, as specified by manufacturer, or shown on the plans.

**623.11 Paving Fabric**

The fabric shall be non-woven, needle punched, with long-chain synthetic polymers composed of at least 85% polyolephins, polyesters, and polyamides by mass. The fabric shall be designed as a paving underseal fabric. The fabric shall be resistant to chemical attack, mildew, and rot. The fabric shall meet the following physical requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Mass</td>
<td>Texas DOT Test Method Tex-616-J</td>
<td>100 min.-200 max. g/m^2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 oz/sq. yd.</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 5034</td>
<td>400 min. N</td>
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<tr>
<td></td>
<td>Grab Method G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASTM 4632-91</td>
<td>90-100 min.lbs.</td>
</tr>
<tr>
<td>Elongation at Break %</td>
<td>ASTM D 5034 Grand Method G</td>
<td>50 minimum</td>
</tr>
<tr>
<td>Asphalt Retention</td>
<td>Texas DOT Test Method Tex-616-J</td>
<td>900 min. ml/m^2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.20 g/yds^2</td>
</tr>
<tr>
<td>Melting Point</td>
<td>ASTM D 276</td>
<td>142 min. °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 – 300 °F</td>
</tr>
</tbody>
</table>
The minimum roll width shall be three meters (3 m) or twelve feet (12’). Notarized tests for samples taken for the lot(s) of fabric delivered to the project shall be submitted by the Contractor with the certification for the paving fabric. The number of samples taken for testing shall be in accordance with Procedure A of ASTM D 4354. A production lot shall be defined in ASTM D 4354 Section 6.1. A production unit is referred to in ASTM D 4354 Section 6.2.1. shall be an individual roll of fabric.
## MEMBRANE SPECIFICATIONS

### 624.01 Geotextile Membrane Requirements

<table>
<thead>
<tr>
<th>Fabric and Membrane Property</th>
<th>Test Method</th>
<th>Drainage &amp; Filtration</th>
<th>Erosion Control</th>
<th>Silt Fence</th>
<th>Separation &amp; Stabilization</th>
<th>Embankment &amp; Retaining Wall Reinforcement</th>
<th>Impermeable Plastic Membrane</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Geotextile and Membrane Requirements (*Minimum Roll Averages)</td>
<td></td>
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</tr>
<tr>
<td>Equivalent or Apparent Opening Size, US Standard Sieve (mm)</td>
<td>ASTM D4751</td>
<td>40-70 (0.425-0.212)</td>
<td>40-100 (0.425-0.150)</td>
<td>20-30 (0.850-0.600)</td>
<td>30-50 (0.600-0.300)</td>
<td>40-100 (0.425-0.150)</td>
<td>30-70 (0.600-0.212)</td>
</tr>
<tr>
<td>Thickness, Mils (mm)</td>
<td>ASTM D 5199</td>
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</tr>
<tr>
<td>Permittivity, Sec –1</td>
<td>ASTM D 4491</td>
<td>1.0</td>
<td>1.0</td>
<td>0.05</td>
<td>0.05</td>
<td>1.0</td>
<td>0.05</td>
</tr>
</tbody>
</table>
### GEOTEXTILE AND IMPERMEABLE PLASTIC MEMBRANE SPECIFICATIONS

#### Geotextile and Membrane Requirements (*Minimum Roll Averages*)

<table>
<thead>
<tr>
<th>Fabric and Membrane Property</th>
<th>Test Method</th>
<th>Drainage &amp; Filtration</th>
<th>Erosion Control</th>
<th>Silt Fence</th>
<th>Separation &amp; Stabilization</th>
<th>Embankment &amp; Retaining Wall Reinforcement</th>
<th>Impermeable Plastic Membrane</th>
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</tbody>
</table>

#### STRENGTH REQUIREMENTS

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Grab Tensile Strength, lb. (N)</th>
<th>Elongation at Failure, %</th>
<th>Trap Tear Strength, lb. (N)</th>
<th>Puncture Strength, lb., (N)</th>
<th>Seam Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength, lb. (N)</td>
<td>ASTM D 4632</td>
<td>90 (400)</td>
<td>180 (800)</td>
<td>15 MIN</td>
<td>40 MIN</td>
<td>40%</td>
</tr>
<tr>
<td>Elongation at Failure, %</td>
<td>ASTM D 4632</td>
<td>40 MIN</td>
<td>40 MIN</td>
<td>15 MIN</td>
<td>40 MIN</td>
<td>40%</td>
</tr>
<tr>
<td>Trap Tear Strength, lb. (N)</td>
<td>ASTM D 4533</td>
<td>40 (175)</td>
<td>70 (310)</td>
<td>50 (220)</td>
<td>65 (300)</td>
<td>90%</td>
</tr>
<tr>
<td>Puncture Strength, lb., (N)</td>
<td>ASTM D 4833</td>
<td>50 (220)</td>
<td>90 (400)</td>
<td>50 (220)</td>
<td>90 (400)</td>
<td>90%</td>
</tr>
<tr>
<td>Seam Efficiency, %</td>
<td>ASTM D 4632</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

*Numbers in parentheses indicate metric values.*
624.02 Environmental Requirements

<table>
<thead>
<tr>
<th>Geotextile And Membrane Requirements (*Minimum Roll Averages)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENVIRONMENTAL REQUIREMENTS</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Ultraviolet Resistance, %</td>
</tr>
</tbody>
</table>

* Minimum Roll Average: All property values, with the exception of apparent opening size (AOS) represents minimum average roll values in the weakest principal direction (i.e., average test results of any roll in a lot sampled for conformance or quality assurance testing shall meet or exceed the minimum values provided. Values for AOS represent maximum average roll values.