Please read this entire document before implementing its content. All other standards referenced in this manual shall be considered to be the current version of that particular standard.

Welcome to construction in the City of Temple! This publication has been created through the efforts of builders, utility contractors, civil contractors, civil engineers, developers and city staff. The City of Temple Design and Development Standards Manual is intended to serve as a minimum guideline for infrastructure construction within the City of Temple.

Hundreds of hours have been spent by dedicated participants to develop minimum design and development standards for use in the City of Temple. Revisions to the manual are on-going and will be incorporated into the Manual as approved in accordance with the City Development Standards process. Please verify that your Manual is up to date with all revisions.

This manual is for the use of civil engineers, architects, builders and developers for minimum specification for construction. Each project designed in the City of Temple should include plans and specifications based upon these standards.

The Development Manual is not to be used as a second set of specifications for any given project. Project specifications should not simply refer to the manual, but should incorporate those aspects relevant to the particular job.

Accompanying the written specifications are drawings that further explain the construction methods.
<table>
<thead>
<tr>
<th>Change No.</th>
<th>Effective Date</th>
<th>Division No.</th>
<th>Section No.</th>
<th>Revision Description</th>
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<tr>
<td>1</td>
<td>1/17/2008</td>
<td>200</td>
<td>End</td>
<td>Survey Monumentation Standards</td>
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<td>2</td>
<td>12/13/2007</td>
<td>Details</td>
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<td>ROW Management</td>
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<td>3</td>
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<td>500</td>
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**DIVISION 100**

**General Provisions**

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<tr>
<td>101</td>
<td>Definitions and Abbreviations</td>
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</tbody>
</table>
ITEM 101. DEFINITIONS AND ABBREVIATIONS

101.1 DEFINITIONS
The following words and expressions, or pronouns used in their place, shall wherever they appear in this Contract be construed as follows, unless a different meaning is clear from the context:

**Approved, Directed, Required, and Words of Like Import:** Whenever they apply to the work or its performance, the words “directed,” “required,” “permitted,” “ordered,” “designated,” “established,” “prescribed” and words of like import used in the contract, specifications or upon the drawings shall imply the direction, requirement, permission, order, designation or prescription of the CITY; and “approved,” “acceptable,” “satisfactory” and words of like import shall mean approved by, acceptable to or satisfactory to the CITY.

**Addendum, Bulletin or Letter of Clarification:** Any additional contract provisions, or change, revisions or clarification of the contract documents issued in writing by the CITY, to prospective bidders prior to the receipt of bids.

**Backfill:** embedment and final backfill

**Base:** a layer of specified material of plan thickness placed immediately below the pavement course surfacing.

**Bedding:** material upon which a pipe rests.

**Bulletin:** see Addendum.

**Change Order:** A written order to the CONTRACTOR authorizing and directing an addition, deletion or revision in the work within the general scope of the contract documents, or authorizing an adjustment in the contract price or the contract time.

**CITY:** City of Temple, Texas or its representatives.

**Contract or Contract Documents:** Contract documents are all of the written, printed, typed and drawn instruments that comprise and govern the performance of the contract as defined herein. The contract and contract documents include the advertisement, instructions to bidders, proposal, addendum, specifications, including the general, special and technical conditions, provisions, plans or working drawings - and any supplemental changes or agreements pertaining to the work or materials therefore; and bonds and any additional documents incorporated by reference in the above.

**Contract Price:** The total monies payable to the CONTRACTOR under the terms and conditions of the contract documents. When used in such context, it may also mean the unit price of an item of work under the contract terms.

**Contract Work:** Everything expressly or impliedly required to be furnished and done by the CONTRACTOR by any one or more parts of the contract documents, except "extra work" as hereinafter defined; is being understood that, in case of any inconsistency between any part or parts of this Contract, the CITY shall determine which shall prevail.

**CONTRACTOR:** The person, persons, partnership, firm, corporation, association or organization, or any combination thereof, as an independent contractor entering into the contract for the execution of the work, acting directly or through a duly authorized representative.

**Other CONTRACTORS:** Any contractor, other than the CONTRACTOR or its subcontractors, who has a direct contact with the CITY for work on or adjacent to the site of the work.

**Day or Days:** Any successive days of the week or month, no days being excepted. It shall be taken to mean the same as a normal calendar day.

**Drawings or Contract Drawings:** Only those drawings specifically entitled as such and as specified in the contract or in any bulletin, or any detailed drawing furnished by the CITY, pertaining or supplemental thereto.

**Embedment:** bedding and initial backfill.

**Engineer:** The Engineer or its duly authorized representative means the Engineer of the CITY.

**Equivalent:** Material, articles or methods which are of equal or higher quality than those specified or shown on the drawings and as determined by the engineer in his or her sole discretion.

**Extra Work:** Work other than that which is expressly or impliedly required by the Contract documents at the time of the execution of the Contract.

**Final backfill:** material required to fill the trench from the top of the initial backfill to ground elevation or subgrade of a street.

**Initial backfill:** material that covers the wastewater collection system and water lines, storm sewer, box culvert and the like.

**Inspector:** Any representative of the CITY designated to inspect the work.
Letter of Clarification: See Addendum.

Maintenance Bond: A bond executed by a corporate surety in accordance with Article 7.19-1, Vernon’s Texas Insurance Code, in the amount of the contract guaranteeing the prompt, full and faithful performance of the general guaranty and warranty contained in the Contract Documents.

Major Item: A major item is any line item of the work to be performed which amounts to 5 percent or more of the total contract amount.

Vendor or Supplier: Any subcontractor contracting with the CONTRACTOR, or any of its subcontractors, to fabricate or deliver or who actually fabricates or delivers, materials, supplies or equipment to be consumed or incorporated into the work.

Notice: Written notice effective the date of the postmark thereon, or if hand delivered, effective the date of hand delivery, or if electronically delivered.

Payment Bond: A bond executed by a corporate surety in accordance with Article 7.19-1, Texas Insurance Code and Chapter 2253, Texas Government Code, in the amount of the contract, solely for the protection and use of payment bond beneficiaries who have a direct contractual relationship with the general CONTRACTOR or a subcontractor to supply public work labor or material.

Performance Bond: A bond executed by a corporate surety in accordance with Article 7.19-1, Texas Insurance Code and Chapter 2253, Texas Government Code, in the amount of the contract, solely for the protection of the CITY, conditioned on the faithful performance of the work in accordance with the plans, specifications, and contract documents.

Plan or Plans: The plans are the drawings or reproductions there from made by or approved by the CITY showing in detail the location, dimension and position of the various elements of the project, including such profiles, typical cross-sections, layout diagrams, working drawings, preliminary drawings and such supplemental drawings as the CITY may issue to clarify other drawings or for the purpose of showing changes in the work hereinafter authorized by the CITY. The plans are usually bound separately from the other parts of the Contract Documents, but they are part of the Contract Documents just as though they were bound therein.

Proposal: The written and signed offer of the bidder, when submitted on approved proposal forms, to perform the contemplated work and furnish the necessary material and labor in accordance with the provisions of the plans and specifications, special and general provisions, and all contract documents.

Site: The area upon or in which the CONTRACTOR’S operations are carried on, and such other areas adjacent thereto as may be designated as such by the CITY.

Special Provisions or Conditions: The special clauses of the contract, setting forth conditions or requirements peculiar to the specific project involved, supplementing the standard or general specifications and taking precedence over any conditions or requirements of the standard or general specifications with which they are in conflict.

Specifications or Contract Specifications: All of the general, special and technical conditions or provisions, and all addendum or supplements thereto.

Subbase: a layer of specified material of plan thickness between a base and a subgrade.

Subcontractors: Any persons, firm or corporation, other than employees of the CONTRACTOR, who or which contracts with the CONTRACTOR to furnish, or who actually furnishes, labor and/or materials and equipment at or about the site.

Subgrade: that portion of the roadbed upon which the subbase, base or the pavement is to be placed. 18-24 in. beyond the back of the curb for streets, which are to be paved with concrete.

Sureties: The corporate bodies which are bound by such bonds as are required with and for the CONTRACTOR. The sureties engaged to be responsible for the entire and satisfactory fulfillment of the Contract, and for any and all requirements as set out in the specifications, Contract or plans. In order for a surety to be acceptable, the surety shall conform to the requirements of Article 7.19-1, Texas Insurance Code.

Work: All work including the furnishing of all labor, materials, tools, equipment, required submittals and incidentals to be performed by the CONTRACTOR under the terms of the contract.

Working Time, Completion Time or Contract Time: The time set forth in the contract for the performance and completion of the work contracted for. The time may be expressed as calendar days, working days or a specific date.

Working Day: A working day is defined as a calendar day not including Saturdays, Sundays or those legal holidays as specified in the list prepared by the CITY for contract purposes, in which weather or other conditions not under the control of the CONTRACTOR shall permit the performance of the principal units of work underway for a
continuous period of not less than seven hours between 7am and 6pm. A principal unit of work shall be that unit which controls the completion time of the contract.

101.2 ABBREVIATIONS AND ACRONYMS
Wherever the abbreviations defined herein occur on the plans, in the specifications, contract, bonds, advertisement, proposal or in any other document or instrument herein contemplated or to which the specifications apply or may apply, the intent and meaning shall be as follows:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>%</td>
<td>Percent</td>
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<tr>
<td>'</td>
<td>Foot or Feet</td>
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<tr>
<td>”</td>
<td>Inch or Inches</td>
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<tr>
<td>#</td>
<td>Pound or pounds</td>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
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<tr>
<td>ABA</td>
<td>American Bankers Association</td>
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<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
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<tr>
<td>AYA</td>
<td>American Public Works Association</td>
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<tr>
<td>AWPA</td>
<td>American Wood-Preservers' Association</td>
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<tr>
<td>AWS</td>
<td>American Welding Society</td>
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<tr>
<td>AVWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>B</td>
<td>Trench width</td>
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<td>B.</td>
<td>Centigrade</td>
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<tr>
<td>C</td>
<td>Cubic Centimeter</td>
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<tr>
<td>cc</td>
<td>Code of Federal Regulations</td>
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<tr>
<td>CFR</td>
<td>Cubic feet per second</td>
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<tr>
<td>cfs</td>
<td>Cast Iron</td>
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<tr>
<td>CI</td>
<td>Center Line</td>
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<td>CL</td>
<td>Centimeter</td>
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<tr>
<td>cm</td>
<td>Cleanout</td>
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<tr>
<td>CO</td>
<td>Cleveland Open Cup</td>
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<tr>
<td>C.O.C.</td>
<td>Concrete</td>
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<tr>
<td>Conc.</td>
<td>Conduit</td>
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<tr>
<td>Cond.</td>
<td>Corrugated Centistokes</td>
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<tr>
<td>Corr.</td>
<td>(Viscosity)</td>
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<tr>
<td>cSt</td>
<td>Cubic</td>
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<td>Cu.</td>
<td>Culvert</td>
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<td>Culv.</td>
<td>Cubic Yard</td>
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<tr>
<td>CY, C.Y.</td>
<td>Inside Diameter</td>
</tr>
<tr>
<td>D</td>
<td>Ductile Iron</td>
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<tr>
<td>DI</td>
<td>Diameter</td>
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<tr>
<td>Dia.</td>
<td>Driveway</td>
</tr>
<tr>
<td>Dr.</td>
<td>Elevation</td>
</tr>
<tr>
<td>Elev.</td>
<td>Fahrenheit</td>
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<tr>
<td>F</td>
<td>Factory Mutual</td>
</tr>
<tr>
<td>FM</td>
<td>Feet per second</td>
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<tr>
<td>fps</td>
<td>Foot or Feet</td>
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<tr>
<td>Ft.</td>
<td>Gallon</td>
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<tr>
<td>Gal.</td>
<td>Gram</td>
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<tr>
<td>g, gm</td>
<td>High Density Polyethylene</td>
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<tr>
<td>HDPE</td>
<td>Horsepower</td>
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<tr>
<td>HP</td>
<td>Horsepower</td>
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<td>Hr.</td>
<td>Hour</td>
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ID  Inside Diameter
in.  Inch or Inches
ISSA  International Slurry Surfacing Association
Kg or kg  Kilogram
kPa  Kilopascals
L  Liter
Lb.  Pound or Pounds
LDPE  Low Density Polyethylene
LF.  Linear foot or feet
Lin.  Linear
LL  Liquid Limit
LLDPE  Linear Low Density Polyethylene
LMDPE  Linear Medium Density Polyethylene
LOI  Loss on Ignition
M  Meter
Max.  Maximum
MH  Manhole
Min.  Minimum or Minute
M.J.  Mechanical Joint
mm  Millimeter
Mod.  Modified
Mono.  Monolithic
mph  Miles per hour
MSS  Manufacturers Standardization Society of the Valve and Fittings Industry
MPa  Megapascal
MUTCD  (Texas) Manual on Uniform Traffic Control Devices
NACE  National Association of Corrosion Engineers
Nat’l  National
NEMA  National Electrical Manufacturers Association
No.  Number
N.P.T.  National Pipe Thread
NRMCA  National Ready-mixed Concrete
NSF  National Sanitation Foundation
o.d., OD  Outside Diameter
OSHA  Occupational Safety and Health Administration
oz.  Ounce
Pa  Pascal
PI, P.I.  Plasticity Index
pm, p.m.  After noon
psi  Pounds per Square Inch
PVC  Polyvinyl Chloride
PVCO  Molecularly Oriented PVC
R  Radius
RAP  Recycled/Reclaimed Asphalt Pavement
RCP  Reinforced Concrete Pipe
RCRA  Resource Conservation and Recovery Act
Reinf.  Reinforced or reinforcing
Rem.  Remove
Rep.  Replace
Sani., San.  Sanitary
SD  Storm Drainage
Sec.  Second
S.F.  Saybolt Furol (Viscosity)
Sq.  Square
SSPC  The Society for Protective Coatings [formerly Steel Structures Painting Council]
St.  Street
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>Std.</td>
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<td>Str.</td>
<td>Strength</td>
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<tr>
<td>STS</td>
<td>Stainless Steel</td>
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<tr>
<td>SWPPP</td>
<td>Storm Water Pollution Prevention Plan</td>
</tr>
<tr>
<td>SY</td>
<td>Square Yard</td>
</tr>
<tr>
<td>TAC</td>
<td>Texas Administrative Code</td>
</tr>
<tr>
<td>Tex-####-X</td>
<td>Refer to TxDOT Manual of Testing Procedures</td>
</tr>
<tr>
<td>TCEQ</td>
<td>Texas Commission on Environmental Quality [formerly Texas Natural Resource Conservation Commission (TNRCC)]</td>
</tr>
<tr>
<td>TMUTCD</td>
<td>Texas Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>TxDOT</td>
<td>Texas Department of Transportation</td>
</tr>
<tr>
<td>TxDOT Item #</td>
<td>Refer to TxDOT Standard Specifications for Construction of Highways, Streets and Bridges</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriter’s Laboratory</td>
</tr>
<tr>
<td>um,μm</td>
<td>Micrometers</td>
</tr>
<tr>
<td>US, U.S.</td>
<td>United States</td>
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<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
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<tr>
<td>Vert.</td>
<td>Vertical</td>
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<tr>
<td>Vol.</td>
<td>Volume</td>
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<tr>
<td>Wt.</td>
<td>Weight</td>
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<tr>
<td>WW</td>
<td>Wastewater</td>
</tr>
<tr>
<td>Yd.</td>
<td>Yard</td>
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</table>
ITEM SUBJECT
201 Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control
202 Landscaping
203 Site Preparation
  ▶ Survey Monumentation Standards
ITEM 201. TEMPORARY EROSION, SEDIMENTATION, AND WATER POLLUTION PREVENTION AND CONTROL

201.1. DESCRIPTION
This Item shall govern the control measures necessary to prevent and control soil erosion, sedimentation, and water pollution that may degrade receiving waters including rivers, streams, lakes, reservoirs, groundwater, and wetlands. The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with any permanent or temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction periods. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the CITY in writing. The controls may include silt fences, rock berms, diversion dikes, interceptor swales, sediment traps and basins, pipe slope drains, inlet protection, stabilized construction entrances, seeding, sodding, mulching, soil retention blankets, or other structural or non-structural storm water pollution controls.

The CITY reserves the right to have required temporary erosion sedimentation and water pollution prevention and control work performed by others should the CONTRACTOR fail to perform required temporary erosion, sedimentation, and water pollution prevention and control work in a timely fashion or should the CONTRACTOR fail to prevent and control soil erosion, sedimentation, and water pollution which may degrade receiving water. All costs including engineering and right-of-way costs for the work required shall be borne by the CONTRACTOR. The CONTRACTOR shall reimburse the CITY for all such costs within 30-days after receipt of the reimbursement request from the CITY. Failure to submit payment for such reimbursement costs in the time prescribed above may result in the CITY withholding the reimbursement due from the monthly progress payments to the CONTRACTOR until reimbursement to the CITY is made.

201.2. ITEMS OF WORK AND MATERIALS
The items, estimated quantities, and locations of the control measures will be shown on the plans; however, the CITY may increase or decrease the quantity of these items as needs arise. The materials will be shown on the plans and in the specifications. The CITY may allow, in writing, the use of other materials and work methods as the need arises.

201.3. PRECONSTRUCTION SUBMITTALS
Prior to the start of construction, the CONTRACTOR shall submit to the CITY’S representative for acceptance schedules for accomplishment of the storm water pollution control measures in accordance with the erosion and sediment control plan or the Storm Water Pollution Prevention Plan (SWPPP). Work on the project shall not begin until the schedules for implementation of the controls and methods of operations have been reviewed, and accepted by the CITY. The CONTRACTOR shall provide the CITY, for information purposes, proposed methods of storm water pollution control for CONTRACTOR operations in areas which are outside the limits of the erosion control plan or the SWPPP (such as construction and haul roads, field offices, equipment and supply storage areas, portable process plants, and source material storage), as well as a plan for disposal of waste materials.

201.4. CONSTRUCTION REQUIREMENTS

201.4.1. General. The CONTRACTOR shall provide control measures to prevent or minimize the impact of the CONTRACTOR’S operations to receiving waters as required by the plans or Storm Water Pollution Prevention Plan (SWPPP) and/or as directed by the CITY in writing.

In any disturbed area where construction activities have ceased, permanently or temporarily, the CONTRACTOR shall initiate stabilization of the area by the use of seeding, mulching, soil retention blankets or other appropriate measures within 14-days, except in areas where construction activities are scheduled to resume within 21-days.

The CONTRACTOR shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation. The CONTRACTOR shall limit the amount of disturbed earth to the area(s) shown on the plans or as directed by the CITY. The CITY has the authority to limit the disturbed surface area exposed by construction operations. If, in the opinion of the CITY, the CONTRACTOR is not able to effectively control soil erosion and sedimentation resulting from construction operations, the CITY will limit the amount of disturbed area to that which the CONTRACTOR is able to control.
Should the control measures fail to function effectively, the CONTRACTOR shall act immediately to bring the erosion and sedimentation under control by maintaining existing controls or by providing additional controls as directed by the CITY. When, in the opinion of the CITY, the site is adequately stabilized, the control measures, except mulches and soil retention blankets, will be removed and properly disposed of by the CONTRACTOR. Soil retention blankets shall be removed only when, in the opinion of the CITY, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

All erosion, sediment, and water pollution controls will be maintained in good working order. A rain gauge provided by the CONTRACTOR will be located at the project site. Every 14-days, and also within 24-hours of a rainfall event of 0.5-in. or more as measured by the project rain gauge, the CONTRACTOR and CITY will inspect the entire project to determine the condition of the control measures. Sediment will be removed and devices repaired as soon as practicable but no later than 7-days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment operations needed for repairs.

In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the CONTRACTOR will install additional backup devices, as determined by the CITY, by other appropriate methods. The CONTRACTOR will remove silt accumulations and deposit the spoils in an area approved by the CITY as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the CITY; however, areas adjacent to receiving waters shall generally have priority, followed by devices protecting storm sewer inlets.

In the event of conflict between these requirements and storm water pollution control laws, rules or regulations of other Federal, State, or Local agencies, the more restrictive laws, rules or regulations shall apply.

201.4.2. Other Practices and Controls.

201.4.2.1. Location and Construction of CONTRACTOR’S Auxiliary Areas. Disposal areas, stockpiles, and haul roads shall be constructed in a manner that will minimize and control the amount of sediment that may enter receiving waters. Disposal areas shall not be located in any floodplain or receiving waters. Construction roads may not be located in or cross any receiving waters without prior approval of the CITY and shall be done in compliance with applicable rules and regulations. Staging areas and vehicle maintenance areas shall be constructed by the CONTRACTOR in a manner to minimize the runoff of pollutants and at a location approved by the CITY. The CONTRACTOR shall prevent pollution of receiving waters with petroleum products or other hazardous or regulated substances.

201.4.2.2. Activity In or Near Waters. Construction operations in receiving waters shall be restricted to those areas where it is necessary to perform the work shown on the plans. Wherever streams are crossed, temporary bridges, timber mats, or other structures shall be used and approved by the CITY. When work areas or material sources are located adjacent to a receiving water, control measures such as diversion dikes or rock berms shall be used to keep sediment and other contaminants from entering the adjacent receiving water. Care shall be taken during the construction and removal of such barriers to minimize down-gradient sedimentation.

All receiving waters shall be cleared as soon as practicable of temporary embankment, temporary bridges, matting, falsework, piling, debris, or other obstructions placed during construction operations that are not a part of the finished work.

201.4.2.3. Materials Storage. Protected storage for paints, chemicals, solvents, fertilizers, and other potentially toxic materials will be provided by the CONTRACTOR at a location approved by the CITY.

201.4.2.4. Vegetation. Disturbance of vegetation shall be minimized and limited to only what is shown on the construction plans or as directed by the CITY in writing. Operations shall be in accordance with Item 202. Landscaping.

201.4.2.5. Keeping Roadways Clean. The CONTRACTOR shall clean paved surfaces, as necessary, to remove sediment that has accumulated on the roadway.

201.4.3. Cleaning and Stabilizing Project Area. The project will not be accepted until the CONTRACTOR has cleaned up. Project Clean-up to the satisfaction of the CITY. The project will also not be accepted until the CONTRACTOR provides a uniform perennial vegetative cover with a density of 70-percent of adjacent undisturbed areas or, if in the opinion of the CITY, permanent measures (such as riprap, gabions, geotextiles, or other stabilization methods approved by the CITY), supplemented by temporary measures (such as mulching with seed, silt fences, earth dams, etc.) have been employed that will control erosion, sedimentation, and water pollution until sufficient vegetative cover can be established.
201.5. SILT FENCE

201.5.1. Description. Silt Fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. This includes all labor and materials associated with installation and maintenance of the silt fence as shown in the construction drawings or similar document.

The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas to a limited extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence shall remain in place until the disturbed area is permanently stabilized. Silt fence shall not be used where there is a concentration of water in a channel or drainage way or where soil conditions prevent a minimum toe-in depth of 6-inches or installation of support post to depth of 12-inches. If concentrated flow occurs after installation, corrective action shall be taken such as placing rock berm in the areas of concentrated flow.

201.5.2. Materials.

201.5.2.1. Geotextile. Silt Fence Fabric shall be a synthetic fabric that conforms to Item 803.4. Geotextiles Used in Drainage and Stabilization Applications unless otherwise specified. The fabric must meet the following minimum criteria:
- Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 70

201.5.2.2. Posts. Fence Posts shall be galvanized steel and may be rolled, formed or tubular in cross-section in accordance with Item 801.4.2.2. Posts. "T" posts may be used when in conformance with specification.

201.5.2.3. Wire Support. The minimum acceptable support material shall be W 1.4 x W 1.4, 4" x 4", zinc coated (galvanized) steel, 14-gauge wire fence fabric. Standard 2" x 2" chain link fence fabric is acceptable as well as other welded or woven steel fabrics consisting of equal or greater gauge wire and equal or smaller spacing as that listed herein.

201.5.3. Construction. Silt Fence shall consist of synthetic fabric supported by wire mesh, W 1.4 x W 1.4 and galvanized steel posts set a minimum of 1-foot depth and spaced not more than 6-feet on center. A 6-inch wide trench is to be cut 6-inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel. This entrenchment prevents any bypass of runoff under the fence. Fabric shall overlap at abutting ends a minimum of 3-feet and shall be joined such that no leakage or bypass occurs.

201.6. INTERCEPTOR SWALE

201.6.1. Description. A temporary interceptor swale is excavated as required by the erosion control plan. This includes all labor and materials associated with installation and maintenance of the interceptor swale as shown in the construction drawings or similar document.

Interceptor swales may have a V-shape or be trapezoidal with a flat bottom and sideslopes of 3:1 or flatter, whichever may be shown on the plans. These are used to shorten the length of exposed slope by intercepting runoff and can also serve as perimeter swales preventing off-site runoff from entering the disturbed area or prevent sediment-laden runoff from leaving the construction site or disturbed area. The outflow from a swale must be directed to a stabilized outlet or sediment trapping device. The swales shall remain in place until the disturbed area is permanently stabilized.

201.6.2. Materials. Stone Stabilization shall be used when grades exceed 2% or velocities exceed 6-feet-per-second and shall consist of a layer of crushed stone 3-inches thick, riprap (Item 803.3 Riprap) or high velocity erosion control mats (Item 201.16 Erosion Control Matting). Stabilization shall extend across the bottom of the swale and up both sides of the channel to minimum height of 3-inches above the design water surface elevation based on a 2-year storm.

201.6.3. Construction and Maintenance. Interceptor swale shall be installed across exposed slopes during construction and should intercept no more than 5-acres of runoff. Swales shall have a minimum bottom width of 2.0-feet and a maximum depth of 1.5-feet with side slopes of 3:1 or flatter. Swale must have positive drainage for its entire length to an outlet. When the slope exceeds 2-percent, or velocities exceed 6-feet-per-second (regard-
less of slope), stone stabilization is required. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary. CONTRACTOR shall inspect swales on a weekly basis during wet weather and repairs should be made promptly to maintain a consistent cross section.

201.7. DIVERSION DIKE

201.7.1. Description. A temporary diversion dike is a barrier created by the placement of an earthen embankment to reroute the flow of runoff to an erosion control device or away from an open, easily erodible area. This includes all labor and materials associated with installation and maintenance of the diversion dike as shown in the construction drawings or similar document.

A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, sandbag berm, or stone outlet structure. Dikes are generally used for the duration of construction to intercept and reroute runoff from disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized.

201.7.2. Materials.

201.7.2.1. Stone Stabilization. Stone stabilization (required for velocities in excess of 6-fps) shall consist of Type A Riprap conforming to Item 803.3. Riprap shall be placed in a layer of at least 3-inches thickness and shall extend a minimum height of 3-inches above the design water surface up the existing slope and the upstream face of the dike.

201.7.2.2. Geotextile. Fabric shall be a non-woven polypropylene fabric conforming to Item 803.4. Geotextiles Used in Drainage and Stabilization Applications unless otherwise specified, and be designed specifically for use as a soil filtration media with an approximate weight of 6-oz./yd², a mullen burst rating of 140-psi as measured by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and having an apparent opening size (AOS) greater than a #50 sieve as measured by ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile.

201.7.3. Construction. Diversion dikes shall be installed prior to and maintained for the duration of construction and should intercept no more than 10-acres of runoff. Dikes shall have a minimum top width of 2.0-ft. and a minimum height of compacted fill of 18" measured from the top of the existing round at the upslope toe to top of the dike and having side slopes of 3:1 or flatter. The soil for the dike shall be placed in lifts of 8" or less and be compacted to 95-percent standard proctor density. The channel formed by the dike must have positive drainage for its entire length to an outlet. When the slope exceeds 2-percent, or velocities exceed 6-feet-per-second (regardless of slope), stabilization is required. Situations in which velocities do not exceed 6-fps, vegetation may be used to control erosion.

201.8. TRIANGULAR SEDIMENT FILTER DIKE

201.8.1. Description. The work shall consist of installing a temporary triangular sediment filter dike as shown on the plans during the construction period to control erosion, sedimentation and dust.

The purpose of a triangular sediment filter dike is to intercept and retain water-borne sediment from unprotected areas of limited extent. The triangular sediment filter dike is used where there is no concentration of water in a channel or other drainage way above the barrier and the contributing drainage area is less than 1-acre. If the uphill slope above the dike exceeds 10-percent, the length of the slope above the dike should be less than 50-feet. If concentrated flow occurs after installation, CONTRACTOR shall take corrective action such as placing rock berm in the areas of concentrated flow. This measure is effective on paved areas where installation of silt fence is not possible.

201.8.2. Materials.

201.8.2.1. Geotextile. Fabric shall be a non-woven polypropylene fabric conforming to Item 803.4. Geotextiles Used in Drainage and Stabilization Applications unless otherwise specified, and be designed specifically for use as a soil filtration media with an approximate weight of 6-oz./yd², a mullen burst rating of 140-psi as measured by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and having an apparent opening size (AOS) greater than a #50 sieve as measured by ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile.
201.8.2.2. **Wire Mesh Support.** The dike structure shall be 6-gauge 6" x 6" wire mesh folded into triangular form being 18-inches on each side.

201.8.3. **Construction.** Triangular sediment filter dikes shall be installed across exposed slopes during construction with ends of the dike tied into existing grades to prevent failure and should intercept no more than 1-acre of runoff. Filter material shall lap over ends 6-inches to cover dike-to-dike junction; each junction shall be secured by shooat rings.

201.9. **ROCK BERM**

201.9.1. **Description.** The work shall consist of constructing temporary rock berm as shown on the plans during the construction period to control erosion, sedimentation and dust. This includes all labor and materials associated with installation and maintenance of the rock berm as shown in the construction drawings or similar document.

The purpose of a rock berm is to serve as a check dam in areas of concentrated flow to intercept sediment-laden runoff, detain the sediment and release the water in sheet flow. The rock berm should be used when the contributing drainage area is less than 5-acres.

201.9.2. **Materials.**

201.9.2.1. **Stone.** Stone shall consist of Type A riprap conforming to Item 803.3. Riprap.

201.9.2.2. **Wire Mesh Support.** The berm structure shall be secured with a woven wire sheathing having maximum opening of 1-inch and a minimum wire diameter of 20-gauge galvanized and shall be secured with shooat rings.

201.9.3. **Construction and Maintenance.** Rock berm shall be installed at the toe of a slope or the perimeter of a developing or disturbed area. The purpose of a rock berm is to intercept sediment-laden water from unprotected areas, detain the sediment and release the water in sheet flow. Rock berm should have a maximum flow through rate of 60-gallons-per-minute-per-square-foot. Minimum height shall be 18-inches measured from the top of the existing ground at the upslope toe to top of the berm. Berm shall have a top width of 2-feet minimum with side slopes being 2:1 or flatter. Berm shall be built along the contour at zero-percent grade or as near as possible. The ends of the berm shall be tied into existing upslope grade and the berm shall be buried in a trench approximately 3-inches to 4-inches deep to prevent failure of the control.

The area upstream from the rock berm shall be maintained in a condition that will allow sediment to be removed following the runoff of a rainfall event. Inspection shall be made weekly and after each rainfall by the responsible party and when the silt reaches a depth equal to the height of the berm or 1-foot, whichever is less, it shall be removed and the accumulated silt disposed of properly. For installations in streambeds, additional daily inspections shall be made on rock berm. Silt shall be removed when accumulation reaches approximately ½ the height of the berm. The berm shall be reshaped as needed during inspection. The rock berm shall be left in place until all upstream areas are stabilized and accumulated silt removed.

201.10. **STABILIZED CONSTRUCTION ENTRANCE**

201.10.1. **Description.** The work shall consist of constructing a temporary stabilized construction entrance as shown in the plans and remaining in place for the duration of the construction period to prevent sediment from leaving the project site and becoming a nuisance on a paved surface. This includes all labor and materials associated with installation and maintenance of the stabilized construction entrance as shown in the construction drawings or similar document.

201.10.2. **Materials.**

201.10.2.1. **Stone.** Stone material shall consist of Type A riprap conforming to Item 803.3. Riprap and shall be placed in a layer of at least 6-inches thickness.

201.10.2.2. **Geotextile.** Fabric shall be a non-woven polypropylene fabric conforming to Item 803.4. Geotextiles Used in Drainage and Stabilization Applications unless otherwise specified, and be designed specifically for use as a soil filtration media with an approximate weight of 6-oz./yd², a mullen burst rating of 140-si as measured by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and having an apparent opening size (AOS) greater than a #50 sieve as measured by ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile.
201.10.3. Construction and Use. A temporary stabilized construction entrance shall be installed at any point where traffic will be entering or leaving a construction site to or from a paved surface such as a street, alley, sidewalk or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking or flowing of sediment onto paved surfaces. The entrance shall be properly graded or incorporate a drainage swale to prevent runoff from leaving the construction site. The length of the entrance shall be as shown on the plans.

The temporary stabilized construction entrance shall be maintained in a condition that will prevent tracking or flowing of sediment onto paved surfaces. This may require periodic top dressing with additional stone as conditions demand. All sediment spilled, dropped, washed or tracked onto public rights of way shall be removed immediately by the CONTRACTOR.

When necessary, vehicles must be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it shall be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin or other sedimentation/filtration device. All sediment shall be prevented from entering any storm drain, ditch or watercourse using approved methods.

201.11. SAND BAG BERM

201.11.1. Description. The work shall consist of installing a temporary sand bag berm as shown in the plans for the duration of construction to control erosion, sedimentation and dust. This includes all labor and materials associated with installation and maintenance of the sand bag berm as shown in the construction drawings or similar document.

The purpose of a sand bag berm is to intercept sediment-laden water from disturbed areas such as construction in streambeds, create a retention pond, detain sediment and release water in sheet flow.

201.11.2. Materials.

201.11.2.1. Bag and Sand. Bag material shall be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight 4-ounces-per-square-yard, mullen burst strength exceeding 300-psi as determined by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and ultraviolet stability exceeding 70-percent. Bag length shall be 24-inches to 30-inches, width shall be 16-inches to 18-inches and thickness shall be 6-inches to 8-inches and having an approximate weight of 40-pounds. Sand bags shall be filled with coarse grade sand, free from deleterious material. All sand shall pass through a No. 10 sieve.

201.11.2.2. Pipe. Pipe shall be schedule 40 or stronger polyvinyl chloride (PVC) having a nominal internal diameter of 4-inches.

201.11.3. Construction and Maintenance. A temporary sand bag berm shall be installed across a channel or right of way in a developing or disturbed area and should be used when the contributing drainage area is greater than 5-acres. The berm shall be a minimum height of 18-inches, measured from the top of the existing ground at the upslope toe to the top of the berm. The berm shall be sized as shown in the plans but shall have a minimum width of 48-inches measured at the bottom of the berm and 16-inches measured at the top of the berm.

The sand bag berm shall be inspected after each rain. The sandbags shall be reshaped or replaced as needed during inspection. Additional inspections shall be made daily by the CONTRACTOR and when the silt reaches 6-inches, the accumulated silt shall be removed and disposed of at an approved site in a manner that will not contribute to additional siltation. The sand bag berm shall be left in place until all upstream areas are stabilized and accumulated silt removed; removal shall be done by hand.

201.12. STONE OUTLET SEDIMENT TRAP

201.12.1. Description. A stone outlet sediment trap is an impoundment created by the placement of an earthen and stone embankment to prevent soil and sediment loss from a site. This includes all labor and materials associated with installation and maintenance of the stone outlet sediment trap as shown in the construction drawings or similar document.

The purpose of a sediment trap is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights-of-way below the sediment trap from sedimentation. A sediment trap is usually installed at points of discharge from disturbed areas. The drainage area for a sediment trap is recommended to be less than 5-acres.
201.12.2.1. Filter Stone. Filter stone shall consist of Type A riprap conforming to Item 803.3. Riprap.
201.12.2.2. Geotextile. Fabric shall be a non-woven polypropylene fabric conforming to Item 803.4. Geotextiles Used in Drainage and Stabilization Applications unless otherwise specified, and be designed specifically for use as a soil filtration media with an approximate weight of 6-oz./yd², a mullen burst rating of 140-psi as measured by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and having an apparent opening size (AOS) greater than a #70 sieve as measured by ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile.

201.12.3. Construction and Maintenance.
201.12.3.1. Earth Embankment. CONTRACTOR shall place fill material in layers not more than 8-inches in loose depth. Before compaction, CONTRACTOR shall moisten or aerate each layer as necessary to provide the optimum moisture content of the material in order to achieve 95-percent standard proctor density on each compacted layer. CONTRACTOR shall not place material on surfaces that are muddy or frozen. Sideslopes for the embankment shall be 3:1. A gap shall be left in the embankment in the location where the natural confluence of runoff crosses the embankment line. The gap shall have a width in feet equal to 6 times the drainage area in acres.

201.12.3.2. Geotextile Covered Rock Core. A core of filter stone having a minimum height of 1.5-feet and a minimum width at the base of 3-feet shall be placed across the opening of the earth embankment and shall be covered by geotextile fabric which shall extend a minimum distance of 2-feet in either direction from the base of the filter stone core.

201.12.3.3. Filter Stone Embankment. Filter stone shall be placed over the geotextile and is to have a sideslope which matches that of the earth embankment of 3:1 and shall cover the geotextile/rock core a minimum of 6-inches when installation is complete.

201.12.3.4. Maintenance. Accumulated silt shall be removed from behind the embankment when the level of silt is 1-foot below the top of the filter stone at its lowest point.

201.13. PIPE OUTLET SEDIMENT BASIN

201.13.1. Description. A temporary pipe outlet sediment basin is an impoundment created by the placement of an earthen embankment and an integral pipe spillway structure for the purpose of de-watering the impoundment as well as an emergency spillway structure for heavy flows. This includes all labor and materials associated with installation and maintenance of the pipe outlet sediment basin as shown in the construction drawings or similar document.

The purpose of a sediment basin is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights-of-way below the sediment basin from sedimentation. A sediment basin is usually installed at points of discharge from disturbed areas. The drainage area for a sediment basin is recommended to be less than 100-acres.

201.13.2. Materials. Riser shall be corrugated metal or reinforced concrete pipe or box and shall have watertight fittings or end-to-end connections of sections. Riser shall be anchored by 3000-psi concrete base. An outlet pipe of corrugated metal or reinforced concrete shall be attached to the riser and shall have positive flow to a stabilized outlet on the downstream side of the embankment. An anti-vortex device and rubbish screen shall be attached to the top of the riser and shall be made of polyvinyl chloride or corrugated metal.

201.13.3. Construction and Maintenance.

201.13.3.1. Earth Embankment. CONTRACTOR shall place fill material in layers not more than 8-inches in loose depth. Before compaction, CONTRACTOR shall moisten or aerate each layer as necessary to provide the optimum moisture content of the material in order to achieve 95-percent standard proctor density on each compacted layer. CONTRACTOR shall not place material on surfaces that are muddy or frozen. Sideslopes for the embankment shall be 3:1.

201.13.3.2. Principal Outlet Control Device. The principal outlet control device shall consist of a rigid vertically oriented pipe or box of corrugated metal or reinforced concrete. Attached to this structure shall be a horizontal pipe which shall extend through the embankment to the toe of fill to provide a de-watering outlet for the basin. Attached to the inlet portion of the principal outlet control device shall be an anti-vortex device that shall be made to serve as a rubbish screen. A concrete base shall be used to anchor the principal outlet control device and shall have dimensions of 18-inches depth and twice the diameter of the riser pipe in width minimum in all directions.
201.13.3. Emergency Spillway. An emergency spillway shall be installed adjacent to the embankment on undisturbed soil and shall be sized to carry the full amount of flow generated by a 10-year-storm less the amount which can be carried by the principal outlet control device. The emergency spillway shall be lined with riprap as shall the swale leading from the spillway to the normal watercourse at the base of the embankment.

201.13.3.4. Maintenance. Accumulated silt shall be removed and the basin shall be re-graded to its original dimensions at such point that the capacity of the impoundment has been reduced to one-half of its original storage capacity. The removed sediment shall be stockpiled or redistributed in areas that are protected from erosion.

201.14. PIPE SLOPE DRAIN

201.14.1. Description. A temporary pipe slope drain is an erosion control device that combines an earthen embankment and a rigid or flexible pipe to carry runoff over an exposed slope to a stabilized outlet apron. This includes all labor and materials associated with installation and maintenance of the pipe slope drain as shown in the construction drawings or similar document. Pipe slope drains can also be used as emergency spillways for sediment basins.


201.14.2.1. Pipe. The drain pipe shall be made of any material, rigid or flexible capable of conveying runoff. Regardless of material, the drain pipe shall be completely water-tight so that no water leaks onto the slope to be protected.

201.14.2.2. Riprap. Riprap to be used in the outlet apron shall consist of either crushed stone or broken Portland cement concrete. All stones used shall weigh between 50-pounds and 150-pounds each, shall have a thickness of at least 12-inches and shall be as nearly uniform in section as is practicable.

201.14.3. Construction.

201.14.3.1. Pipe Slope Drain. A diversion dike shall be constructed at the top of the slope which shall be protected. This dike shall be sized so that no runoff may overtop the dike. A rigid section of pipe shall be installed through the dike with length as necessary to completely cross the dike section. Attached to the inlet end of the pipe, using water-tight fittings, shall be a standard flared-end section with an integral toe plate extending a minimum of 6-inches from the bottom of the end section to prevent runoff from washing out the soil under the inlet. Attached to the other end of this pipe shall be rigid or flexible pipe to be used for containment of the runoff from the top of the slope to the bottom.

201.14.3.2. Riprap Lined Apron. A riprap lined apron shall be excavated to accept the runoff from the pipe and dissipate the energy of the flow. The width of the bottom of the apron shall be 3 times the pipe diameter, and the length shall be a minimum of 6 times the pipe diameter of the drain pipe. The apron shall be a minimum of 12-inches in depth and shall be lined with riprap weighing between 50-pounds and 150-pounds per stone with a thickness of 12-inches minimum. The apron shall be designed so that the released flow has a velocity less than 3-feet-per-second and is not concentrated in any way.

201.15. INLET PROTECTION

201.15.1. Description. Temporary inlet protection is a series of four different measures that provide protection against silt accumulation in storm sewer systems. Clogging can greatly reduce or completely stop the flow in the pipes. The different measures are used for different site conditions and inlet types. These measures include all labor and materials associated with installation and maintenance of inlet protection as shown in the construction drawings or similar document.

Filter barrier protection using silt fence is appropriate when the drainage area is less than 1-acre and the basin slope is less than 5-percent. This type of protection is not applicable in paved areas.
Block and gravel protection is used when flows exceed 0.5-cubic-feet-per-second and it is necessary to allow for overtopping to prevent flooding. This form of protection is also useful for curb type inlets as it works well in paved areas.

Wire mesh and gravel protection is used when flows exceed 0.5-cfs and construction traffic may occur over the inlet. This form of protection may be used with both curb and drop inlets.

Excavated impoundment protection around a drop inlet may be used for protection against sediment entering a storm drain inlet. With this method, it is necessary to install weep holes to allow the impoundment to drain completely. The impoundment shall be sized such that the volume of excavation shall be 1800- to 3600-cubic-feet-per-acre of disturbed area entering the inlet.

201.15.2. Materials.

201.15.2.1. Geotextile. Filter fabric shall be a synthetic fabric conforming to Item 201.5.2.1. Geotextile.

201.15.2.2. Posts. Posts for fabric shall be galvanized steel, tubular in cross-section in accordance with Item 801.4.2.2. Posts, or they may be standard fence "T" posts.

201.15.2.3. Filter Gravel. Filter gravel shall conform to as defined in Item 504.2.2.5. Natural Gravel.

201.15.2.4. Concrete Blocks. Concrete blocks shall be standard 8" x 8" x 16" concrete masonry units and shall be in accordance with ASTM C139, Concrete Masonry Units for Construction.

201.15.2.5. Wire Mesh. Wire mesh shall be standard hardware cloth or comparable wire mesh with an opening size not to exceed ½-inch.

201.15.3. Construction and Maintenance.

201.15.3.1. Filter Barrier Protection. Silt Fence shall consist of geotextile supported by galvanized steel posts set a minimum of 1-foot depth and spaced not more than 6-feet on center. A 6-inch wide trench is to be cut 6-inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel. This entrenchment prevents any bypass of runoff under the fence.

201.15.3.2. Block and Gravel Protection. Concrete blocks are to be placed on their sides in a single row around the perimeter of the inlet, with ends abutting. Openings in the blocks should face outward, not upward. Wire mesh shall then be placed over the outside face of the blocks covering the holes. Filter stone shall then be piled against the wire mesh to the top of the blocks with the base of the stone being a minimum of 18-inches from the blocks. Periodically, when the stone filter becomes clogged, the stone shall be removed and cleaned in a proper manner or replaced with new stone and piled back against the wire mesh.

201.15.3.3. Wire Mesh and Gravel Protection. Wire mesh shall be placed across the opening of the inlet with at least a 12-inch extension beyond the opening of the inlet. For curb inlet applications, the wire fabric shall be firmly secured to prevent loss of rock into the protected storm sewer system.

Gravel shall be placed around and over the inlet such that a 12-inch layer of stone covers the opening of the inlet and extends at least 12-inches beyond the inlet in all directions. CONTRACTOR shall ensure that any flow to the inlet passes through a minimum of 12-inches of gravel.

For areas subjected to high flows or high velocities, CONTRACTOR shall inspect the protection on a regular basis to ensure integrity of the gravel filter.

201.15.3.4. Excavated Impoundment Protection. An excavated impoundment shall be sized to provide a storage volume of between 1800- and 3600-cubic-feet-per-acre of disturbed area. The trap shall have a minimum depth of 1-foot and a maximum depth of 2-feet as measured from the top of the inlet and shall have sideslopes of 2:1 or flatter. Weep holes shall be installed in the inlet walls to allow for the complete de-watering of the trap. When the storage capacity of the impoundment has been reduced by one-half, the silt shall be removed and disposed in a proper manner.

201.16. EROSION CONTROL MATTING

201.16.1. Description. An erosion control mat (ECM) is a geotextile or biodegradable fabric placed over disturbed areas to limit the effects of erosion due to rainfall impact and runoff across barren soil. Erosion control mats are manufactured by a wide variety of vendors addressing a wide variety of conditions such as vegetation establishment and high velocity flow. Matting is used in areas that are difficult to stabilize such as steep slopes, drainage swales or high pedestrian traffic areas.

201.16.2. Materials.

201.16.2.1. Matting. Erosion control mat shall be of a type and class appropriate to site-specific requirements as determined by the Engineer. Installed materials shall meet the applicable “Minimum Performance Standards for TxDOT” as published by TxDOT in its “Erosion Control Report” unless materials are otherwise approved.
by the CITY. Proving compliance with TxDOT standards is the responsibility of the CONTRACTOR and may be proven by official listing on the most current annual “Approved Products List for TxDOT” applicable to TxDOT Item 169 Soil Retention Blanket and its Special Provisions.

201.16.2.2. Fasteners. Fasteners shall conform to the recommendations shown within the manufacturer's published literature for the approved soil retention blanket. In the absence of manufacturer's recommendation for fasteners, a minimum 11-gauge wire staples 6-inches in length and 1-inch in width shall be used.

201.16.3. Construction and Maintenance.

201.16.3.1. Erosion Control Matting. Prior to the installation of any erosion control matting, all rocks, dirt clods, stumps, roots, trash and any other obstructions that would prevent the mat from lying in direct contact with the soil shall be removed. Anchor trenching shall be located along the entire perimeter of the installation area. These trenches shall be 6-inches deep and 6-inches wide and the matting shall be laid into the trench then backfilled with compacted soil or gravel. Matting shall be fastened to the ground according to the manufacturer's instruction. CONTRACTOR shall submit staple pattern to the CITY. Installations shall be in accordance with manufacturers recommended guidelines with the exception of the minimum criteria stated herein.

201.16.3.2. Maintenance. Matted areas must be inspected on a weekly basis, and after each significant rainfall event to locate bare spots caused by weather or other events. Missing or loosened matting shall be promptly replaced or re-anchored.

201.17. MULCHING

201.17.1. Description. Mulching provides protection for bare soil by absorbing the energy of each raindrop prior to the point when this energy would dislodge individual soil particles and begin the erosion process. Mulching fosters plant growth by providing insulation from temperature extremes and retaining valuable moisture necessary for proper germination.

201.17.2. Materials.

201.17.2.1. Organic Mulches.

201.17.2.1.1. Straw. The best quality straw mulch comes from wheat, oats or barley and shall be free of weed and grass seed that may not be desired vegetation for the area to be protected. Straw mulch is light and therefore shall be properly anchored to the ground.

201.17.2.1.2. Hay. Hay is very similar to straw with the exception that it is made of grasses and weeds and not grain stems. This form of mulch is very inexpensive and is widely available but does introduce weed and grass seed to the area. Like straw, hay is light and shall be anchored.

201.17.2.1.3. Wood Chips. Wood chips are suitable for areas that will not require mowing frequently and are heavy enough that they do not require anchoring. They do however deplete nitrogen from the soil, which is a necessary nutrient for all plants. To alleviate this condition wood chips must be treated with 12-pounds ammonium-nitrate-per-ton of mulch used.

201.17.2.1.4. Bark Chips. Bark chips are popular for ornamental applications as they do not require anchoring, do not decompose very rapidly and serve as an excellent insulation material. When using bark chips, it is not necessary to treat for nitrogen deficiency or to fertilize.

201.17.2.1.5. Other. Other types of organic mulches are available but usually are very seasonal and may have a limited availability.

201.17.2.2. Matting and Geotextiles. Many geotextile materials are very beneficial when used in conjunction with other mulching agents. Geotextile materials and installation shall be specified by the Engineer. Matting shall conform to requirements of Item 201.16. Erosion Control Matting.

201.17.3. Construction and Maintenance.

201.17.3.1. Organic Mulch. Prior to the placement of any mulch, the area to be protected shall be graded completely in accordance with plans. Fertilization and soil treatment shall then be done prior to placement of mulch with the exceptions of when seed is to be applied by means of hydraulic seeding or when seed is distributed following straw mulch spreading during winter months. Organic mulches may be distributed by hand or by mechanical means, so long as a complete covering is achieved. Straw and hay mulches shall be distributed at the rate of 75- to 90-pounds-per-1000-feet of treated area. To be fully effective, straw or hay mulch shall be anchored by means of application of a fiber mulch binder, the application of a synthetic liquid mulch binder or by using a tractor-drawn crimper to punch mulch into the soil.

201.17.3.2. Maintenance. All mulching materials shall be inspected on a weekly basis, and after each significant rainfall event to locate areas of erosion. Where erosion has occurred, either additional mulch shall be
applied or an alternative method shall be considered and implemented, as required by the Engineer. Missing or loosened matting shall be promptly replaced or re-anchored.
ITEM 202. LANDSCAPING

202.1. REMOVAL, PROTECTION, AND REPLACEMENT OF TREES, SHRUBBERY, PLANTS, SOD, AND OTHER VEGETATION

No trees shall be removed unless so noted on the plans or upon the specific approval of the CITY. Where trees, plants, shrubbery, etc., are adjacent to the line of the work and are not to be removed or are designated on the plans to be removed and replaced, the CONTRACTOR shall protect such trees, plants, shrubbery, etc. by substantial wooden boxes and guards and shall not permit machinery or employees to scrape, tear the limbs from, damage or attach guy cables to them. If, in the opinion of the CITY, such trees, plants, shrubbery, etc., would be damaged by machinery, etc., hand excavation may be required. Shrubbery, plants, etc. shall be removed with a ball of dirt about their roots and shall be carefully stored and given proper attention. Where sod is to be saved, it is to be removed in squares cut out with a sharp spade and of such sizes that they may be handled conveniently without breaking. They shall be carefully stored and given proper attention. During hot, dry weather the stored sod shall be protected by covering with canvas or burlap.

The CONTRACTOR shall be responsible for all damage to adjacent trees, plants, shrubbery, etc., and any such damage shall be remedied to the satisfaction of the CITY. All damaged limbs over 1-inch in diameter shall be sawed clean adjacent to the damaged area or at the trunk and dressed with acceptable tree wound treatment material, unless dressing is waived by the CITY.

The cost of removal shall be paid for as a separate contract pay item if a separate pay item is provided; otherwise, the costs thereof shall be included in such pay items as are provided in the proposal and contract. The cost of protection shall not be paid for as a separate contract pay item; the costs thereof shall be included in such pay items as are provided for in the proposal and contract.

Where sod, shrubbery, plants, etc., are removed in making the excavation, such areas shall have the same sod, shrubbery, plants, etc., of the same kind and in good condition, replaced in their prior positions. Trees that are to be removed and subsequently replaced shall be designated on the plans. When backfilling is completed, the sod, shrubbery, plants, etc. shall be carefully replaced in their original location and the area thoroughly wet down.

The cost of such replacement shall be paid for as a separate contract pay item if a separate pay item is provided; otherwise, the costs thereof shall be included in such pay items as are provided in the proposal and contract.

202.2. TOPSOIL

202.2.1. Description. This Item shall consist of furnishing and placing topsoil, free from rock and foreign material, as indicated on the plans, to the lines and grades as established by the construction plans.

202.2.2. Materials and Storage. All excavated material which is suitable for topsoil shall be used before any topsoil is obtained from a borrow source. Topsoil shall be secured from borrow sources as required to supplement suitable material secured from project excavation. Topsoil material secured from excavations shall be stockpiled at locations approved by CITY.

202.2.3. Construction Methods. Approved topsoil shall be a minimum thickness of 6-inches unless otherwise specified on the plans, and shall be placed on areas formed to the line and grade specified in the plans.

202.3. SOIL AMENDMENTS

202.3.1. General. Where indicated on the plans and defined in the specifications, soil amendments shall be added as defined or as noted in these specifications.
202.3.2. Sand. All sand shall be thoroughly washed, coarse grade construction or brick sand, free of clay balls, weeds or grass. So-called cushion sand, blow sand, creek silt or water treatment solid byproducts shall not be acceptable. A quart sample of the sand proposed to be used shall be submitted for the CITY’s approval.

202.3.3. Minerals.

202.3.3.1. Elemental Sulfur. Sulfur shall be a commercially produced, granular product of pure sulfur.

202.3.3.2. Gypsum. Gypsum (calcium sulphate) shall be ground to the size specified on the plans.

202.3.3.3. Lime. Lime shall be of finely ground or pulverized raw, commercial grade dolomitic limestone, all of which shall pass through a #10 (210mm) sieve, and at least half of which shall pass through a #100 (150mm) sieve. Dolomitic lime shall contain roughly equal portions of magnesium and calcium carbonates, which together total 90-percent or more of the value of neutralizing power or the calcium oxide equivalent. A producer’s specification or a sample label of the lime proposed to be used shall be submitted for the CITY’s approval.

202.3.4. Compost. This Item shall govern for the furnishing and placing of approved compost material to the depths and area shown on the plans or as directed by the Engineer.

202.3.4.1. Materials. Compost material shall be an organic substance produced by the aerobic (biological) decomposition of organic matter. All compost is to be clean and free of visible refuse, live plants, seed, excessive cotton lint and any chemical elements harmful to plant growth. Composted matter may include, but is not limited to, leaves and yard trimmings, brush, biosolids, food scraps, food processing residues, manure and/or other agricultural residuals, forest residues and bark, and soiled and/or recyclable paper. Mixed municipal solid waste compost, and Class B Biosolids (as defined in 40 CFR part 503) shall not be allowed. Raw organics in the finished compost shall not be allowed.

Compost materials furnished shall meet all applicable Federal (40 CFR Part 503 Standards for Class A Biosolids) and TCEQ health and safety regulations (TAC Chapter 332). All compost material supplied shall be processed to meet the time and temperature standards in TAC Chapter 332 Subchapter B Part 23 to control noxious weeds, pathogen and vector attraction; and the physical requirements shown in Table 202.3.4.1.(a) Compost Physical Requirements.

<table>
<thead>
<tr>
<th>Compost for Manufactured Topsoil</th>
<th>Erosion Control Compost</th>
<th>General Use Compost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic Matter Content</strong></td>
<td>as determined by loss on ignition (ASTM D5268 Standard Specification for Topsoil Used for Landscaping Purposes @ 824°F)</td>
<td>30% (dry mass)</td>
</tr>
<tr>
<td><strong>Particle Size</strong></td>
<td>as determined by TEX-110-E Particle Size Analysis of Soils</td>
<td>100% passing 1&quot;</td>
</tr>
<tr>
<td><strong>Soluble Salts</strong></td>
<td>as determined by TEX-129-E Measuring the Resistivity of Soil Materials</td>
<td>5.0 max. mmhos/cm</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>Finished</td>
<td>Finished</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>as determined by TEX-128-E Determining Soil pH</td>
<td>5.5 - 8.5</td>
</tr>
</tbody>
</table>

202.3.4.2. Construction Methods. After the designated areas have been completed to the lines, grades, and cross sections shown on the plans and as provided for in other items to the contract, compost of the type specified shall be placed in accordance with the requirements hereinafter described and as directed by the Engineer. Any stockpile areas shall be well drained, and shall be left in a neat and presentable condition upon completion of the removal of the materials. Where rolling is specified, the roller shall be a light corrugated drum roller of the type approved by the Engineer. Compost shall be loose and friable and not dusty at the time of application. Compost may be required to be brought to an acceptable moisture content, as directed by the Engineer. No compost materials shall be placed within 30-yards of any source of surface water or drinking water supply.

202.3.4.2.1. Compost Manufactured Topsoil. Compost manufactured topsoil shall consist of soil constituents amended with 5- to 30-percent compost, measured by volume, as shown on the plans. Any trash, stumps, roots, weeds, or other objectionable materials in the soil shall be removed and disposed of, as approved by the Engineer, prior to beginning the mixing process.
Blended On-Site. Compost shall be spread in a uniform layer over the previously prepared subgrade area and thoroughly incorporated into the soil materials, to the depths shown on the plans, by rototilling, harrowing, or other suitable methods. After the topsoil has been produced and shaped, it shall be sprinkled and rolled as directed by the Engineer.

Pre-Blended. Topsoil manufactured from sources outside the right-of-way shall be produced in accordance with the requirements for Blended On-Site topsoil, and spread over the prepared subgrade so as to form a uniform layer of loose material of the thickness shown on the plans. After the topsoil has been placed, it shall be raked carefully to remove all objectionable materials and to yield a consistent grade, and then sprinkled and rolled as directed by the Engineer.

202.3.4.2.2. Erosion Control Compost. Compost shall be spread evenly over the previously prepared subgrade or slopes so as to form a uniform layer of loose material of the thickness shown on the plans. Erosion Control Compost shall not be placed on any slope having a slope ratio steeper than 2:1. After the compost has been placed, it shall be sprinkled and rolled as directed by the Engineer.

202.3.4.2.3. General Use Compost. General use compost shall be applied as a top dressing by placing the material evenly upon established areas of turf, grass, or other ground cover growth to the depth specified on the plans or as directed by the Engineer. Compost applications shall not bury or kill existing vegetation. All stems, roots, or other debris larger than 2-inches diameter shall be removed from the ground surface.

202.4. FERTILIZER

202.4.1. General. Fertilizer shall be a commercial product, uniform in composition, free flowing, with uniform particle size, minimal dust, and suitable for application with approved equipment. Fertilizer may be a natural organic, synthetic organic or inorganic fertilizer. A sample label or specification of proposed fertilizer(s) to be used shall be submitted to the CITY for approval.

All fertilizer used shall be delivered in original bags or containers clearly labeled to show analysis of the contents. Fertilizer shall be in good physical condition. Fertilizer which has been exposed to high humidity and moisture or has become caked or otherwise damaged, making it unsuitable for use, shall be rejected.

The fertilizer is subject to testing by the CITY in accordance with the Texas Fertilizer Law. A fertilizer shall be used with an analysis as indicated below. The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively, as determined by the methods of the Association of Official Agricultural Chemists. In the event it is necessary to substitute a fertilizer of a different analysis with a lower concentration, the total amount of nutrients furnished and applied per unit area shall equal or exceed that specified for each nutrient.

202.4.2. Preplanting Application. Fertilizer analysis shall be based on soil test results and the nitrogen requirements for the turfgrass specified. If the CITY waives soil testing, fertilizer analysis shall be, by weight, in a 1-1-1 or 1-2-1 (N-P-K) ratio (such as 13-13-13 or 10-20-10,) and 10- to 15-percent sulphate and traces of iron and zinc as required and approved by the CITY.

Preplanting application rate shall be 10-lbs.-fertilizer-per-1,000-sq.ft.

202.4.3. Post Planting Application. Fertilizer analysis shall be based on soil test results and the nitrogen requirements for the turfgrass specified. If the CITY waives soil testing, fertilizer analysis shall be as specified below except that for autumn applications a complete fertilizer with a 4-1-2 to 3-1-2 (N-P-K) ratio shall be applied.

Fertilizer shall contain 30- to 50-percent slow release nitrogen, unless specified otherwise by the CITY.

202.4.3.1. Seeds or Sprigs. As soon as new growth starts after seeding or sprigging, grass shall be fertilized every 10- to 14-days with 0.75- to 1.0-lb.-nitrogen-per-1,000-sq.ft. Applications shall alternate between nitrogen only fertilizer whose analysis is, by weight, 21-0-0 or 45-0-0 (N-P-K) and a complete fertilizer with a 3-1-2 or 4-1-2 (N-P-K) ratio (such as 21-7-14.)
202.4.3.2. Sod. Fertilizer analysis shall be based on soil test results. Fertilizer shall be applied every 4-to 6-weeks at 1.0-lb.- (actual) nitrogen-per-1,000-sq.ft.

202.5. SODDING

202.5.1. Description. Sodding shall consist of furnishing and planting grass as designated on the plans and in accordance with the requirements of this specification and special conditions.

202.5.2. Materials. Sod shall be “Stenotaphrum secundatum” (St. Augustine grass), “Cynodon dactylon” (Common Bermudagrass), “Buchloe dactyloides” (Buffalograss), an approved hybrid of Common Bermudagrass, or an approved Zoysiagrass. Sod shall consist of stolons, leaf blades, rhizomes, and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than 0.75-in. (2cm). Sod shall be alive, healthy, vigorous, free of insects, disease, stones, and undesirable foreign materials, weeds and grasses deleterious to its growth or which might affect its subsistence or hardiness when transplanted. The grass shall have been mowed prior to sod cutting so that the height of the grass shall not exceed 2-inches (5cm). St. Augustine grass sod shall have been produced on growing beds of clay or clay loam topsoil. Bermudagrasses and zoysiagrasses shall have been grown on sand or sandy loam soils. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival shall be affected. Sod shall be protected from exposure to wind, sun and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots to roots and grass to grass.

Sod to be placed between curb and walk and on terraces shall be the same type grass as adjacent grass or existing lawn.

Sod to be placed during the dormant stage of these grasses shall be inspected by the CITY to verify that the grass is acceptable.

202.5.2.1. Dimensions. All sod shall have been machine cut to uniform soil thickness of ½-in. (13mm) ± 1/32 - in. (0.3mm). All sod shall be of the same thickness. Rectangular sections of sod may vary in length, but all shall be of equal width and of a size that permits the sod to be lifted, handled and rolled without breaking. Broken pads and torn, uneven ends shall be rejected.

202.5.3. Construction Methods. After the designated areas have been completed to the lines, grades and cross sections shown on the plans and as provided for in other items of the contract, sodding of the type specified shall be performed in accordance with the requirements hereinafter described. Sodding shall be either plugging or solid.

Care shall be taken at all times to retain native soil on the roots of the sod during the process of excavating, hauling and planting. Sod material shall be kept moist from the time it is dug until planted. When so directed by the CITY, the sod existing at the source shall be watered to the extent required prior to excavating. Sod material shall be planted within 3-days after it is excavated unless preserved by techniques such as shrink wrapping and transporting in refrigerated trucks, in which case the CITY shall approve the time interval between excavation and planting.

When necessary, the sodded areas shall be smoothed after planting has been completed and shaped to conform to the cross section previously provided and existing at the time sodding operations were begun. Any excess dirt from planting operations shall be spread uniformly over the adjacent areas or disposed of as directed by the CITY, so that the completed surface shall present a sightly appearance.

202.5.3.1. Plugging. Furrows parallel to the curb line or sidewalk lines, 12-in. (300mm) on centers or to the dimensions shown on the plans, shall be opened on areas to be sodded. In all furrows, sod approximately 3-in.-square (75mm-square) shall be placed on 12-in. (300mm) centers at proper depth so that the top of the sod shall not be more than ½-in. (13mm) below finished grade. Holes of equivalent depth and spacing may be used instead of furrows. Soil shall be firm around each block; then the entire sodded area shall be carefully rolled with a heavy, hand roller developing 15- to 25-lb.-per-square-inch (100- to 170-kPa) compression. Hand tamping may be required on terraces.

202.5.3.2. Solid Sodding. At locations on the plans, or where directed, sod blocks shall be carefully placed on the prepared areas. Sod shall be so placed that the entire designated areas shall be covered. Any voids left in the solid sodding shall be filled with additional sod and tamped. The entire sodded area shall be rolled and tamped to form a thoroughly compact solid mass. Surfaces of solid sod which, in the opinion of the CITY, may slide due to the height or slope of the surface or nature of the soil, shall, upon direction of the CITY, be pegged with wooden pegs driven through the sod block to the firm earth, sufficiently close to hold the sod firmly in place.
202.5.3.3. Fertilizing Sod. Fertilizing shall consist of providing and distributing fertilizer over such areas as are designated on the plans and in accordance with these specifications. The fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed. Fertilizer for sod shall comply with applicable provisions of Item 202.4. Fertilizer.

202.5.3.4. Watering and Finishing Sod. Sodded areas shall be thoroughly watered immediately after they are planted. Large areas shall be planted by irrigation zones, so areas can be watered as soon as they are planted. Sod shall be subsequently watered and mowed at such time and in a manner and quantity directed by the CITY until completion and final acceptance of the project by the CITY.

Sod shall not be considered finally accepted until the sod has started to peg down (roots growing into the soil), and is free from dead blocks or rolls of sod.

202.6. SEEDING TURFGRASS

202.6.1. General. Seeding shall consist of preparing the ground, providing and planting seed or a mixture of seed of the kind specified along and across such areas as may be designated on the plans and in accordance with these specifications.

202.6.2. Materials. All material for turfgrass provided shall be in accordance with these specifications and as noted in the plans and contract documents. Prior to planting, CONTRACTOR shall provide the CITY with the State of Texas Certificate stating analysis of purity and germination of seed.

Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

202.6.2.1. Bermuda Grass Seed. Turfgrass seed shall be “Cynodon Dactylon” (Common Bermuda Grass). The seed shall be harvested within 1-year prior to planting, free of Johnsongrass, field bind weed, dodder seed, and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall not be a mixture. The seed shall be hulled, extra fancy grade, and have a germination and purity that shall produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85-percent. Pure Live Seed (PLS) Percent shall be determined using the formula:

Percent Pure Live Seed = \( \frac{\text{Purity} \times (\text{Germination} + \text{Firm or Hard Seed})}{100} \)

202.6.2.2. Ryegrass Seed. Turfgrass seed shall be “Lolium multiflorum” (Italian or Annual Ryegrass). The seed shall be harvested within 1-year prior to planting and shall be free of perennial ryegrass seed, other grass seed and weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. Seed shall be at least 95-percent pure, treated with fungicide, and shall have a 90-percent minimum germination rate.

202.6.2.3. Sprigs. Turfgrass sprigs and stolons shall be “Cynodon Dactylon” (Common Bermuda Grass) (Hybrid Bermuda Grass of the Tifway 419/ Tifton 10/Tifgreen Strain). Sprigs shall be acquired from a healthy stand of grass, free of weeds and other grasses. The source is to be inspected and approved by the CITY. Sprigs and stolons are to be delivered and planted within 24-hours of harvest unless special precautions are taken to prevent drying of sprigs to assure optimum rooting.

202.6.3. Planting Season and Application Rates. All planting shall be done between the dates specified for each grass type except when specifically authorized in writing. The seeds planted per acre shall be of a type specified with the mixture, rate and planting dates as shown in Table 202.6.3. (a) Seeding Turfgrass, or as specified by the CITY.

<table>
<thead>
<tr>
<th>Type</th>
<th>Planting Season</th>
<th>Seed and Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>March through September</td>
<td>Bermuda Grass, hulled, 50-lb.- (22.7-kg)-PLS 1-per-acre</td>
</tr>
<tr>
<td>Type II</td>
<td>October through February</td>
<td>Rye Grass, 100-lb.- (45.4-kg)-PLS 1-per-acre combined with Bermuda Grass, unhulled, 20-lb.- (9.1-kg)-PLS 1-per-acre</td>
</tr>
<tr>
<td>Other</td>
<td>specified on the plans</td>
<td>specified on the plans</td>
</tr>
</tbody>
</table>

1. Pure Live Seed (PLS) is determined by multiplying the gross weight times purity times the germination. (For example, a 100-lb. (45.4-kg) bag with 85% purity and 80% germination: PLS = pounds (kg) in bag x purity x germination = 100-lb. (45.4-kg) x 0.85 x 0.80 = 60.8-lb. (27.6-kg) of pure live seed.)

202.6.4.1. General. After the designated areas have been completed to the lines, grades and cross sections shown on the plans and as provided for in other items of this contract, seeding of the type specified shall be performed in accordance with the requirements hereinafter described. All seeding operations shall be performed by either “drilling” or “cultipacker” process or approved equivalent. Seed shall be covered by + ¼” (6mm) topsoil.

The CITY may reject seeded area on the basis of weed populations.

202.6.4.2. Broadcast Seeding. Area to be treated shall be rough graded and raked. Seed or seed mixture in the quantity specified shall be uniformly distributed over the areas shown on the plans and where directed. If the sowing of seed is by hand rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. Seed and fertilizer may be distributed at the same time, provided the specified uniform rate of application for both is obtained.

202.6.4.3. Disced Seeding. Soil over the area shown on the plans as directed to be seeded shall be loosened to a minimum depth of 3-in. (75mm). All particles in the seedbed shall be reduced to less than 1-in. (25mm) in diameter, or they shall be removed. The area shall then be finished to the line and grade as specified under Item 202.6.4.6. Watering, Maintaining, and Finishing Seeded Areas.

Seed or seed mixture specified shall then be planted at the rate required, and application shall be made uniformly. If the sowing of seed is by hand rather than by mechanical methods, seed shall be sown in two directions at right angles to each other. Seed and fertilizer may be distributed at the same time, provided the specified uniform rate of application for both is obtained. After planting, the seed shall be raked or harrowed into the soil to a depth of approximately 0.125-in. (3mm).

202.6.4.4. Hydraulic Mulching. All mulch shall be cellulose fiber mulch and shall be refined specifically for lawn hydraulic mulch applications. Use “Conwed” or an approved equal. Adhesive (Tacking) agents for mulch may include guar gum, polyacrylamide, or other tacking agent, as approved by the CITY. Tacking agent shall be evenly distributed in the hydraulic mulch before land application in the proportion recommended by the mulch manufacturer.

Seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans or where directed. Seed and fertilizer are to be distributed as a water slurry, and the mixture shall be applied to that area to be seeded within 30-minutes after all components are placed in the equipment. Fertilizer shall conform to the applicable requirements of Item 202.4. Fertilizer. After placement is completed, the planted area shall be watered sufficiently to assure uniform moisture from the surface to a minimum 6-in. (150mm) depth.

202.6.4.5. Fertilizing. Fertilizing shall consist of providing and distributing fertilizer over such areas as are designated on the plans and in accordance with applicable requirements of Item 202.4. Fertilizer. The fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed.

202.6.4.6. Watering, Maintaining, and Finishing Seeded Areas. Seeded areas shall be thoroughly watered immediately after they are planted. Seeded areas shall be watered as directed by the CITY at least twice daily for at least 14-days after seeding in such a manner as to prevent washing of the slopes or dislodgment of the seed. Water shall be applied to the cultivated areas until a minimum depth of 6-inches is thoroughly moistened. CONTRACTOR shall re-seed washed areas. The CONTRACTOR shall be responsible for proper watering until final acceptance.

Seeded areas shall be maintained, including watering and mowing, at such time and in a manner and quantity directed by the CITY until completion and final acceptance of the project by the CITY. At minimum, the CONTRACTOR shall maintain the seeded area until each of the following conditions is achieved: vegetation is evenly distributed, without large bare areas, and covers 70% of the seeded area.

Where applicable, the shoulders, slopes and ditches shall be smoothed after seeding has been completed and shaped to conform to the cross section previously provided and existing at the time planting operations were begun.
202.7. REJECTION
Landscape materials may be rejected for failure to meet any of the requirements of this specification or as shown on the plans or in the contract specifications.
ITEM 203. SITE PREPARATION

203.1. DETERMINING LOCATION AND PROTECTION OF EXISTING STRUCTURES AND UTILITIES

Determining location and protection of existing structures and utilities shall comply with this Item 203.1.

203.1.1. Determining Location. Determining the location of existing structures, utilities and appurtenances shall proceed according to the specifications herein.

BIDDERS must satisfy themselves as to the actual existing subsurface conditions, including but not limited to the depth, location and sizes of pipe or conduits of various kinds in place. Where the exact depth of any utility or obstruction is not shown on a plan, excavation shall be made prior to reaching the obstruction in order to determine adjustments in grade if needed to prevent interference. Redesign to eliminate conflicts may be necessary. Extra compensation shall not be paid for such delays.

203.1.2. Protection. All existing structures, improvement and utilities designated to remain shall be adequately protected, at the expense of the CONTRACTOR, from damage that might otherwise occur due to construction operations. Where construction comes in close proximity to existing structures, utilities or appurtenances, or if it becomes necessary to move services, poles, guy wires, pipe lines or other obstructions, the CONTRACTOR shall notify and cooperate with the owner of the utility, structure, or appurtenance. The utility lines and other existing structures shown on the plans are for information only and are not guaranteed by the CITY to be complete or accurate as to location and/or depth. The CONTRACTOR shall be liable for damage to any utilities resulting from the CONTRACTOR’S operations. During construction, all fire hydrants, valve boxes, fire or police call boxes and other existing utility controls shall be left intact, unobstructed and accessible unless noted on the plan.

All water mains, wastewater collection mains, wastewater collection house laterals, storm drains, power conduits, gas mains, gas service laterals and other lines or appurtenances encountered during construction shall be supported or replaced as detailed on the plans. Water service lines shall not be removed during excavation, and the CONTRACTOR shall provide adequate support for the services across the open ditch.

203.1.2.1. Utility Supports. Pipe capable of supporting its weight approximately at right angles to the ditch shall not require additional support, unless otherwise directed by the CITY or shown on the plans, other than the exercise of care in placing new conduit under same and in placing backfill, except when the span is excessive. If directed by the CITY, utilities shall be replaced with cast iron or any suitable piping to convey the contents, supported with concrete or a concrete utility support per details on the plans, as directed by the CITY. After the new utility is laid, the backfill to the base of the concrete support shall be stabilized by the use of cementstabilized soil, if directed by the CITY.

Pipes parallel to and in the edge of cut, shall be supported or rerouted if so indicated on the plans. Utilities parallel to and in edge of cut shall be adequately protected without additional compensation except as set out in the contract and proposal.

203.1.3. Relocating or Replacing Structures, Utilities or Appurtenances. Utility locations shall be obtained prior to the commencement of work. Unless noted on plans that utilities are to be moved by others, any cost of temporarily or permanently relocating utilities shall be borne by the CONTRACTOR. The cost of these replacements shall be included in the CONTRACTOR’S bid price for the various items of work, and no separate payment shall be made. In case damage to an existing structure or utility occurs, whether such damage results directly or indirectly from the CONTRACTOR’S operations, the CONTRACTOR shall be responsible to restore the structure or utility to its original condition and position with out extra compensation. Temporary shut down of water and/or storm or wastewater services shall not extend overnight, holidays or weekends. The CITY shall approve all shut downs and may assist in the shut down operations.

When it is necessary to remove or adjust another utility, a representative of that utility shall be notified to decide method and work to be done. The CONTRACTOR shall make satisfactory arrangements with other utilities for the required cutting or adjustments at the CONTRACTOR’S own expense, other than for items that may be provided in the contract for such work. No extra compensation shall be paid due to delays caused by removal of public utility structures.

203.1.3.1. Interrupted Wastewater Services. All wastewater collection services damaged during construction shall be replaced at the CONTRACTOR’S expense. Cuts or breaks in wastewater collection mains and laterals, or service connections shall be restored at the earliest practicable moment. Temporary restoration of service shall be installed within 4-hours of damage. Permanent repairs shall be in place in agreement with the
City. Wastewater collection service reconnections, including necessary adjustments to a replacement, shall not require the services of a master plumber, if being replaced by an approved utility contractor; however, in all cases, repair shall be inspected by the city. It shall be the responsibility of the contractor to maintain such services throughout the construction process.

Any spill of wastewater must be returned to the sanitary sewer and remediation of the spill is the responsibility of the contractor. Spill and remediation will be reported by the city to the TCEQ and USEPA. The contractor shall be responsible for notifying customers of temporary interruption of service.

203.1.3.2. Street Sign Posts and Signs. The contractor shall be responsible for all damage to street sign posts and signs within the limits of the contractor's operations that remain in place or are removed and replaced. In the event that street sign posts and signs are damaged or destroyed by the contractor's operations, they shall be replaced at the contractor's expense.

203.1.3.3. Methods of Removal and Disposal. Materials or parts of structures which are to be broken up, dismantled or removed, and which are to be salvaged, shall be removed, loaded, cleaned and unloaded at sites designated by the city. Materials that are not salvageable shall become the property of the contractor. Disposal of such materials, in accordance with applicable local, state, and federal regulations, shall be at the contractor's expense.

203.2. MAINTENANCE OF STREETS DURING CONSTRUCTION

The contractor shall at all times maintain the surfaces of streets on which work was or is being performed. The maintenance required shall include the filling of holes; blading or otherwise smoothing of the street surfaces (particularly in a trench area); cleaning and removal of surplus excavation material rubbish, etc.; sprinkling of streets to abate dust nuisances and the elimination of interference resulting from blocking the street to residents thereon. Any or all of such operations shall be performed by the contractor upon demand by the city, but the contractor shall not wait for instruction from the city before performing maintenance work obviously in need of being done to meet the requirements of these specifications. All costs of work covered by this paragraph shall be included in the price bid for the various items of work, and no separate payment shall be made.

In the event the contractor fails or refuses to properly maintain the surfaces of streets on which work was or is being performed, the city, after due notice to the contractor, shall perform the necessary maintenance. All costs to the city incurred in the performance of such work shall be deducted from any monies due or to become due to the contractor for work performed, or the contractor shall be billed for such costs directly as the city shall elect. Notice to the contractor to be given by the city shall be in writing, and it shall be delivered to the contractor or an authorized agent. Except in emergency cases, where immediate action is required. The contractor shall have 24-hours in which to comply with the instructions from the city. Should the contractor fail to do so, the city shall proceed with the work as set forth above.

Where traffic must cross open trenches, such as street intersections and driveways, the contractor shall provide suitable backfill bridges, protective barricades and such other safety equipment as required. The use of machinery must be so regulated as to preclude any unnecessary interference with traffic, utilities, etc. The contractor shall abide by all applicable federal, state or local laws governing excavation work, including OSHA and USEPA regulations.

203.3. GENERAL SITE PREPARATION

203.3.1. Description. This Item shall consist of preparing the right-of-way and designated easements for construction operations by the removal and disposal of all obstructions from the right-of-way and from designated easements, where removal of such obstructions is not otherwise provided for in the plans and specifications. Such obstructions shall be considered to include remains of houses not completely removed by others, founda-
tions, floor slabs, concrete, brick, lumber, plaster, septic tanks, basements, abandoned utility pipes or conduits, equipment or other foundations, fences, retaining walls, outhouses, sheds and other debris.

This item shall also include the removal and disposal of designated trees, stumps, bushes, vegetation, roots, shrubs, brush, and logs. It is the intent of this specification to provide for the removal and disposal of all obstructions and objectionable materials not specifically provided for elsewhere in the plans and specifications. This item does not include the removal and disposal of hazardous material.

203.3.2. Construction Methods. The entire right-of-way for this project and such additional areas, including public or corporate areas and public or corporate lands, as made available for construction of this project, shall be cleared of all structures and obstructions, as defined above, except that trees or shrubs shall be protected unless specifically designated by the CITY for removal. Unless designated for removal without replacement, trees and shrubs shall be treated according to Item 202.1. Removal, Protection, and Replacement of Trees, Shrubbery, Plants, Sod, and Other Vegetation. Unless otherwise indicated on the plans, all foundations and underground obstructions shall be removed to the following depths:

1. In areas to receive embankment, 2-ft. (0.6m) below natural ground or to bottom of structure.
2. In areas to be excavated, 2-ft. (0.6m) below the lower elevations of the excavation, or to the bottom of structure.
3. In all other areas, 1-ft. (0.3m) below natural ground or to bottom of structure.

All basement walls and floors, septic tanks and storage tanks within the limits of the right-of-way shall be removed and the resulting holes backfilled as directed by the CITY. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc., shall be backfilled. The CONTRACTOR shall complete the operation of preparing right-of-way so that the prepared right-of-way shall be free of holes, ditches and other abrupt changes in elevations and irregularities to contour.

The remaining ends of all abandoned-in-place storm sewers, culverts, sanitary sewers, conduits and water or gas pipes shall be plugged with an adequate quantity of concrete to form a tight closure. All materials and debris removed shall become the property of the CONTRACTOR unless otherwise provided for on the plans or in the specifications and shall be removed from the right-of-way. Unless otherwise provided, all merchantable timber removed as previously specified shall become the property of the CONTRACTOR. Gravel, brick, stone or broken concrete, when permitted by special conditions, may be used in the roadway embankment.

203.4. UNCLASSIFIED STREET EXCAVATION

203.4.1. Description. Unclassified street excavation shall consist of all the required excavation within the limits of the right-of-way and areas adjacent thereto (except excavation specifically described and provided for elsewhere in the specifications); the removal, proper utilization or disposal of all excavated material; and the shaping and finishing of all earthwork in conformity with the lines and grades as shown on the plans or as established by the CITY all in accordance with the specification requirements contained herein.

203.4.2. Classification. Without regard to materials encountered, all street excavations shall be unclassified and shall be designated as “Unclassified Street Excavation,” which shall include all materials excavated. It is to be distinctly understood that any reference to rock or other material on the plans and/or in this specification is solely for the CITY’S and CONTRACTOR’S information and is not to be taken as an indication of classification of excavation.

203.4.3. Construction Methods. All excavation shall be in accordance with the lines, grades and typical sections as shown on the plans or as established by the CITY. Unless otherwise shown on the plans or established by the CITY, the street excavation shall be made to the subgrade of the roadway and finished grade of park-
ways. Where excavation to grades established in the field by the CITY would terminate in unstable soil, the CONTRACTOR shall remove the unstable soil and backfill to the required grade.

Unless otherwise approved in writing by the CITY, where excavation to grade established in the field by the CITY terminates in loose or solid rock, the CONTRACTOR shall excavate 6-inches (15cm) below the required subgrade elevations for the entire roadbed width and shall backfill with suitable selected materials approved by CITY. Payment for such work will be made in accordance with the contract documents.

The CONTRACTOR shall conduct operations in such a manner that adequate measurements may be taken before any backfill, as required above, is placed. Dragging, pushing or scraping of material along or across the surface of the complete concrete improvements or pavements shall not be permitted.

203.4.4. Provisions For Drainage. If it is necessary in the execution of the work to interrupt the natural surface drainage or the flow of artificial drains, the CONTRACTOR shall provide temporary drainage facilities that shall prevent damage to public or private interest and shall restore the original drains as soon as the work shall permit.

The CONTRACTOR shall be held liable for all damages which may result from neglecting to provide for either natural or artificial drainage which its work may have interrupted.

203.4.5. Excess Excavation. The CONTRACTOR shall dispose of excavation in excess of that needed for construction. In general, suitable excess street excavation shall be used in construction of parkways, widening of embankments, flattening of slopes, etc., but, if it becomes necessary to waste any material, it shall be disposed of in such a manner as to present a neat appearance and to not obstruct proper drainage or cause injury to any street improvements or abutting property. If necessary to haul off excess or unsuitable material, the CONTRACTOR shall dispose of it in accordance with local, state, and federal guidelines.

203.4.6. Parkways. Parkways shall be finished as shown on plans. Whenever the adjacent property is lower than the design curb grade and drains away from the street, the parkway grade may be set level with the top of the curb, if approved by the CITY. The CITY may approve variations from these standards in special cases.

Sprinklers that are damaged as a result of Work shall be repaired by the CONTRACTOR to pre-Work condition.

203.5. UNCLASSIFIED CHANNEL EXCAVATION

203.5.1. Description. Channel excavation shall consist of required excavation for channels within the limits of the CITY’s right-of-way or designated easements; the removal and proper utilization or disposal of all excavated materials; compacting and refilling, after settlement of all excavated areas; and constructing, shaping and finishing of all earthwork involved in conformity with the required lines, grades and typical cross sections in accordance with specification requirements herein outlined.

203.5.2. Classification. All authorized channel excavation shall be “unclassified” and involves removal of all materials necessary to permit carrying on the completion of the work.

203.5.3. General. In general, all excavation shall be made in open cut from the surface of the ground and shall be no greater in width or depth than is necessary to permit the proper construction of the work in accordance with the plans and these specifications. Work shall be executed in a neat workmanlike manner. A trench safety plan shall be submitted. All excavation shall be to the line and grade as provided by the CITY. The CONTRACTOR shall abide by all applicable federal, state and/or local laws governing excavation work.

The CONTRACTOR shall provide for the uninterrupted flow of storm and wastewater lines and surface waters during progress of the construction.

Completed work shall conform to the established alignment, grades and cross sections.

203.5.4. Dewatering. During construction, the channel shall be kept drained, insofar as practicable, and the Work shall include the installation and operation of all pumping, bailing and draining necessary to keep the excavation free from seepage water, water from storm drains, wastewater collection systems, ditches, creeks and other sources. The CONTRACTOR shall remove all water from any source that may accumulate in the excavation. The embankment or pipe shall not be installed in water. No water shall be allowed to flow through or over unset
The CONTRACTOR shall use only such methods as are approved as are provided for in the contract.

203.5.5. Excavated Material. Excavated materials shall be handled at all times in such manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

All suitable materials removed from the excavation shall be used, insofar as practicable, in the formation of embankments as required by Item 203.7. Embankment, or shall be otherwise utilized. Desirable topsoil, sod, etc. shall be carefully removed and piled separately adjacent to the work when required. Suitable excavated materials may be piled adjacent to the work to be used for backfilling.

Unsuitable channel excavation and suitable channel excavation in excess of that needed for construction shall be known as "waste" and, unless specified otherwise, shall become the property of the CONTRACTOR to be disposed of outside the limits of the right-of-way in accordance with local, state, and federal guidelines. The excavated material in rock that is not suitable material for bedding or backfill shall similarly be disposed of by the CONTRACTOR. Suitable bedding or backfill material shall be provided at no additional cost to the CITY.

The CONTRACTOR shall indemnify and hold harmless the CITY and all related officers, agents, and employees from all suits, actions or claims of any character resulting form arrangements for and disposal of soil.

203.5.6. Open Cut Construction Methods.

203.5.6.1. Trench Bottom Elevation. All trenches for installation of water, storm water collection system and/or wastewater collection system lines shall be excavated to a point below the barrel of the pipe for the type of embedment specified and as described in Item 504.5. Embedment.

203.5.6.2. Trench Overcut. Should the CONTRACTOR excavate below the plan trench bottom for water or wastewater collection system lines, the CONTRACTOR shall backfill to trench bottom grade shown on the plans with approved aggregate, consolidated and compacted to meet the CITY's approval.

If the CONTRACTOR elects to overcut the trench and use gravel and drain pipe as an underdrain in lieu of or in conjunction with pumping, draining or well pointing, the additional work shall be considered as incidental work and additional compensation shall not be allowed.

Where the character of the foundation material is such that a proper foundation cannot be prepared at the elevation shown on the plans, then, when directed by the CITY, the CONTRACTOR shall deepen the excavation to where a proper foundation entirely satisfactory to the CITY can be prepared. Such materials removed shall be replaced with foundation materials as specified in Item 504.3. Excavation and Foundation, or with other material satisfactory to the CITY and thoroughly compacted in place to finish grade elevation in a manner satisfactory to the CITY.

203.5.6.3. Excess Trench Width. When the plan trench width is not maintained to a point of 1-ft. (0.3m) above the top of the pipe, the CONTRACTOR shall provide embedment as directed by the CITY, which shall provide adequate support at no additional cost to the CITY.

203.5.6.4. Progress. The CITY shall have the right to limit the amount of trenches that shall be opened, or partly opened, in advance of or following the pipe laying operation. Unless otherwise directed by the CITY, the completion of backfill shall immediately follow the pipe laying. In the event the CONTRACTOR fails to comply with the requirement, the CITY may stop the pipe laying until the requirements are met.

203.5.6.5. Excavation for Altered Grade. If excavation for the conduit or appurtenance due to the altered grade is altered more than 1-ft. (0.3m) and has not been classified as a separate contract pay item, the increased or decreased amount of excavation due to the altered grade may constitute a basis for revised consideration by either party to the contract.

203.5.7. Alternate Methods of Excavation. Prior to commencing any excavation, the CONTRACTOR shall provide ample labor, equipment, shoring material and such other safety equipment as required to insure that the work shall be carried on without interruption or damage to existing installations and to provide the least interruption of traffic commensurate with the project requirements.

203.5.7.1. Blasting. In cases where the plans and specifications do not require the use of explosives, if (after written approval by the CITY) the CONTRACTOR elects to use explosives in the performance of the work, utmost care shall be exercised so as not to endanger life or property. The CONTRACTOR shall use only such methods as are currently utilized by persons, firms or corporations engaged in a similar construction business. The CONTRACTOR shall be solely responsible for the determination as to whether explosives shall be used and for any
result from the use of explosives. The CONTRACTOR shall indemnify and hold the CITY whole and harmless against any claim for damage or injury to persons or property, real or personal, as the result of the use of explosives by the CONTRACTOR or any subcontractor.

The following criteria with regard to the use of explosives and blasting shall be satisfied:

1. Certification. Certification by the proper authorities for personnel involved with the actual use of explosives is required and must be obtained prior to the use of explosives.

2. Insurance. The CONTRACTOR shall furnish the CITY with evidence of insurance sufficient to cover any such possibility, which insurance shall either include the CITY as an assured or be of such character as to protect the CITY.

3. Restrictions. No blasting shall be permitted within highway right-of-way or railroad right-of-way without written permission from TxDOT, the railroad involved and the CITY.

4. Limitations. When blasting is authorized, the blast shall be covered with heavy timbers chained together, a rope mat, or some other equally effective method of blast effect protection, approved by the CITY. All explosives shall be stored in a safe and secure manner and such storage places shall be clearly marked, “DANGEROUS — EXPLOSIVES.” Blasting caps and explosives shall be stored separately. In addition to the “DANGEROUS — EXPLOSIVES” sign which must be displayed, at least two signs marked, “EXPLOSIVES, TURN ALL RADIOS OFF,” shall be placed in a conspicuous location readily visible to vehicular traffic and not less than 350-ft. (150m) from electric explosive caps storage area. During each blast the exposed end of the pipe shall be covered with planking.

5. Notification. The CONTRACTOR shall notify each utility company having structures in proximity to the site of the work of the intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. Such notice shall not relieve the CONTRACTOR of responsibility for any damage resulting from blasting operations.

6. Laws and Ordinances. The method of blasting, storing and handling explosives must be carried on in full conformance with the requirements of all federal and state laws and municipal ordinances.

203.5.7.2. Tunneling. When the CONTRACTOR installs wastewater collection system and/or water mains by jacking, boring or tunneling, the CONTRACTOR shall comply with the provisions of Item 503. Trenchless Installation.

When shown on the plans or proposal or as directed by the CITY, the CONTRACTOR shall be paid for tunneling work as outlined in the bid proposal.

If approved by the CITY, the CONTRACTOR may voluntarily elect to install by tunneling, boring or jacking any portion of the work that is designated on the plans for open cut installation. The CONTRACTOR shall be paid for only the pay items that would have been paid for if the work had been done by open cut.

203.5.7.3. Cofferdam. Where shown and/or detailed on the plans, excavation shall be performed within a cofferdam. The CONTRACTOR shall install and securely brace the cofferdam in accordance with Item 802.4. Cofferdams and shall remove the excavation within the area so protected without damage to or displacement of the cofferdam and bracing.

203.6. BORROW

203.6.1. Description. Borrow shall consist of required excavation, removal, and proper utilization of materials obtained from designated or approved sources.

203.6.2. Classification. All authorized borrow shall be “unclassified” unless otherwise noted.

203.6.3. Construction Methods. All suitable materials removed from the excavation shall be used, insofar as practicable, in the formation of the embankment as required by the governing item for embankment; or shall otherwise be utilized as indicated on the plans or as directed. The completed work shall conform to the established alignment, grades and cross section. Site of the borrow operations shall be left in a suitable and sightly condition,
such as to provide proper drainage where practicable. Where indicated on the plans, the sides and/or ends of
borrow pits shall be sloped to the dimensions indicated on the plans.

203.6.4. Selection of Materials. Where shown on the plans, selected materials shall be utilized in the formation
of embankment, embayment or backfill, or to improve the roadbed, in which case the work shall be performed in
such manner and sequence that suitable material may be selected, removed separately and deposited in the
roadway within limits and all elevations required. When required, acceptable borrow material, tested by standard
laboratory methods, shall meet the requirements indicated on the plans.

203.7. EMBANKMENT

203.7.1. Description. Embankment shall consist of the placement and compaction of all suitable materials
obtained from excavation, borrow or any other approved excavation.

203.7.2. Construction Methods. Prior to the placing of any embankment, all clearing and grubbing and site
preparation shall have been completed. Stump holes or other small excavations within the limits of the embankment
shall have been backfilled before commencing the embankment construction. The surface of the ground, including
plowed or loosened ground or small ditches or washes, shall be restored to approximately its original slope.

The surface of hillsides shall be loosened by the scarifying or plowing to a depth of not less than 4-in. (100mm)
or cut into steps before embankment materials are placed. The embankment shall then be placed in layers as
hereinafter specified, beginning at the low side in part widths as the embankment is raised. The material which has
been loosened shall be recompacted simultaneously with the embankment material placed at the same elevation.
Where embankment is to be placed over or adjacent to the existing roadbeds, the slopes shall be plowed or scarified
to a depth not less than 4-in. (100mm) and the embankment built up in successive layers, as hereinafter specified, to
the level of the old roadbed before its height is increased. Then the old roadbed shall be scarified and recompacted
with the next layer of embankment. The total depth of the scarified and added materials shall not exceed the
permissible depth of the layer.

All embankments for roadbeds shall be constructed in layers approximately parallel to the finished grade of the
street and shall be so constructed as nearly as possible to conform to the cross section of the subgrade section.

Embankments shall be constructed to the established grade and to the shape of the typical section shown on
the plans, and each section shall conform to the detailed sections of slopes. After completion of the embankment, it
shall be continuously maintained to its finished section and grade until the project is accepted.

Earth embankments shall be constructed in successive layers, for the full width of specified depth or cross
sections; and in such lengths as are suitable for the sprinkling and compaction methods to be used. Each layer of
earth embankment shall be uniform as to material, density, and moisture content before beginning compaction. Prior
to compaction, the layers shall not exceed 6-in. (150mm) in depth for pneumatic tire rolling or 8-in. (200mm) in depth
for rolling with other types of rollers.

Earth embankment placed adjacent to and over pipes, culverts, arches and bridges shall be of suitable material
and shall be placed in successive layers approximately horizontal. Layers of embankment shall be brought up
uniformly on each side of the structure, and special care shall be taken to prevent any wedging action against the
structure. For such distances along embankments adjacent to structures where it is impracticable to obtain com-
paction by rolling, the embankment material shall be placed in layers not exceeding 6-in. (150mm) in depth for loose
material wetted uniformly to the moisture content directed; and shall then be compacted by methods approved by
the CITY, maintaining the required moisture content by additional sprinkling, if necessary, supple-
mented by such hand work as is necessary to secure a uniform and thoroughly compacted fill, until each layer has
been uniformly compacted to the satisfaction of CITY.

All earth cuts, full or part width in the side of a hill, which are not required to be excavated below subgrade ele-
vation for base or backfill, shall be scarified to a uniform depth of not less than 6-in. (150mm) below grade shown on
the plans, and the materials shall be mixed and reshaped by blading and then sprinkled and rolled in accordance
with the hereinabove outlined requirements for earth embankments.
Rock embankments shall be composed principally of rock and shall be constructed in successive layers for the full width of the specified depths or cross sections, and each layer shall be 18-in. (450mm) or less in depth. Each layer shall be constructed by starting at one end, dumping the rock on top of the layer being constructed and then pushing the dumped material ahead in such a manner that the larger rock shall be placed on the ground or preceding rock embankment layer; and the interstices between the larger stones shall be filled with smaller stones and spalls both by this operation and from the placing of succeeding loads of rock materials. The upper or final layer of rock embankment shall contain no stones larger than 4-in. (100mm) in their maximum dimension, and insofar as such is available by selection of the excavation, this layer shall be composed of materials so graded that the maximum density and uniformity of the surface layer may be secured. Each rock embankment layer shall be rolled as directed by the CITY.

In addition to the foregoing selection of materials and utilization of the materials in the embankment, the embankment shall be constructed in the proper sequence to receive select materials as specified or as shown on the plans, with any modifications as may be directed by the CITY. The layer of embankment immediately preceding the upper layer of select material shall be constructed to the required cross section and the proper elevation within a tolerance of not more than 0.1-ft. (30mm) from the established cross section or elevation after proper compaction and shall be finished as necessary to receive the select material.

203.7.3. Density. For each layer of earth embankment and select material, the relative compaction of the embankment shall be as shown on the plans. After each section of earth embankment or select material is completed, such tests as are necessary shall be made as specified by the CITY, unless otherwise specified in the special provisions or in the plans.

203.8. DUST CONTROL

203.8.1. Description. Sprinkling for dust control shall consist of the authorized application of water or other material approved by the CITY on those portions of the projects as shown on the plans or as directed and as herein specified. It shall be the responsibility of the CONTRACTOR to take preventive measures to eliminate, reduce, or alleviate any dust nuisance in the work area. This control of dust nuisance is most important in populated areas. The CITY will approve the method used. Should the CONTRACTOR fail to control dust as outlined above, the OWNER may suspend the work until corrective measures are taken.

203.8.2. Materials. Water or other material approved by the CITY shall be furnished by the CONTRACTOR and shall be clean, free from industrial waste and other objectionable matter. Emulsions shall meet the requirements of Item 2.4.5. Emulsions for Priming, Curing and Erosion Control.

203.8.3. Construction Methods. The CONTRACTOR shall furnish and operate a sprinkler equipped with positive and rapidly working cutoff valves and approved spray bars, which shall insure the distribution of material in a uniform and controllable rate of application. It shall be the CONTRACTOR’S continuous responsibility to be on call at all times including nights, holidays, weekends, etc. and respond in a timely manner, until acceptance of the project by the CITY, to maintain the project free of dust in a manner which shall cause the least inconvenience to the public.
Survey & Monumentation Standards

All subdivisions prepared for submittal to City of Temple shall be prepared by a Registered Professional Land Surveyor, licensed in the state of Texas, and all survey work shall be performed in compliance with the current Minimum Standards of Practice governed by the Texas Board of Professional Land Surveying (TBPLS).

1.) CONTROL - The perimeter boundary of the subdivision must be tied to the City of Temple Horizontal and Vertical Control system, and the physical (measured) tie (grid bearing and surface distance) must be displayed on the subdivision plat, or described thoroughly with a note on the face of the plat.

All elevations shown on construction plans or on the plat (if needed) must be tied to an existing City of Temple Control Point, and the description/location of this control point/benchmark must be noted on the plans, and in some events – on the plat.

2.) BOUNDARY MONUMENTATION - All subdivisions shall have the perimeter boundary of the subdivision properly marked and said markers must consist of monuments that are set or found (and appropriately described on the plat and in the accompanying surveyor’s field notes), and are of sufficient size and depth to retain a stable and distinctive location and to withstand the deteriorating forces of nature, and shall be of such material that, in the surveyor’s judgment, will best achieve this goal (this is required in order to comply with TBPLS rules).

All of the perimeter corners of the subdivision must have actual “in the ground” markers that meet the TBPLS minimum standards, or have reference markers in the event of drastic terrain creating a situation where a marker cannot be placed at the actual corner.

All street Rights-Of-Way (ROW) corners (this includes block corners, angle points, points of curvature and points of tangency) must have a marker placed by a surveyor prior to final plat approval by the City of Temple or recording of plat and prior to final acceptance of the subdivision. In accordance with the TBPLS rules, where practical, all monuments/markers set by professional land surveyors to delineate or witness a boundary corner shall be marked in a way that is traceable to the responsible surveyor or associated firm.

3.) INDIVIDUAL LOT CORNERS - Each and every lot corner is not required to be in place at the time the plat is approved or recorded, unless said corner is a subdivision perimeter corner, block corner, or ROW corner. Prior to commencement of building/structure construction, all lot corner monuments for the lot(s) included in the permit must be in place.

DSAB Approved: 10/10/2007
City Council Approved: 1/17/2008
City Ordinance # 2008-4194
DIVISION 300  
ROADWAY CONSTRUCTION

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ITEM 301. SUBGRADE, SUBBASE, AND BASE PREPARATION

301.1. GENERAL
Subgrade is that portion of the roadbed upon which the subbase, base or the pavement is to be placed. It includes 12-in. (30cm) beyond the back of the curb for streets, which are to be paved with concrete. Subbase is that layer of specified material of plan thickness between a base and a subgrade. Base is that layer of specified material of plan thickness placed immediately below the pavement course surfacing.

301.1.1. Subgrade Preparation.

301.1.1.1. Description. These specifications shall govern for the preparation of the subgrade except as otherwise provided or specified.

301.1.1.2. Equipment. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. Any equipment that achieves the desired results in the time frame allowed is acceptable.

301.1.1.3. Construction Methods. After the excavation of embankment has been substantially completed, the subgrade shall be shaped so that after rolling as specified in Item 301.1.2. Rolling of Embankment, Subgrade or Flexible Base and subsequent finishing operations, it shall conform to the correct alignment, cross section and elevation. Rolling and sprinkling, as needed, shall be performed when and to the extent directed and the roadbed shall be completed to or above the plane of the typical section shown on the plans and the lines and grades established by the CITY.

After completion of the compaction and immediately before the application of subbase, base or pavement, the subgrade preparation equipment shall be operated using approved methods in a manner to finish the subgrade to the required section. The subgrade shall then be tested with the approved template, operated and maintained by the CONTRACTOR. All irregularities which develop in excess of ½-in. in a length of 16-ft. (13mm in 5m) measured longitudinally shall be corrected by loosening, adding or removing material; reshaping; and recompacting by sprinkling and rolling. The completed subgrade shall have a uniform density of not less than 95-percent of the maximum density determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)). Moisture content shall be within minus-2- to plus-4-of-optimum.

The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade, until the subbase, base or pavement is placed, and shall be kept wetted down sufficiently in advance of placing any subbase, base or pavement to insure its being in a firm and moist condition for at least 2-in. (5cm) below surface of the prepared subgrade. Only such subgrade as is necessary for the satisfactory execution of the work shall be completed ahead of the placement of base or pavement. Hauling or operating of unnecessary equipment on the completed subgrade shall be kept to a minimum. If equipment is operated on recent work, the CITY may inspect and require subgrade replacement for such defects as fractures, rutting, or any other failure. Complete drainage of the subgrade shall be provided at all times.

Finishing of the subgrade by other methods shall be permitted on pavement widening projects, on sections where the pavement width is not uniform, at intersections and elsewhere where the operation of certain equipment would not be practical. Subgrade finished by hand or other methods shall conform to the requirements above specified.

301.1.2. Rolling of Embankment, Subgrade or Flexible Base

301.1.2.1. Description. Rolling shall consist of the compaction of embankment, subgrade or flexible base by the operation of approved power rollers, as herein specified and as directed by the CITY.

301.1.2.2. Roller Requirements. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. Any equipment that achieves the desired results in the time frame allowed is acceptable. If equipment fails to produce the desired result within the required time frame, its use shall be discontinued and the CONTRACTOR will be required to furnish equipment, as determined by the Engineer, at no additional cost to the CITY.
Sufficient rollers shall be provided to compact the material in a manner satisfactory to the CITY. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, the CONTRACTOR shall provide additional roller units.

301.1.2.3. Rolling Methods. The embankment, subgrade or base course shall be sprinkled as directed by the CITY. Rolling patterns and speeds shall be established per project and indicated on the plans.

301.2. LIME TREATMENT
This item shall consist of treating subgrade, subbase, and base courses by the pulverization, addition of lime, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment, or pulverized recycled asphalt pavement base or subbase courses placed under this contract, which shall be constructed as specified herein and in conformity with the typical section, lines and grades as shown on the plans.

301.2.1. Materials.
301.2.1.1. Hydrated Lime (Slurry).

301.2.1.1.1. General. Hydrated lime slurry shall be a pumpable suspension of solids in water. The solids portion of the mixture, when considered on the basis of "solids content," shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

301.2.1.1.2. Chemical Composition. The "solids content" of the lime slurry shall have a hydrate alkalinity Ca(OH)_2 of not less than 90-percent by weight.

301.2.1.1.3. Residue. The percent by weight of residue retained in the "solid content" of lime slurry shall conform to the requirements in Table 301.2.1.1.3.(a) Hydrated Lime.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Residue Retained, Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 6 (3360 micron)</td>
<td>None</td>
</tr>
<tr>
<td>No. 10 (2000 micron)</td>
<td>Max. 1.0%</td>
</tr>
<tr>
<td>No. 30 (590 micron)</td>
<td>Max. 2.5%</td>
</tr>
</tbody>
</table>

301.2.1.1.4. Slurry Grades. Type B, commercial lime slurry, shall conform to one of the following three grades:

1) Grade 1: The "dry solids contents" shall be at least 31-percent by weight of the slurry.
2) Grade 2: The "dry solids contents" shall be at least 35-percent by weight of the slurry.
3) Grade 3: The "dry solids contents" shall be at least 46-percent by weight of the slurry.

When Type B, commercial lime slurry, is specified, the CONTRACTOR shall select, prior to construction, the grade to be used and shall notify the CITY in writing before changing from one grade to another.

301.2.1.2. Quicklime.

301.2.1.2.1. General. Quicklime is a dry material consisting essentially of calcium oxide. It shall be furnished either in "pebble" gradation suitable for dry placing and slurry placing, or as a dry powder suitable only for slurry placing. Powdered quicklime is restricted to slurry placing, as the possibility of appreciable amounts of finely divided powdered quicklime makes it unsuitable for dry placing.

301.2.1.2.2. Chemical Composition. Quicklime shall conform to the chemical requirements of ASTM C977 Quicklime and Hydrated Lime for Soil Stabilization.

CAUTION: HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.
301.2.1.3. Tests. If the minimum design strength or percent lime to be used for the treated subgrade, existing base, new subbase or new base is specified, it shall be determined by preliminary laboratory tests at the CITY’s expense. Optimum lime addition percentage shall be determined by Tex-112-E Admixing Lime to Reduce Plasticity Index of Soils (Atterberg Limits Soil-Lime Series) and/or by ASTM D6276 Test Method for Using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization (pH Soil-Lime Series.)

301.2.1.4. Lime Delivery and Storage. If hydrated lime is furnished in bags, each bag shall bear the manufacturer’s certified weight. Bags varying more than 5-percent by weight may be rejected, and the average weight of the bags in any shipment, as shown by weighing 50 bags taken at random, shall not be less than the manufacturer’s certified weight. If lime is furnished in trucks, each truck shall bear the weight of lime measured on certified scales, or the CONTRACTOR shall place a set of standard platform truck scales or hopper scales at a location approved by the CITY.

Hydrated lime and quicklime shall be stored and handled in closed, weatherproof containers until immediately before distribution on the road. If storage bins are used, they shall be completely enclosed. Hydrated lime bags shall be stored in weatherproof buildings with adequate protection from ground dampness. Quicklime, when permitted, shall be shipped only in bulk; bagged material shall not be acceptable.

301.2.1.5. Water. Water shall conform to the requirements of Item 303.2.7. Water.

301.2.1.6. Soil. The soil shall consist of the in-situ soil or approved soil, free from vegetation, roots, or other objectionable matter. It may be either the material encountered in the existing section, material secured from approved sources shown on the plans or as designated by the CITY, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the CITY.

301.2.1.7. Recycled/Reclaimed Asphalt Pavement. Recycled/Reclaimed asphalt pavement is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement uncontaminated by dirt or other objectionable materials.

301.2.1.8. Rejection. Any materials that do not conform to the requirements of this specification shall be rejected.

301.2.2. Equipment. Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the CITY prior to the beginning of construction operations.

When permitted, quicklime shall be slurried in agitated slurry tanks. The distributor truck used for slurry placing need not necessarily be equipped with an agitator. However, the slurry at the time of distribution must meet the consistency requirements specified.

All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

301.2.3. Lime Treatment Construction Methods.

301.2.3.1. General. It is a primary requirement of this specification to secure a completed course of treated material containing a uniform lime mixture, free from loose or segregated areas, or uniform density and moisture content, well bound for its full depth, and with a smooth surface and suitable for placing subsequent courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.

Prior to beginning any lime treatment, the roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the CITY.

In cases where groundwater is present, application of lime for stabilization shall be evaluated by the CITY.

301.2.3.2. General Construction.

301.2.3.2.1. Treatment for Materials in Place. Materials to be treated shall be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary grade. Any wet or unstable material below the secondary grade shall be corrected by scarifying, adding lime and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the CONTRACTOR elects to use a cutting or pulverizing machine that shall remove the subgrade material accurately to the secondary grade and to pulverize the material at the same time, CONTRACTOR shall not be required to expose the secondary grade or windrow the material. However, the CONTRACTOR shall be required to roll the subgrade before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method shall be permitted only where a machine is provided which shall insure that the material is cut uniformly to the proper depth and which has cutters that shall place the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.
301.2.3.2. Treatment for New Materials. The base and subbase materials, as provided in the governing specifications, shall be delivered, placed and spread in the required amount per station. The material shall be manipulated as specified and thoroughly mixed prior to the addition of the lime.

301.2.3.3. Lime Application. Lime shall be spread only on that area where the first mixing operation can be completed in the same working day, except that quicklime shall be mixed at the time of application. The application and mixing of lime with the materials shall be accomplished by the methods hereinafter described unless otherwise approved by the CITY.

301.2.3.3.1. Dry Placing Quicklime. Quicklime may be placed dry if it is in pebble form. A spreader or motor grader shall be used to spread pebble Quicklime.

301.2.3.3.2. Slurry Placing. Lime shall be mixed with water and applied as a thin water suspension or slurry. Type B, commercial lime slurry, shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime at the rate shown on the plans shall be attained by successive passes over a measured surface of roadway until the proper moisture and lime content have been achieved.

Quicklime. When Quicklime is applied as a slurry, the amount of dry quicklime shall be 80-percent of the amount shown on the plans. The residue from the Quicklime slurring procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the CITY. This residue is primarily inert material with little stabilizing value, but may contain a small amount of Quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

301.2.3.4. Mixing. Mixing procedure shall be the same for “dry placing” or “slurry placing” as hereinafter described.

301.2.3.4.1. Treatment for Materials-In-Place. Material and lime shall be thoroughly mixed by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture of material and lime is obtained, free from all clods or lumps. Materials containing plastic clay or other materials which shall not readily mix with lime shall be mixed as thoroughly as possible at the time of the lime application, brought to the proper moisture content, sealed with a pneumatic roller, and left to cure 1- to 4-days as directed by the CITY. During the curing period, the material shall be kept moist. After the required curing time, the material shall be uniformly mixed by approved methods. If the soil binder lime mixture contains clods, they shall be reduced in size by raking, blading, discing, harrowing, scarifying or the use of other approved pulverization methods so that when all nonslaking aggregates obtained on the No. 4 sieve are removed, the remainder of the material shall meet the requirements of Table 301.2.3.4.1.(a) Lime Treated Materials-In-Place when tested dry by laboratory sieves.

### Table 301.2.3.4.1.(a) Lime Treated Materials-In-Place

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Minimum Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1¾-in. (45mm)</td>
<td>100%</td>
</tr>
<tr>
<td>No. 4 (4.75mm)</td>
<td>60%</td>
</tr>
</tbody>
</table>

1. Recycled asphalt pavement shall be pulverized so that 100-percent shall pass a 2-in. (50mm) sieve.

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6-hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

In addition to the above, when pebble quicklime is used, the material and lime shall be mixed as thoroughly as possible at the time of application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for 2- to 7-days, as approved by the CITY. After curing, mixing shall continue until the pulverization requirements are met.

301.2.3.4.2. Treatment of New Material. The base or subbase material, lime and required water shall be thoroughly mixed and blended by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture is obtained. When lime is placed as a slurry and mixed by the use of blades, the material shall be bladed as the lime water mixture is applied; after the total amount has been placed, the mixture shall be thoroughly blended to the satisfaction of the CITY.
During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6-hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

301.2.3.5. Compaction. Compaction of the mixture shall begin immediately after final mixing and in no case later than 3-days after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted as shown on the plans or specified by the CITY. The compacted mixture shall have a uniform density of not less than 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN·m/m³)). Moisture content shall be within minus-2- to plus-4-of optimum. After each section is completed, such tests as are necessary shall be made by the CITY. If any portion fails to meet the density specified, it shall be reworked as necessary to obtain the specified density. After the mixture has been compacted, the surface shall be shaped to the required line, grades and cross sections and then thoroughly rolled sufficiently lightly to prevent hairline cracking.

301.2.3.6. Maintenance. The CONTRACTOR shall be required to maintain the completed soil lime base within the limits of its contract in good condition, satisfactory to the CITY as to grade, crown and cross section until such time as the surface course is constructed. The surface of the compacted layer shall be kept moist until covered by other base or paving material or application of a curing seal of emulsified asphalt conforming to requirements of Item 302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE). If a curing seal is used, it should be applied as soon as possible after completion of final rolling, at a rate of between 0.10- and 0.20-gallons-per-square-yard (0.5- to 1.0-liters-per-m²), the exact rate to be determined by the CITY. No equipment or traffic shall be permitted on lime treated material for 72-hours after curing seal is applied, unless otherwise permitted by the CITY. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic 2-days after compaction. The CONTRACTOR shall immediately repair all irregularities or other defects that may occur at the CONTRACTOR’S expense. Repairs are to be made as directed by the CITY and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

301.3. PORTLAND CEMENT TREATMENT
This item shall consist of the treatment of the subgrade, subbase or base course which is to be composed of a compacted mixture of soil, and/or pulverized recycled asphalt pavement, Portland cement and water and shall be constructed as herein specified and in conformity to the cross sections, lines and grades as established by the CITY. In the event new materials are placed, rather than using in-situ soils, the subbase or base shall be constructed as herein specified and in conformity with the items governing the base or subbase courses.

301.3.1. Materials.
301.3.1.1. Portland Cement. Cement shall be ASTM C150 Type I, II or IP and conform to the requirements of Item 303.2.2. Portland Cement.
301.3.1.2. Water. Water shall conform to the requirements of Item 303.2.7. Water.
301.3.1.3. Soil. The soil shall consist of the in-situ soil or approved soil, free from vegetation, roots, or other objectionable matter. It may be either the material encountered in the existing section, material secured from approved sources shown on the plans or as designated by the CITY, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the CITY.
301.3.1.4. Recycled/Reclaimed Asphalt Pavement. Recycled/Reclaimed asphalt pavement is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement uncontaminated by dirt or other objectionable materials.
301.3.2. Equipment. All equipment necessary to properly prosecute, perform and complete the work within the contract time shall be on the project and shall be approved by the CITY as to type and condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used.

The cement-modified soil layer may be constructed with any machine or combination of machines and auxiliary equipment that shall produce the results meeting the requirements for soil pulverization, cement application, water application, mixing, incorporation of materials, compaction, finishing and curing as specified herein. The CONTRACTOR shall at all times provide sufficient equipment to enable continuous performance of the work and its completion in the required number of working days.

301.3.3. Portland Cement Treatment Construction Methods.

301.3.3.1. General. The primary requirement of this specification is to secure a complete course of treated material containing a uniform Portland cement mixture, free from loose or segregated areas, of uniform density and moisture content, well bound and compacted for its full depth with a smooth surface suitable for placing additional subbase, base or surface courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to process a sufficient quantity of material so as to provide full depth as shown on plans, to use the proper amount of Portland cement, maintain the work and to rework the courses as necessary to meet the foregoing requirements.

Cement stabilized base shall not be mixed or placed when the air temperature is below 40°F (5°C) and falling, but may be mixed or placed with the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade and away from artificial heat, and with the further provisions that cement stabilized base shall be mixed or placed only when weather conditions, in the opinion of the CITY, are suitable.

301.3.3.2. Treatment for Materials-In-Place. Before other construction operations are begun, the roadbed shall be graded and shaped as required to construct the Portland cement treatment for material in place in conformance with the lines, grades, thickness and typical cross sections shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil. The subgrade shall be firm and able to support without displacement the construction equipment and achieve the compaction herein specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

The soil and/or recycled asphalt pavement shall be so pulverized that at the completion of moist-mixing, it meets the gradation in Table 301.3.3.2.(a) Cement Treated Materials-In-Place.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Minimum Passing by Dry Weight¹²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-in. (25mm)</td>
<td>100%</td>
</tr>
<tr>
<td>No. 4 (4.75mm)</td>
<td>80%</td>
</tr>
</tbody>
</table>

¹ Excluding gravel or stone retained on these sieves.
² Recycled asphalt pavement shall be pulverized so that 100-percent shall pass a 2-in. (50mm) sieve.

301.3.3.2.1. Application of Cement to Materials-In-Place. Portland cement shall be spread by an approved dry or slurry method uniformly on the soil at the rate specified on the plans or as determined by preliminary laboratory tests. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement. Cement shall be applied only to such an area that all the operations can be continuous and completed in daylight within 6-hours of such application.

The percentage of moisture in the soil at the time of cement application shall not exceed the quantity that shall permit uniform and intimate mixture of soil and cement during dry-mixing operations, and it shall not exceed the specified optimum moisture content for the soil and cement mixture. In the event of high soil-moisture contents, cement may be applied at one-half the specified rate when approved by the Engineer. The remainder of the application rate of cement shall be applied the following day(s), not to exceed 48-hours. The usual construction sequence shall then be resumed.

No equipment, except that used in the spreading and mixing, shall be allowed to pass over the freshly spread cement until it is mixed with the soil.

301.3.3.2.2. Mixing and Processing of Stabilized Materials-In-Place. Any method used to achieve the specified results is acceptable. Mixing shall continue until a homogeneous, friable mixture of the material and cement is obtained, free from all clods or lumps. The mixture shall be kept within moisture tolerances throughout the operation.

301.3.3.2.3. Compaction and Finishing of Stabilized Materials-In-Place. Compaction shall begin after mixing and after gradation and moisture requirements have been met. The material shall be compacted to
at least 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)). At the start of compaction, the percentage of moisture in the mixture and in un pulverized soil lumps, based on oven-dry weights, shall be within 2-percentagepoints of the specified optimum moisture content and shall be less than the quantity which shall cause the soil-cement mixture to become unstable during compaction and finishing. When the uncompacted soil-cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the CONTRACTOR. The specified optimum moisture content and density shall be determined in the field on the representative samples of soil-cement mixture obtained from the area being processed. Final moisture content shall be within minus-2- to plus-4-of-optimum.

Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted. The loose mixture shall then be uniformly compacted to the specified density within 2-hours. After the soil and cement mixture, except the top mulch, is compacted, water shall be uniformly applied as needed and thoroughly mixed in. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by the compacting or shaping equipment.

The resulting surface shall be thoroughly rolled with a pneumatic tire roller and “clipped,” “skinned,” and “tight-bladed” by a power grader to a depth of approximately ¼-in. (6mm), moving all loosened soil and cement from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. When directed by the CITY, surface finishing methods may be varied from this procedure, provided a dense, uniform surface, free of surface material, is maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than 2-hours, a smooth, closely knit surface, free of cracks, ridges or loose material, conforming to the drawn grade and line shown on the plans.

CITY shall conduct In-place density tests shall as outlined in ASTM D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). In-place density tests shall be performed at the rate of one-per-300-linear-ft. (1-per-91m) of paving for two (2) lanes. The suitability of the modification shall be confirmed by Atterberg Limit testing at the rate of one-test-per-2,500-cubic-yards (one-per-1,910-m³) of processed material.

In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the CITY. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the stability, density and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the CONTRACTOR.

301.3.3. Plant-Mixed Cement Treated Base.

301.3.3.1. Subgrade Preparation. Before other construction operations are begun, the area to be paved shall be graded and shaped as required to receive the cement treated base in conformance with the grades, lines, thicknesses and typical cross-section shown on the plans. Unsuitable subgrade soil or material shall be removed and replaced with acceptable soil. The subgrade shall be firm and able to support without displacement of the construction equipment and compaction. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

301.3.3.2. Mixing and Processing for Plant-Mixed Cement Treated Base. The aggregate, cement and water shall be mixed in a pug mill as approved by the Engineer. The plant shall be equipped with feeding and metering devices that add the aggregate, cement and water into the mixer in the specified quantities to produce a mixture that meets or exceeds the mix design criteria. Aggregate and cement shall be mixed sufficiently to prevent cement balls from forming when the mix water is added. Mixing time shall be sufficient to assure an intimate, uniform mixture of aggregate, cement and water. The percentage of moisture in the aggregate, at the time of cement application shall be the amount that assures a uniform and intimate mixture of aggregate and cement during mixing operations. It shall not exceed the specified moisture content required for adequate compaction.

Free access to the plant shall be provided to the CITY for construction quality control. The mixture shall be hauled to the paving area in trucks having beds cleaned of deleterious material.

301.3.3.3. Placement of Plant-Mixed Cement Treated Base. The mixture shall be placed on a moistened subgrade in a uniform layer by any approved method of spreading that will deposit the required
quantity per lineal foot, without segregation, to produce a uniformly compacted base conforming to the grade and cross-section. Not more than 30-minutes shall elapse between placement of cement treated base in adjacent lanes at any location except at longitudinal and transverse construction joints. Compaction shall start as soon as possible after spreading. Elapsed time between the addition of water to the cement treated base mixture and the start of compaction shall not exceed 60-minutes under normal conditions. The Engineer may alter this time if environmental conditions, such as temperature, humidity or wind conditions would justify such a change. Laboratory tests may be required to verify changes in compaction time limits.

301.3.3.4. Compaction and Finishing of Plant-Mixed Cement Treated Base. At the start of compaction, the percentage of moisture in the mixture shall not be more than one-percentage-point below or two-percentage-points above the specified optimum moisture content, and shall be less than that quantity which will cause the cement treated base mixture to become unstable during compaction and finishing. The specified optimum moisture content and density shall be determined in the field by a Moisture-Density Test AASHTO T134 or ASTM D558 Test Methods for Moisture-Density Relations of Soil-Cement Mixtures, on representative samples of cement treated base mixture obtained from the area prior to compaction. Prior to compaction, the mixture shall be in a loose condition for its full depth. The loose mixture shall then be compacted uniformly to the specified density. During compaction operations, initial shaping may be required to obtain uniform compaction and required grade and cross-section.

When initial compaction is completed, the surface of the cement treated base shall be shaped to the required lines, grades and cross-section. The moisture content of the surface material shall be maintained at not less than its specified optimum moisture content during finishing operations. If any reshaping of the surface is necessary, it shall be lightly scarified to remove any compaction planes, scales or smooth surfaces left by equipment. Final compaction shall then be continued until uniform and adequate density is obtained. Cement treated base shall be uniformly compacted to a minimum of 95-percent of maximum density. Compaction and finishing shall be done in such a manner as to produce, in not longer than two-hours, a smooth, dense surface free of compaction planes, cracks, ridges, or loose material.

301.3.3.5. Protection and Cover. After the roadway has been finished as specified herein, it shall be immediately protected against rapid drying by applying a curing seal of emulsified asphalt at the rate of 0.2-gallon-per-square-yard (0.7-L-per-m²). The curing seal shall consist of emulsified asphalt conforming to requirements of Item 302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE). Immediately prior to application of the curing seal, the section shall be wetted by the use of pressure water distributors so that all voids in the soil-cement surface are filled with water, but without free water standing on the surface. The curing seal shall be applied while this moisture condition exists so that undue asphalt penetration of the soil-cement surface shall be prevented; and at the same time aided in complete coverage by the curing seal.

Should it be necessary for construction equipment or other traffic vehicles to pass over the section before the curing seal has dried sufficiently to prevent pickup, if shall be the responsibility of the CONTRACTOR to dust or sand the surface before such use. The CONTRACTOR shall also maintain the curing cover for 7-days so that all of the soil-cement base course shall be covered effectively with curing seal during this period. The curing seal shall remain in place for the additional asphalt-wearing surface.

301.3.3.6. Opening to Traffic. The CONTRACTOR shall not be permitted to drive heavy equipment over completed portions. Pneumatic-tired equipment required for hauling cement and water may be permitted to drive over the surface after the mixture has hardened sufficiently to prevent the equipment from marring the surface, provided that the protection and cover are not impaired. The soil-cement course may be opened to local traffic as soon as the surface has been applied and dusted or sanded as necessary to prevent it from being picked up by traffic. Completed portions may be opened to all traffic after 7-days.

301.3.3.7. Maintenance. The CONTRACTOR shall be required within the limits of its contract to maintain the soil-cement treatment in good condition from the time it first starts work until all work shall have been completed. Maintenance shall include immediate repairs of any defect that may occur after the cement is applied. Such maintenance work shall be done by the CONTRACTOR at the CONTRACTOR’S expense and repeated as often as necessary to keep the area continuously intact. Repairs are to be made in such a manner as to insure restoration of a uniform surface for the full depth of treatment. Any low area of treated subgrade shall be remedied by scarifying the surface to a depth of at least 2-in. (5cm), filling the area with treated material and compacting. Any low area of subbase or base shall be remedied by replacing the material for the full depth of subbase or base treatment rather than adding a thin layer of stabilized material to the completed work.
301.4. ASPHALT EMULSION TREATMENT
This item shall consist of treating subgrade, subbase, and base courses by the pulverization, addition of asphalt base stabilization agent, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment, base or subbase courses placed under this contract, which shall be constructed as specified herein and in conformity with the typical section, lines and grades as shown on the plans.

Asphalt stabilization of recycled material such as crushed concrete or other non-hazardous recycled materials, processed recycled asphalt pavements, bottom ash, foundry slag, glass, recycled crumb rubber to create subgrade, subbase or base courses shall conform to TxDOT Special Specification 3157 Cold Processed - Recycled Paving Material (RPM) for Use as Aggregate Base Course. Asphalt emulsion for such recycling shall conform to Item 302.3.6. Specialty Emulsions or Item 302.3.7. Emulsion for In-Place Asphalt Recycling, as specified by the CITY.

301.4.1. Materials.

301.4.1.1. Asphalt Soil (Base) Stabilization Agent. The product shall be composed of petroleum of resin oil base with selective hardening and drying agents to form a stable subgrade, subbase, or base. Independent laboratory tests shall certify compliance with requirements of Table 301.4.1.1(a) Asphalt Soil Stabilization Agent Requirements, as specified on the plans.

If the minimum design strength or percent asphalt base stabilization agent to be used for the treated subgrade, existing base, new subbase or new base is specified, it shall be determined by preliminary laboratory tests at the CITY’s expense.

301.4.1.2. Base and Subbase Materials. Base and subbase materials shall meet the requirements shown on the plans or in the pertinent specifications.

301.4.1.3. Delivery and Storage. If asphalt base stabilization agent is furnished in trucks, each truck shall bear the weight of asphalt base stabilization agent measured on certified scales, or the CONTRACTOR shall place a set of standard platform truck scales or hopper scales at a location approved by the CITY.

Asphalt base stabilization agent shall be stored and handled in tank, tanker or distributor truck until immediately before distribution on the road. Asphalt base stabilization agent shall be stored in freeze-proof containers.

301.4.2. Equipment. Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the CITY prior to the beginning of construction operations. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

301.4.3. Asphalt Emulsion Treatment Construction Methods.

301.4.3.1. General. It is a primary requirement of this specification to secure a completed course of treated material containing a uniform asphalt base stabilization agent mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface and suitable for placing subsequent courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to use the proper amount of asphalt base stabilization agent, maintain the work and rework the courses as necessary to meet the above requirements.

Prior to beginning any asphalt base stabilization agent treatments, the roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the CITY.
Table 301.4.1.1.(a) Asphalt Soil Stabilization Agent Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method, Test</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Visual Inspection</td>
<td>Brown Liquid</td>
<td></td>
</tr>
<tr>
<td>Viscosity S.F. at 77°F Sec</td>
<td>ASTM D244 Emulsified Asphalts</td>
<td>5</td>
<td>175</td>
</tr>
<tr>
<td>Residue, % min</td>
<td>ASTM D244, modified¹</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>Penetration 77°F, Sec</td>
<td></td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Miscibility Test</td>
<td>ASTM D244, modified²</td>
<td>No coagulation</td>
<td></td>
</tr>
<tr>
<td>Moisture, wt %</td>
<td></td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>Volatile %</td>
<td></td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>% Non-Volatile Soluble in Trichloroethylene</td>
<td>AASHTO T 45-56</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Accelerated Weathering (2-year exposure)</td>
<td>Federal Spec TT C-555 B, 40 ml</td>
<td>No material deterioration after exposure</td>
<td></td>
</tr>
<tr>
<td>Resistance To wind and Driven Rain (@ 98 mph)</td>
<td>Federal Spec TT C-555 B, 4 As 4ml sealer after cure</td>
<td>Passes/no wt. gain</td>
<td></td>
</tr>
<tr>
<td>Ash, % wt.</td>
<td></td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Polymer, % wt.</td>
<td></td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Particle Charge</td>
<td>ASTM D244</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>Flash Point</td>
<td>TCC</td>
<td>275°F</td>
<td></td>
</tr>
<tr>
<td>Shaker Test 2- to 4-hrs.</td>
<td>Mix Burrell Wrist Action Shaker Model 75 set on Level 7, diluted 1 part water to 4 parts soil stabilizer, Sieve #40</td>
<td>-</td>
<td>1%</td>
</tr>
</tbody>
</table>

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.

301.4.3.2. General Construction.

301.4.3.2.1. Treatment for Materials-In-Place. Materials to be treated shall be excavated to the secondary grade (proposed bottom of asphalt base stabilization agent) and removed or windrowed to expose the secondary grade. Any wet or unstable material below the secondary grade shall be corrected by scarifying, adding asphalt base stabilization agent and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the CONTRACTOR elects to use a cutting or pulverizing machine that shall remove the subgrade material accurately to the secondary grade and to pulverize the material at the same time, CONTRACTOR shall not be required to expose the secondary grade or windrow the material. However, the CONTRACTOR shall be required to roll the subgrade before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method shall be permitted only where a machine is provided which shall insure that the material is cut uniformly to the proper depth and which has cutters that shall place the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

301.4.3.2.2. Treatment for New Materials. The base and subbase material, as provided in the governing specifications, shall be delivered, placed and spread in the required amount per station. The material shall be manipulated as specified and thoroughly mixed prior to the addition of the asphalt base stabilization agent.

301.4.3.3. Asphalt Base Stabilization Agent Application. Asphalt base stabilization agent shall be spread only on that area where the mixing can be completed in the same working day. Asphalt base stabilization agent shall be mixed with water and applied as a thin water suspension. The distribution of asphalt stabilization agent at the rate shown on the plans shall be attained by successive passes over a measured surface of roadway until the proper moisture content and asphalt base stabilization agent content has been achieved.

The asphalt base stabilization agent shall be distributed at a uniform rate and in such a manner as to reduce heavy or light areas to a minimum. A motor grade can be used to cover the exposed asphalt base stabilization agent. If necessary, the material shall be sprinkled until a proper moisture content has been achieved.
301.4.3.4. Mixing. The application and mixing of asphalt base stabilization agent with the material shall be thorough. During the interval of time between application and mixing, asphalt base stabilization agent that has been exposed to the open air for a maximum time of 2-hours, or a shorter period when the breaking of the emulsion has occurred, shall not be accepted for payment. (Breaking of the emulsion is when the emulsion is over exposed on the surface without mixing, thus turning it from a brown color to black. The color change is due to the evaporation of the water from the emulsion, thus rendering it ineffective in mixing in the soil, base or subbase material). The Contractor is responsible for monitoring the application and the mix time of the asphalt stabilization agent with the soil, base or subbase material. The overexposed area shall be retreated with another application of asphalt base stabilization agent and mixed.

301.4.3.4.1. Treatment for Materials-In-Place. Material and asphalt base stabilization agent shall be thoroughly mixed by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture of material and asphalt base stabilization agent is obtained, free from all clods or lumps. Materials containing plastic clay or other materials which shall not readily mix with asphalt base stabilization agent shall be mixed as thoroughly as possible, and meet the requirements of Table 301.4.3.4.1.(a) Asphalt Emulsion Treated Materials-In-Place when tested dry by laboratory sieve at the time of the asphalt base stabilization agent application, brought to the proper moisture content, sealed with a pneumatic roller, and left to cure 1 to 2 days as directed by the CITY. During the curing period, the material shall be kept moist.

| Table 301.4.3.4.1.(a) Asphalt Emulsion Treated Materials-In-Place |
| Sieve Size | Minimum Passing by Dry Weight¹⁰² |
| 1¾-in. (45mm) | 100% |
| No. 4 (4.75mm) | 60% |

301.4.3.4.2. Treatment of New Material. The base or subbase material, asphalt base stabilization agent and required water shall be thoroughly mixed and blended by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture is obtained. When the asphalt base stabilization agent is placed and mixed by the use of blades, the material shall be bladed as the asphalt base stabilization agent water mixture is applied; after the total amount has been placed, the mixture shall be thoroughly blended to the satisfaction of the CITY.

301.4.3.4.3. Central Mixing Plant. The soil, asphalt base stabilization agent and water shall be mixed in a pugmill either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices which shall add the soil, asphalt base stabilization agent and water into the mixer in the specified quantities. Soil and asphalt base stabilization agent shall be mixed sufficiently to prevent asphalt base stabilization agent balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of soil, asphalt base stabilization agent and water is obtained. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader or spreaders.

After mixing asphalt stabilization agent with the base or subbase material the following conditions shall be met:

1. Not more than 3-hours shall elapse between the placement of soil-asphalt emulsion mixture in adjacent lanes and placement at any location except at longitudinal construction joints.
2. Not more than 3-hours shall elapse between the start of spreading the soil-asphalt emulsion mixture and start of compaction.
3. Not more than 4-hours shall elapse between the start of mixing and the start of compaction.

The layer of soil-asphalt base stabilization agent shall be uniform in thickness and surface contour, and in such quantity that the completed base shall conform to the required grade and cross section. Dumping of the mixture in piles or windrows upon the subgrade shall be permitted.

301.4.3.5. Compaction. Compaction of the mixture shall begin immediately after final mixing and in no case later than 2-days after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture content. At the start of compaction, the moisture in the mixture and in unpulverized soil lumps, based on oven-dry weights, shall be within minus-2- to plus-2-percent-of-optimum. The specified optimum moisture content and density shall be determined in the field on the representative samples of soil-asphalt base stabilization agent mixture obtained from the area being processed. Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. The loose mixture shall be uniformly compacted to the specified density within 4-hours. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted as shown on the plans or specified by the CITY.

301.11
The compacted mixture shall have a uniform density of not less than 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (\(12,400 \text{ ft-lbf/ft}^3\) (600 kN-m/m³)). Final moisture content shall be within minus-2- to plus-4-percent-of-optimum. If the soil/asphalt base stabilization agent mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the CONTRACTOR. After the soil and asphalt base stabilization agent mixture, except the top layer, is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spike tooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross sections and then lightly scarified to loosen any imprint left by the compacting or shaping equipment. After each section is completed, such tests as are necessary shall be made by the CITY. If any portion fails to meet the density specified, it shall be reworked as necessary to obtain the specified density at the sole expense of the CONTRACTOR.

301.4.3.6. Finishing, Curing and Preparation for Surfacing. The resulting surface shall be thoroughly rolled with a pneumatic tire roller and “clipped”, “skinned”, and “tight-bladed” by a power grader to a depth of approximately \(\frac{1}{4}\)-in. (6mm), moving all loosened soil and asphalt base stabilization agent from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. When directed by the CITY, surface finishing methods maybe varied from this procedure, provided a dense, uniform surface, free of surface material, is maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than 4-hours, a smooth, closely knit surface, free of cracks, ridges or loose material, conforming to the drawn grade and line shown on the plans.

The completed section shall then be moist-cured for a minimum of 2-days before further courses are added, unless otherwise directed by the CITY. In cases where, in the opinion of the Engineer, subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic after compaction. The surface of the compacted layer shall be kept moist until covered by other base or paving material or application of a curing seal of emulsified asphalt. If a curing seal is used, it shall be applied as soon as possible after completion of final rolling, at a rate of between 0.10- and 0.20-gallons-persquare-yard (0.5- to 1.0-liters-per-m²), the exact rate to be determined by the CITY. No equipment or traffic shall be permitted on asphalt base stabilization agent treated material for 12-hours after curing seal is applied, unless otherwise permitted by the CITY.

301.4.3.7. Maintenance. The CONTRACTOR shall be required to maintain the completed asphalt stabilized base within the limits of its contract in good condition, satisfactory to the CITY as to grade, crown and cross section until such time as the surface course is constructed. The CONTRACTOR shall immediately repair all irregularities or other defects that may occur at the CONTRACTOR’S expense. Repairs are to be made as directed by the CITY and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

301.5. FLEXIBLE SUBBASE OR BASE (CRUSHED STONE/CONCRETE)
This item shall consist of a foundation course for a surface course or for other subbase or base courses; shall be constructed as herein specified in one or more courses in conformity with the typical section shown on the plans and to the lines and grades as established by the CITY.

301.5.1. Material.

301.5.1.1. General. Should the CONTRACTOR elect to produce the material from local pits, the material shall be secured from sources approved by the CITY. The pits as utilized shall be opened up in such a manner as to immediately expose the vertical faces of all the strata of acceptable material in depth mined. Unless
otherwise directed, the material shall be secured in successive vertical cuts extending through all of the exposed strata, in order that a uniform mixed material shall be secured.

301.5.1.2. Tests and Physical Requirements. Tests shall be performed in accordance with ASTM D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. The preparation of samples for testing according to ASTM D4318 shall be in accordance with the requirements of ASTM D2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants. The material shall also be tested under TxDOT Test Method Tex-116-E The Wet Ball for Determining the Disintegration of Flexible Base Materials. When a magnesium soundness value is shown on the plans the material shall be tested in accordance with Test Method Tex-411-A Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate. Physical properties shall meet the requirements in Table 301.5.1.2.(a) Flexible Base or Subbase Material Requirements, according to specified grade.

<table>
<thead>
<tr>
<th>Table 301.5.1.2.(a) Flexible Base or Subbase Material Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
</tr>
<tr>
<td>Triaxial Class</td>
</tr>
<tr>
<td>Minimum Compressive Strength</td>
</tr>
<tr>
<td>at lateral pressure 0-psi</td>
</tr>
<tr>
<td>at lateral pressure 15-psi (1.1-kg/cm²)</td>
</tr>
<tr>
<td>Master Grading</td>
</tr>
<tr>
<td>Sieve</td>
</tr>
<tr>
<td>1½”</td>
</tr>
<tr>
<td>7/8”</td>
</tr>
<tr>
<td>3/8”</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 40</td>
</tr>
<tr>
<td>Maximum Liquid Limit</td>
</tr>
<tr>
<td>Maximum Plasticity Index</td>
</tr>
<tr>
<td>Maximum Wet Ball Mill</td>
</tr>
<tr>
<td>Maximum increase in passing No. 40</td>
</tr>
<tr>
<td>Maximum foreign material allowed</td>
</tr>
</tbody>
</table>

1. When lightweight aggregates are used, the wet ball mill requirements shall not apply; lightweight aggregate shall meet the Los Angeles Abrasion, Pressure Slaking and Freeze Thaw requirements of TxDOT Item 303 Aggregate for Surface Treatment (Lightweight).

301.5.1.3. Rejection. Aggregate that fails to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY. Aggregate sources from which materials are delivered with properties not meeting these specifications may be rejected as further supply sources to the project by the CITY.

301.5.2. Construction Methods.

301.5.2.1. Preparation of Subgrade. Preparation of the subgrade shall be in conformity with the requirements of Item 301.3.3.3.1. Subgrade Preparation.

301.5.2.2. Placing. Immediately before placing the subbase or base course material, the subgrade shall be checked as to conformity with grade and section.

The material shall be delivered in approved vehicles of a uniform capacity. It shall be the charge of the CONTRACTOR that the required amount of specified material shall be delivered to secure the proper thickness of the completed subbase or base course. Material deposited on the subgrade shall be spread and shaped the same day. All material shall be moved at least once from the original position in which it is deposited. In the event of inclement weather or other unforeseen circumstances which render impracticable the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the CITY. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to the typical section as shown on the plans.

All areas and “nests” of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material as directed by the CITY. If additional binder is considered desirable or necessary after the material is spread and shaped, it shall be furnished and fully incorporated with the material in place by scarifying, harrowing, brooming or by other approved methods. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as specified in Item 301.5.2.3.
Density. In addition to the requirements specified for density, the full depth of flexible subbase or base shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each course is completed, tests as necessary shall be made by the CITY unless otherwise specified in the special provisions or in the plans. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements.

Throughout the entire operation, the shape of the course shall be maintained by blading. The surface, upon completion, shall be smooth and in conformity with the typical sections shown on the plans to the established lines and grades. On the surface on which pavement is to be placed, any deviation in excess of ½-in. in cross section in a length of 16-ft. (13mm in 5m) measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All fractures, settlement, or segregation that develops shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.

Should the subbase or base course, due to any reason or cause, lose the required stability, density and finish before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the CONTRACTOR.

301.5.2.3. Density. The density required under this item shall not be less than 92-percent compaction as determined by ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)). Moisture content shall be within minus-2- to plus-4-of-optimum.

301.5.2.4. Courses. Non full depth asphalt pavements, paving types with flexible base under the curb and gutter shall be placed and compacted at the same time and in the same operation as the flexible base under the pavement. Where the subbase or base course exceeds 6-in. (15cm) in thickness, it shall be constructed in two or more courses of equal thickness as indicated on the typical section. A minimum course depth of 3-inches is recommended. The first course shall be placed and compacted under the curb and gutter and under the pavement. The curb and gutter shall then be built upon the first course. The final course of the flexible base shall be placed following the curing time as specified in Item 305.1. Concrete Curb and Gutter.

301.6. GEOTEXTILES USED IN PAVING APPLICATIONS

301.6.1. Materials.

301.6.1.1. Physical Properties. The fabric properties shall conform to those shown in Table 301.6.1.(a) Geotextiles for Paving, as determined by the Federal Highway Administration Task Force 25 Guidelines using ASTM Test Methods, except where noted.

301.6.1.2. Certification. The manufacturer, if required by the CITY, shall provide documents stating the name and manufacturer, the chemical composition of the filaments or yarns and test values of the properties of the geotextile. The manufacturer must certify that the material meets or exceeds these specifications.

301.6.1.3. Rejection. Geotextile may be rejected for failure to meet any of the requirements of this specification.
### Table 301.6.1.(a) Geotextiles for Paving

<table>
<thead>
<tr>
<th>Designation (Test Method)</th>
<th>Characteristic</th>
<th>Average Roll Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D4632 Grab Breaking Load and Elongation of Geotextiles</td>
<td>Grab Strength</td>
<td>80-lbs. @ 12-in.-per-minute (36.3kg @ 30.5-cm/min)</td>
</tr>
<tr>
<td>ASTM D4632</td>
<td>Elongation @ Break</td>
<td>50% @ 12-in.-per-minute (30.5-cm/min)</td>
</tr>
<tr>
<td>Tex-616-J, Construction Fabrics</td>
<td>Asphalt Retention</td>
<td>0.5-oz.-per-sq.-ft. (0.15-kg/m²)</td>
</tr>
<tr>
<td>ASTM D276 Identification of Fibers in Textiles</td>
<td>Melting Point</td>
<td>300°F (150°C)</td>
</tr>
</tbody>
</table>

### 301.6.2. Construction Methods.

Construction methods for each type unit shall be provided by the manufacturer and approved by the CITY based on the site-specific use.
ITEM 302. ASPHALT PAVEMENT

302.1. DESCRIPTION
This Item establishes the requirements for asphalt construction. This Item includes material requirements and construction methods for emulsified asphalts, hot-mix asphalt pavement, performance graded (PG) asphalts and other miscellaneous asphaltic materials and polymer additives. Refer to Table 302.1.1 for minimum asphalt installation.

302.2. AGGREGATES FOR HOT-MIX ASPHALT PAVEMENT

302.2.1. General Requirements. Aggregates shall conform to the requirements contained in this Item 302.2. Aggregates for Hot-Mix Asphalt Pavement and shall be approved by the CITY prior to use. The integrity of the aggregate shall be such as to produce a workable material within the limits contained in this specification.

302.2.1.1. Deleterious Substances. Aggregates shall be free from loam, clay balls or other injurious foreign matter occurring either free or as a coating on the aggregates.

302.2.1.2. Storage. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds and grass and be relatively smooth. Aggregates shall be stockpiled in such a manner as to prevent mixing of one aggregate with another. Coarse aggregates shall be separated into stockpiles of different gradation, such as a large coarse aggregate and a small coarse aggregate stockpile and such that the grading requirements of the specified type shall be met when the piles are combined in the asphaltic mixture. No coarse aggregate stockpile shall contain more than 15-percent by weight of material that shall pass a No. 10 (2.0mm) sieve except as noted on the plans. Fine aggregate stockpiles may contain coarse aggregate in the amount of up to 20-percent by weight; however, the coarse aggregate shall meet the quality tests specified in Item 302.2.2. Coarse Aggregates. Suitable equipment of acceptable size shall be furnished by the CONTRACTOR to work the stockpiles and prevent segregation of the aggregates.

302.2.1.3. Quality and Testing Requirements. Test of aggregates, when required, shall be made in accordance with applicable Texas Department of Transportation tests or ASTM Test Methods, as shown in the tables below or as required by CITY.

Requirements for hot-mix asphalt pavement aggregates are shown in Table 302.2.2.(a) Aggregate Quality Requirements.

302.2.1.4. Aggregate Rejection. Aggregates that fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY. The CITY may reject sources from which materials are delivered with properties not meeting these specifications. Such rejection shall incur no cost to the CITY.

302.2.2. Coarse Aggregates. Coarse aggregates shall be that portion of the total aggregates retained on the No. 10 sieve (2.0mm). Coarse aggregates shall consist of clean, tough, durable fragments of crushed stone, crushed gravel, or steel slag as specified herein, of uniform quality throughout.

All coarse aggregates shall meet the requirements listed in Table 302.2.2.(a) Coarse Aggregate Quality Requirements.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious Material</td>
<td>Tex-217-F, Part I, Determining Deleterious Material in Coarse Aggregates (Bituminous Mixtures)</td>
<td>1.5% Max.</td>
</tr>
<tr>
<td>Decantation</td>
<td>Tex-217-F, Part III, Decantation Test for Coarse Aggregate (Bituminous Mixtures)</td>
<td>1.5% Max.</td>
</tr>
<tr>
<td>Magnesium Sulfate Soundness Loss, 5 Cycle</td>
<td>Tex-411-A, Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate</td>
<td>30% Max. (lower value may be shown on plans)</td>
</tr>
<tr>
<td>Coarse Aggregate Angularity Two Crushed Faces</td>
<td>Tex-460-A, Part I, Determining Crushed Face Count</td>
<td>90% Min.</td>
</tr>
<tr>
<td>Flat Elongated Particles</td>
<td>ASTM D4791 Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate</td>
<td>20% Max. @ 3:1</td>
</tr>
</tbody>
</table>

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.
Table 302.1.1 HMAC INSTALLATION/TESTING REQUIREMENTS

<table>
<thead>
<tr>
<th>Width</th>
<th>Wheel Loading Design</th>
<th>Plant Control</th>
<th>Field Test</th>
<th>Location of Test</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alley</td>
<td>20</td>
<td>20,000.00</td>
<td>Yes</td>
<td>Nuclear</td>
<td>City</td>
</tr>
<tr>
<td>Local</td>
<td>31</td>
<td>20,000.00</td>
<td>Yes</td>
<td>Nuclear</td>
<td>City</td>
</tr>
<tr>
<td>Street/Culdesac</td>
<td>36</td>
<td>100,000.00</td>
<td>Yes</td>
<td>Core</td>
<td>City</td>
</tr>
<tr>
<td>Collector Street</td>
<td>49</td>
<td>400,000.00</td>
<td>Yes</td>
<td>Core</td>
<td>City</td>
</tr>
<tr>
<td>Arterial Street</td>
<td>60</td>
<td>500,000.00</td>
<td>Yes</td>
<td>Core</td>
<td>City</td>
</tr>
<tr>
<td>Major Thoroughfare</td>
<td>60</td>
<td>500,000.00</td>
<td>Yes</td>
<td>Core</td>
<td>City</td>
</tr>
</tbody>
</table>

Asphalt Testing Method
Marshall (50 Blows)

Nuclear Testing Requirement
Lab Compacted Minimum – 95% Compaction

Core Testing Requirement
Lab Compacted Minimum – 95% Compaction

Hot Mix Sample Location
(For Gradation, Oil Content and Specific Gravity)
* Preferred Location: Plant
  Alternate Location #1: Truck
  Alternate Location #2: Laydown Hopper

* Note: City Determines Sample Extracting Location

Collector Streets, Arterial Streets And /Or Major Thoroughfares Less Than Or Equal To 200 Tons
Must Use Local Street Requirements

HMAC Mix Design Submittal To City
Annually or Annual Verification
302.2.3. Fine Aggregate. Fine aggregate may consist of crushed stone, crushed gravel, sand, and/or limestone or steel slag screenings.

Fine aggregate shall meet the requirements listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Shrinkage</td>
<td>Tex-107-E, Determining the Bar Linear Shrinkage of Soils</td>
<td>3% Max.</td>
</tr>
<tr>
<td>Sand Equivalent Value</td>
<td>Tex-203-F, Sand Equivalent Test</td>
<td>45 Min.</td>
</tr>
</tbody>
</table>

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.

302.2.3.1. Sand. Sand material may constitute a part of the fine aggregates for hot-mix asphalt pavement. The fine aggregate portion of the sand passing the No. 40 (425-um) sieve shall meet the Linear Shrinkage requirement listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements.

302.2.3.1.1. Gradation. Fine aggregate sand shall be that portion of the sand in the total aggregate passing the No. 10 (2.0mm) sieve. It shall be well graded and composed of sound, durable sand particles.

302.2.3.2. Limestone or Steel Slag Screenings. Limestone or steel slag screenings may constitute part or all of the fine aggregates for hot-mix asphalt pavement. Screenings shall be of the same or similar material for coarse aggregates. Where limestone rock screenings are specified for use, they shall be screenings resulting from crushing operation.

The fine aggregate portion passing the No. 40 (425-um) sieve shall meet the Linear Shrinkage requirement listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements. Fine aggregates from each source shall meet Linear Shrinkage requirements.

302.2.3.2.1. Gradation. The limestone or steel slag screening shall meet the grading requirements in Table 302.2.3.2.1.(a) Limestone or Steel Slag Screenings Gradation unless otherwise shown on the plans.

When authorized by the CITY, stone or steel slag screenings containing particles larger than ~2-in. (9.5-mm) may be used but only that portion of the material passing the ~2-in. (9.5-mm) sieve shall be considered as fulfilling the requirements for screenings when a minimum percent of screenings is specified for a particular mixture.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>~2-in. (9.5-mm)</td>
<td>100</td>
</tr>
<tr>
<td>Passing No. 200 (75-um)</td>
<td>0 to 30</td>
</tr>
</tbody>
</table>

302.2.4. Mineral Filler. Mineral filler shall consist of a thoroughly dry stone dust Portland cement or other mineral dust approved by the CITY. All mineral filler shall meet the requirements listed in Table 302.2.4.(a) Mineral Filler Quality Requirements.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Shrinkage</td>
<td>Tex-107-E, Determining the Bar Linear Shrinkage of Soils</td>
<td>3% Max.</td>
</tr>
</tbody>
</table>

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.

302.2.4.1. Gradation. When tested by the method outlined in TxDOT Test Method Tex-200-F Sieve Analysis of Fine and Coarse Aggregates (Part 1 Dry Sieve Analysis (Based on Weight) or Part 3 Volumetric Sieve Analysis, as applicable), it shall meet the requirements of Table 302.2.4.1.(a) Mineral Filler Gradation.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 30 sieve (600-um)</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 80 sieve (180-um)</td>
<td>Not Less Than 75</td>
</tr>
<tr>
<td>No. 200 sieve (75 um)</td>
<td>Not Less Than 55</td>
</tr>
</tbody>
</table>
302.3. BITUMINOUS MATERIALS

302.3.1. General. This Item consists of bituminous material, including performance graded asphalts, modified performance graded asphalts, asphalt cement, emulsified asphalt, and other miscellaneous asphaltic materials. Asphalt for use in paving shall be a refined asphalt produced from crude petroleum. The base asphalt shall be homogeneous and free from water and residue from distillation of coal, coal tar or paraffin oil and shall not foam when heated to 347°F (175°C).

302.3.1.1. Tests and Certification of Bituminous Materials. When tested according to ASTM or AASHTO test methods, the various materials shall meet the applicable requirements of this specification. At the time of delivery of each shipment of asphalt, the vendor supplying the material shall deliver to the CONTRACTOR certified copies of the test report. Two copies of the test reports shall be furnished to the CITY. Test reports shall indicate the name of the vendor, type and grade of bituminous material delivered, date and point of delivery, quantity delivered, delivery ticket number, purchase order number, and results of the specified tests. The test report, signed by an authorized representative of the vendor, shall certify that the product delivered conforms to the specifications for the type and grade indicated. The certified test reports and the testing required in connection with the reports shall be at no cost to the CITY.

Until the certified test reports and samples of the material have been checked by the CITY to determine their conformity with the prescribed requirements, the material to which such report relates and any work in which it may have been incorporated as an integral component, shall be only tentatively accepted by the CITY. Final acceptance shall be dependent upon the determination by the CITY that the material involved fulfills the prescribed requirements.

302.3.1.2. Rejection. Any material specified in this section may be rejected for failure to meet any of the provisions for this specification, or for any defect causing it to be unsuitable for its intended use.

302.3.2. Performance Graded (PG) Asphalt Binders. Performance graded asphalt binders shall be smooth and homogeneous, shall be free from water, shall not foam when heated to 347°F (175°C) and shall meet the requirements for performance graded asphalt binders shown in Table 302.3.2.(a) Performance Graded Asphalt Binders.

PG binders shall show no separation when tested according to Tex-540-C Measurement of Polymer Separation on Heating in Modified Asphalt Systems. Separation testing is not required if one of the following conditions is met:

(1) The modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer; or
(2) The binder is blended on site in continuously agitated tanks; or
(3) Binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

302.3.2.1. Modified Performance Graded Asphalt Binders. In addition to meeting the requirements in Table 302.3.2.(a) Performance Graded Asphalt Binders, modified performance graded asphalt binders shall also meet the requirements listed herein according to grade.

302.3.2.1.1. SBR Latex Rubber Modified Performance Graded Binders. Available grades include PG 64-28L, PG 70-28L, PG 70-22L, PG 76-22L, AND PG 82-22L. The manufacturer shall provide certification that SBR latex rubber was used in production of the binder. Ductility tested according to AASHTO T51: 39.2°F, 1-cm/min, cm, 70-cm minimum.

302.3.2.1.2. SBS Rubber Modified Performance Graded Binders. Available grades include PG 64-28S, PG 70-28S, PG 70-22S, PG 76-22S, AND PG 82-22S. The manufacturer shall provide certification that SBS rubber was used in production of the binder. Elastic recovery tested according to Tex-539-C Measurement of Elastic Recovery of Tensile Deformation Using a Ductilometer: 50°F, 55% minimum.

302.3.2.1.3. Tire Rubber Modified Performance Graded Binders. Available grades include PG 64-28TR, PG 70-28TR, PG 70-22TR, PG 76-22TR, and PG 82-22TR. The manufacturer shall provide certification that tire rubber was used in production of the binder. Elastic recovery tested according to Tex-539-C Measurement of Elastic Recovery of Tensile Deformation Using a Ductilometer: 50°F, 40% minimum.

302.3.2.1.4. Multigrade Modified Performance Graded Binders. Available grades include PG 64-28MG, PG 70-28MG, PG 70-22MG, PG 76-22MG, and PG 82-22MG. The manufacturer shall provide certification that gelling agent was used in production of the binder. Float test made according to AASHTO T50: 140°F, seconds, 1200 minimum.
### Table 302.3.2.(a) Performance Graded Asphalt Binders

<table>
<thead>
<tr>
<th>Performance Grade</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 7-day maximum Pavement Design Temperature, °C</td>
<td>-22</td>
<td>-28</td>
<td>-34</td>
<td>-16</td>
<td>-22</td>
</tr>
<tr>
<td>Minimum Pavement Design Temperature, °C (i.e. design temperature shall be greater than shown)</td>
<td>-22</td>
<td>-28</td>
<td>-34</td>
<td>-16</td>
<td>-22</td>
</tr>
</tbody>
</table>

#### Original Binder

<table>
<thead>
<tr>
<th>Property</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point Temperature, AASHTO T48: Minimum °C</td>
<td>230</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity, AASHTO TP48: Maximum, 3.0 Pa·s, Test Temp, °C</td>
<td>135</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Shear, AASHTO TP5: G'/sin(θ), Minimum, 1.00-kPa Test Temperature @ 10-rad/s, °C</td>
<td>58</td>
<td>64</td>
<td>70</td>
<td>76</td>
<td>82</td>
</tr>
</tbody>
</table>

#### Rolling Thin Film Oven (Tex-541-C)

<table>
<thead>
<tr>
<th>Property</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Loss, percent</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Shear, AASHTO TP5: G'/sin(θ), Minimum, 2.20-kPa Test Temperature @ 10-rad/s, °C</td>
<td>58</td>
<td>64</td>
<td>70</td>
<td>76</td>
<td>82</td>
</tr>
</tbody>
</table>

#### Pressure Aging Vessel Residue (AASHTO PP1)

<table>
<thead>
<tr>
<th>Property</th>
<th>PG 58</th>
<th>PG 64</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Shear, AASHTO TP5: G'/sin(θ), Maximum, 5000-kPa Test Temperature @ 10-rad/s, °C</td>
<td>25</td>
<td>22</td>
<td>19</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>Creep Stiffness, AASHTO TP1: S, Maximum, 300-Mpa m-value, Minimum, 0.300 Test Temp @ 60s, °C</td>
<td>-12</td>
<td>-18</td>
<td>-24</td>
<td>-6</td>
<td>-12</td>
</tr>
<tr>
<td>Direct Tension, AASHTO TP3: Failure Strain, Minimum, 1.0%</td>
<td>-12</td>
<td>-18</td>
<td>-24</td>
<td>-6</td>
<td>-12</td>
</tr>
</tbody>
</table>

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in the PGEXCEL3.XLS software program, may be provided by the specifying agency, or by following the procedures as outlined in AASHTO MP2 and PP28.
2. This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped, mixed and compacted at temperatures that meet all applicable safety, environmental and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T201 or T202) or rotational viscometry (AASHTO TP48).
3. Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. CONTRACTORS should be aware that variation could significantly impact mixing and compaction operations. CONTRACTORS are therefore responsible for addressing any constructability issues which may arise.
4. For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G'/sin(θ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T201 or T202) or rotational viscometry (AASHTO TP48).
5. Silicone beam molds as described in AASHTO TP1-93 are acceptable for use.
6. If the creep stiffness is below 300-Mpa, the direct tension test is not required. If the creep stiffness is between 300- and 600-Mpa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

### 302.3.2.2. Acceptance of Performance Graded (PG) Asphalt Binders.

#### 302.3.2.2.1. Location of Manufacture. Performance graded binder acceptance procedures are dependant on where the binder is manufactured. The requirements are as follows.

**Manufactured at the Source.** PG binders manufactured at the source are normally approved at the
source according to the applicable requirements of the CITY. The CITY may acquire field samples at any time, particularly if material quality is suspect.

**Manufactured at the Job Site.** If PG binders are manufactured at the job site, for example where SBR latex is injected at the hot mix plant, the following quality measures are required. Antistrip agents are not considered asphalt modifiers.

(1) **Preconstruction.** The CONTRACTOR shall provide the CITY with a 1-quart sample of the proposed binder and a test report showing compliance with the required performance grade. The sample and test report will be forwarded to the CITY for verification testing. If the CITY chooses to verify that the sample meets specifications, the CITY will complete verification testing within ten (10) working days after receipt of the sample. If the CITY chooses to verify the sample, then the sample shall be verified before mixture production is allowed to begin.

(2) **Construction.** A sampling port is required which meets the requirements of AASHTO T40 Practice for Sampling Bituminous Materials, Section 9, “Sampling From Pipelines During Loading or Unloading”. This sampling port shall be located on the asphalt line before introduction of the asphalt into the mix plant and shall be downstream from the addition of any modifiers and any dispersing or mixing equipment associated with their introduction.

Sample containers shall be provided by the CONTRACTOR and shall be clean, double friction top round 1-quart cans. All samples shall be taken by the CONTRACTOR, and witnessed by the Engineer.

All samples shall be taken from the sampling port after a sufficient amount of asphalt is run out and wasted, in order to clear any residual asphalt that builds up in the sampling port. All samples shall be taken in a clean, 1-gallon can, immediately stirred and used to fill three (3) 1-quart sample cans. The cans shall be delivered to the CITY. The CITY will choose one sample can for testing and the other cans are retained until testing is complete, in case the original sample is lost or damaged.

**302.3.2.2.2. Sampling Frequency.** A sample of the PG binder may be taken from each mixture production day, at a time determined by the CITY. The sample from the first day’s production may be subjected to verification testing. Additionally, throughout the duration of the project, the CITY may randomly select binder samples for verification testing.

**302.3.2.2.3. Verification Testing.** CITY may perform verification testing on all construction samples. The CITY will complete verification testing within 10 working days after receipt of the sample. For verification testing which fails to confirm the required performance grade, the CONTRACTOR shall review the manufacturing process to locate the source of the problem. The CITY may stop production until the CONTRACTOR can show that the next binder produced will meet the specifications. The CITY may require materials not meeting the specification requirements to be removed and replaced at the CONTRACTOR’s expense.

**302.3.3. Asphalt Cement.** Asphalt cement is bituminous liquid binder. The material for asphalt cement shall be homogeneous, shall be free from water, shall not foam when heated to 347°F (175°C) and shall meet the requirements of Table 302.3.3.(a) Requirements for Asphalt Cement.

<table>
<thead>
<tr>
<th>Property, Test Parameters</th>
<th>Value According to Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC-3</td>
</tr>
<tr>
<td>Viscosity, 140°F (60°C), Stokes</td>
<td>Min</td>
</tr>
<tr>
<td>Viscosity, 275°F (135°C), Stokes</td>
<td>250</td>
</tr>
<tr>
<td>Penetration, 77°F, (25°C) 100-g, 5-sec.</td>
<td>1.1</td>
</tr>
<tr>
<td>Flash point C.O.C., °F(°C)</td>
<td>210</td>
</tr>
<tr>
<td>Solubility in trichloroethylene (%)</td>
<td>425</td>
</tr>
<tr>
<td>Tests on residues from thin film oven test: Viscosity, 140°F (60°C), Stokes</td>
<td>99.0</td>
</tr>
<tr>
<td>Ductility, 77°F (25°C) 5-cms-per-min, cms.</td>
<td>100</td>
</tr>
<tr>
<td>Spot Test</td>
<td>Negative for all grades</td>
</tr>
</tbody>
</table>
302.3.3.1. Polymer Modified Asphalt Cement. For surface treatment applications, a polymer additive consisting of an anionic emulsion of styrene-butadiene low-temperature copolymer shall be added to the AC-5 or AC-10 asphalt when specified on the plans or in the specifications in the contract. The polymer additive shall consist of two-percent (by weight) polymer additive (solids basis) which has good storage stability. Polymer additive shall possess the properties specified in Item 302.3.3.1.1. Polymer Additive Properties. The manufacturer shall furnish the actual styrene-butadiene rubber (SBR) content for each batch of polymer emulsion. This information shall accompany all shipments to facilitate proper addition rates.

The finished polymer modified asphalt cement blend shall be smooth, homogeneous, and comply with the requirements in Table 302.3.3.1.(a) Polymer Modified Asphalt Requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method, Test Parameters</th>
<th>Value According to Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum SBR Content</td>
<td>Tex-533-C Determining Polymer Additive Percentages in Polymer Modified Asphalt Cements, IR Determination</td>
<td>2.0% Solids By Wt.</td>
</tr>
<tr>
<td>Penetration</td>
<td>AASHTO T49, 100-G, 5-Sec, 77°F</td>
<td>120 Min</td>
</tr>
<tr>
<td>Minimum Viscosity</td>
<td>AASHTO T202, 140°F</td>
<td>700-Poise</td>
</tr>
<tr>
<td>Maximum Viscosity</td>
<td>AASHTO T202, 275°F</td>
<td>7.0-Poise</td>
</tr>
<tr>
<td>Ductility</td>
<td>AASHTO T51, 39.2°F, 5-cm/Min</td>
<td>70-cm, Min</td>
</tr>
<tr>
<td>Separation of Polymer</td>
<td>Tex-540-C Measurement of Polymer Separation on Heating in Modified Asphalt Systems, After 48-Hrs. at 325°F</td>
<td>None</td>
</tr>
</tbody>
</table>

1. The asphalt supplier shall furnish the CITY samples of the asphalt cement and polymer emulsion used in making the finished product.

302.3.3.1.1. Polymer Additive Properties. The polymer additive shall be an emulsion of styrene-butadiene low-temperature copolymer in water. The emulsion shall have good storage stability and possess the properties in Table 302.3.3.1.1.(a) Polymer Additive Requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monomer Ratio of Polymer (butadiene to styrene)</td>
<td>73 ± 5</td>
</tr>
<tr>
<td></td>
<td>27 ± 5</td>
</tr>
<tr>
<td>Minimum Solids Content (percent by weight)</td>
<td>45</td>
</tr>
<tr>
<td>Viscosity of Emulsion at 77 ± 1°F, cps, max (No.3 spindle, 20-rpm, Brookfield RVT Viscometer)</td>
<td>2000</td>
</tr>
</tbody>
</table>

302.3.4. Emulsified Asphalt. Emulsified asphalt shall be composed of a paving asphalt base uniformly emulsified with water. It shall be homogeneous throughout and, when stored, shall show no separation within 30-days after delivery. Emulsified asphalt shall meet the requirements for the specified type and grade shown in Tables 302.3.4.(a) through (d).

302.3.4.1. Testing Requirements. Test reports and certification shall be made for emulsified asphalt in accordance with Item 302.3.1.1. Tests and Certification of Bituminous Materials.

302.3.4.2. Temperature. Emulsified asphalt may be reheated, but at no time after loading for transportation from refinery to the purchaser shall the temperature of the emulsion be raised above 160°F (70°C). During reheating, the emulsified asphalt shall be agitated to prevent localized overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40°F (4°C). Unless otherwise specified, emulsified asphalt shall be applied at a temperature within the limits specified in Table 302.5.(a) Requirements for Storage, Heating and Application Temperature. CONTRACTOR shall furnish and keep on the site an accurate thermometer suitable for determining the temperature of the emulsified asphalt.
### Table 302.3.4.(a). Tests and Properties of Anionic Emulsions

<table>
<thead>
<tr>
<th>Property</th>
<th>Rapid Setting</th>
<th>Medium Setting</th>
<th>Slow Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol at 77°F, sec</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>at 122°F, sec</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
</tr>
<tr>
<td>Miscibility (Standard Test)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cement Mixing, %</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Demulsibility, 35-ml of 0.02 N CaCl₂, %</td>
<td>60</td>
<td>60</td>
<td>-</td>
</tr>
<tr>
<td>Storage Stability, 1-day, %</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Freezing Test, 3 cycles</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Distillation Test:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue by Distillation, % by weight</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Oil Distillate, % by volume of emulsion</td>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration at 77°F, 100 g, 5 sec</td>
<td>120</td>
<td>160</td>
<td>80</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
</tr>
<tr>
<td>Ductility at 77°F, 5 cm/min, cm</td>
<td>100</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

1. Applies only when the Engineer designates material for winter use.

### Table 302.3.4.(b). Tests and Properties of High Float Anionic Emulsions

<table>
<thead>
<tr>
<th>Property</th>
<th>Rapid Setting</th>
<th>Medium Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol at 77°F, sec</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>at 122°F, sec</td>
<td>150</td>
<td>400</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating Ability and Water Resistance:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coating, dry aggregate</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, after spraying</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, wet aggregate</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, after spraying</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Demulsibility 35-ml of 0.02 N CaCl₂, %</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Storage Stability Test, 1-day, %</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Distillation Test:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue by Distillation, % by weight</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Oil Distillate, by volume of emulsion</td>
<td>1/2</td>
<td>-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration at 77°F, 100 g, 5 sec</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.5</td>
<td>-</td>
</tr>
<tr>
<td>Ductility at 77°F, 5 cm/min, cm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Float Test at 140°F, sec</td>
<td>1200</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 302.3.4.(c). Tests and Properties of Cationic Emulsions

<table>
<thead>
<tr>
<th>Property</th>
<th>Rapid Setting</th>
<th>Medium Setting</th>
<th>Slow Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRS-2(1)</td>
<td>CRS-2h</td>
<td>CMS-2</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>at 77°F, sec</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>at 122°F, sec</td>
<td>150</td>
<td>400</td>
<td>150</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>-</td>
<td>0.10</td>
<td>-</td>
</tr>
<tr>
<td>Cement Mixing, %</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate, %</td>
<td>40</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Storage Stability, 1 day, %</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Coating Ability and Water</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Resistance:</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, dry aggregate</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, after spraying</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, wet aggregate</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating, after spraying</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>positive</td>
<td>positive</td>
<td>positive</td>
</tr>
<tr>
<td>Distillation Test:</td>
<td>-</td>
<td>½</td>
<td>-</td>
</tr>
<tr>
<td>Residue by Distillation, % by wt</td>
<td>65</td>
<td>-</td>
<td>65</td>
</tr>
<tr>
<td>Oil Distillate, % by volume of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emulsion</td>
<td>-</td>
<td>½</td>
<td>-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration at 77°F, 100-g, 5-sec</td>
<td>120</td>
<td>160</td>
<td>80</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.5</td>
<td>-</td>
<td>97.5</td>
</tr>
<tr>
<td>Ductility at 77°F, 5 cm/min, cm</td>
<td>100</td>
<td>-</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 302.3.4.(d). Tests and Properties of Polymer Modified Emulsions

<table>
<thead>
<tr>
<th>Property</th>
<th>High Float Anionic</th>
<th>Rapid Setting</th>
<th>Cationic</th>
<th>Rapid Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type - Grade</td>
<td>CRS-2P</td>
<td>HFRS-2P</td>
<td>CRS-2P</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Polymer Content, percent by weight of the distillation residue</td>
<td>3.0</td>
<td>-</td>
<td>3.0</td>
<td>-</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol at 122°F, sec</td>
<td>150</td>
<td>400</td>
<td>150</td>
<td>400</td>
</tr>
<tr>
<td>Storage Stability Test, 1-day, %</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Demulsibility, 35-ml of 0.02 N CaCl₂, %</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Demulsibility, 35-ml 0.8-percent sodium dioctyl sulfosuccinate, %</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Sieve Test, %</td>
<td>-</td>
<td>0.10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>-</td>
<td>-</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Distillation Test:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil distillate, by volume of emulsion, %</td>
<td>-</td>
<td>½</td>
<td>-</td>
<td>½</td>
</tr>
<tr>
<td>Residue, % by wt</td>
<td>65</td>
<td>-</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Float Value at 140°F, sec</td>
<td>1200</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Penetration, 77°F, 100-g, 5-sec</td>
<td>100</td>
<td>140</td>
<td>110</td>
<td>150</td>
</tr>
<tr>
<td>Ductility, 39.2°F, 5-cm/min, cm</td>
<td>50</td>
<td>-</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Viscosity at 140°F, poises</td>
<td>1500</td>
<td>-</td>
<td>1300</td>
<td>-</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97</td>
<td>-</td>
<td>97</td>
<td>-</td>
</tr>
</tbody>
</table>

1. The emulsion supplier shall furnish the CITY samples of the asphalt cement and polymer used in making the finished emulsion.
2. The temperature on the lower thermometer shall be brought slowly to 350°F plus or minus 10°F and maintained at this temperature for 20-minutes. The total distillation shall be completed in 60-minutes plus or minus 5-minutes from the first application of heat.
302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE).

302.3.5.1. General Use Emulsions. The emulsion shall be a slow curing anionic or cationic emulsion of a petroleum based material in water. The supplier must state whether the material supplied is cationic or anionic. Such emulsions may be used for priming of base materials, curing seal for stabilized base materials, and erosion control applications such as dust control, soil surface stabilization, or mulch binder.

Emulsion properties shall fall within the ranges as shown in Table 302.3.5.1.(a) Tests and Properties of PCE (General Use) Emulsions. The base emulsion material may be diluted with water to achieve the desired concentration of residual with maximum dilution rates as indicated in Table 302.3.5.1.(b) Maximum Dilution Rate.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Methods, Test Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>Saybolt Furol, 25°C</td>
<td>10-seconds</td>
<td>100-seconds</td>
</tr>
<tr>
<td>Sieve Test</td>
<td>Sieve Test</td>
<td>-</td>
<td>0.1 %</td>
</tr>
<tr>
<td>Miscibility</td>
<td>ASTM D244 Emulsified Asphalts, modified¹</td>
<td>Passing</td>
<td>-</td>
</tr>
<tr>
<td>Residue by Evaporation</td>
<td>ASTM D244, modified²</td>
<td>60% by weight</td>
<td>-</td>
</tr>
<tr>
<td>Tests on Residue from Evaporation</td>
<td>Flash Point, C.O.C.</td>
<td>200°C</td>
<td>-</td>
</tr>
<tr>
<td>Kinematic Viscosity, 60°C</td>
<td></td>
<td>100-cSt</td>
<td>350-cSt</td>
</tr>
</tbody>
</table>

1. Except the dilution shall use 350-ml of distilled or deionized water and a 100-ml beaker.
2. Except the sample shall remain in the oven until foaming ceases, then cooled and weighed.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Methods, Required Test Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priming of Base Materials</td>
<td>(1) part PCE to (3) parts water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curing Seal</td>
<td>(1) part PCE to (3) parts water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion Control</td>
<td>(1) part PCE to (7) parts water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

302.3.5.2. Emulsions Specifically for Priming and Curing. Product shall be a water-based emulsion composed of petroleum of resin oil base with selective hardening and drying agents to form a road prime and sealer. Emulsions may be provided either concentrated or pre-diluted. Concentrated prime and/or road sealing emulsions specified in this Item 302.3.5.2. shall meet the requirements of Table 302.3.5.2.(a) Requirements for MCS-600-C – Concentrated. Diluted prime and/or road sealing emulsions specified in this Item 302.3.5.2. shall meet the requirements of Table 302.3.5.2.(b) Requirements for MCS-600-D – Dilute.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Methods, Required Test Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Visual Inspection</td>
<td>Brown Liquid</td>
<td></td>
</tr>
<tr>
<td>Viscosity S.F. at 77°F Sec</td>
<td>ASTM D244 Emulsified Asphalts</td>
<td>15</td>
<td>200</td>
</tr>
<tr>
<td>Residue, % min</td>
<td>ASTM D244, modified¹</td>
<td>56</td>
<td>65</td>
</tr>
<tr>
<td>Miscibility</td>
<td>ASTM D244, modified²</td>
<td>No coagulation</td>
<td></td>
</tr>
<tr>
<td>Moisture, wt %</td>
<td>-</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Volatile %</td>
<td>-</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>% Non-Volatile Soluble in Trichloroethylene</td>
<td>AASHTO T 45-56</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Accelerated Weathering (2-year exposure)</td>
<td>Federal Spec TT C-555 B, 40 ml</td>
<td>No material deterioration after exposure</td>
<td></td>
</tr>
<tr>
<td>Resistance To wind and Driven Rain (@ 98 mph)</td>
<td>Federal Spec TT C-555 B, As 4ml sealer after cure</td>
<td>Passes/no wt. gain</td>
<td></td>
</tr>
<tr>
<td>Ash, % wt.</td>
<td>-</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Polymer, % wt.</td>
<td>-</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Freeze Test (Concentrated Form)</td>
<td>3-cycle</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td>Particle Charge</td>
<td>ASTM D244</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td>Shaker Test 2- to 4-hrs.</td>
<td>Mix Burrell Wrist Action Shaker Model 75 set on Level 7, diluted 1 part water to 4 parts road prime, Sieve #40</td>
<td>-</td>
<td>1%</td>
</tr>
</tbody>
</table>

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.
### Table 302.3.5.2.(b) Requirements for MCS-600-D – Dilute

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Methods, Test Parameters</th>
<th>Required Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Visual Inspection</td>
<td>Brown Liquid</td>
</tr>
<tr>
<td>Viscosity S.F. at 77°F Sec</td>
<td>ASTM D244 Emulsified Asphalts</td>
<td>5-70</td>
</tr>
<tr>
<td>Residue, % min</td>
<td>ASTM D244, modified¹</td>
<td>10-20</td>
</tr>
<tr>
<td>Miscibility Test</td>
<td>ASTM D244, modified²</td>
<td>No coagulation</td>
</tr>
<tr>
<td>Moisture, wt %</td>
<td>-</td>
<td>90</td>
</tr>
<tr>
<td>Volatile %</td>
<td>90-20</td>
<td></td>
</tr>
<tr>
<td>% Non-Volatile Soluble in Trichloroethylene</td>
<td>AASHTO T 45-56</td>
<td>0-2</td>
</tr>
<tr>
<td>Accelerated Weathering (2-year exposure)</td>
<td>Federal Spec TT C-555 B, 40 ml</td>
<td>No material deterioration after exposure</td>
</tr>
<tr>
<td>Resistance To wind and Driven Rain (@ 98 mph)</td>
<td>Federal Spec TT C-555 B, As 4ml sealer after cure</td>
<td>Pass/ no wt. gain</td>
</tr>
<tr>
<td>Ash, % wt.</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Polymer, % wt.</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Freeze Test (Concentrated Form)</td>
<td>3-cycle</td>
<td>Pass</td>
</tr>
<tr>
<td>Particle Charge</td>
<td>ASTM D244</td>
<td>Positive</td>
</tr>
<tr>
<td>Shaker Test 2- to 4-hrs. (non-diluted)</td>
<td>Mix Burrell Wrist Action Shaker Model 75 set on Level 7, Sieve #40</td>
<td>- 1%</td>
</tr>
</tbody>
</table>

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 100-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.

#### 302.3.6. Specialty Emulsions

Specialty emulsions shall be slow setting emulsions of a petroleum-based material in water. Specialty emulsions may be used for purposes such as tack coat, fog seals, priming base materials, curing seal for stabilized base materials, recycled/reclaimed asphalt pavement (RAP) rejuvenator, repairing surface deficiencies, and erosion control applications. Specialty emulsions are classified as either Restorative Seal or Maltene Rejuvenator and shall meet the requirements for the specified type shown in Table 302.3.6.(a) Requirements for Restorative Seal or Table 302.3.6.(b) Requirement for Maltene Rejuvenator, respectively. Specialty emulsions shall be freeze stabilized and if freezing has occurred a homogeneous mixture shall be obtained when the material has thawed and been thoroughly mixed.
### Table 302.3.6.(a) Requirements for Restorative Seal

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Methods</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test on Emulsion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity @77°F (25°C), SES</td>
<td>ASTM D244 Emulsified Asphalts</td>
<td>25 - 150</td>
</tr>
<tr>
<td>Sieve Test, % by Wt.</td>
<td>ASTM D244, modified1</td>
<td>0.1 Max.</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>ASTM D244</td>
<td>Positive</td>
</tr>
<tr>
<td>Cement Mixing Test, % by Wt.</td>
<td>ASTM D244</td>
<td>2.0 Max.</td>
</tr>
<tr>
<td>Pumping Stability</td>
<td>See Note 2.</td>
<td>Pass</td>
</tr>
<tr>
<td>5-day Settlement Test, % by Wt.</td>
<td>ASTM D244</td>
<td>5.0 Max.</td>
</tr>
<tr>
<td>Residue, % Wt.</td>
<td>ASTM D244, modified3</td>
<td>64 Min.</td>
</tr>
<tr>
<td><strong>Test on Residue from Distillation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity @ 140°F (60°C), cSt</td>
<td>ASTM D2170 Kinematic Viscosity of Asphalts (Bitumens)</td>
<td>1,000 – 4,000</td>
</tr>
<tr>
<td>Maltene Distribution Ratio4</td>
<td>ASTM D2006-70 Method of Test for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method (Discontinued 1975)</td>
<td>0.7 – 1.1</td>
</tr>
<tr>
<td>PC/S Ratio4</td>
<td>ASTM D2006-70</td>
<td>0.5 Min.</td>
</tr>
<tr>
<td>Asphaltenes, % Wt.</td>
<td>ASTM D2006-70</td>
<td>11.00 Max.</td>
</tr>
</tbody>
</table>

1. Test procedure identical with ASTM D244 except that distilled water shall be used in place of two-percent sodium oleate solution.
2. Pumping stability is determined by charging 15-ounces (450-ml) of emulsion into 30-ounce (one-liter) beaker and circulating the emulsion through a gear pump (Roper 29.B22621) having ¼” inlet and outlet. The emulsion passes if there is not significant oil separation after circulating ten-minutes.
3. ASTM D244 Evaporation Test for percent of residue is modified by heating 2-ounces (50-gram) sample to 300°F (149°C) until foaming ceases, then cooling immediately and calculating results.
4. In the Maltene Distribution Ratio Test by ASTM Method D2006-70:
   \[(PC + A_1) / (S + A_2)\]
   \(PC=\)Polar Compounds \(A_1=\)First Acidaffins
   \(A_2=\)Second Acidaffins \(S=\)Saturated Hydrocarbons
### Table 302.3.6.(b) Requirement for Maltene Rejuvenator

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Methods</th>
<th>ASTM</th>
<th>AASHTO</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @77°F (25°C), SES</td>
<td>D244 Emulsified Asphalts</td>
<td>T-59</td>
<td>T-59 (Mod)</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Residue, % Wt.</td>
<td>D244 (Mod)1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscibility Test</td>
<td>D244 (Mod)2</td>
<td></td>
<td></td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Sieve Test, % by Wt.</td>
<td>D244 (Mod)3</td>
<td></td>
<td></td>
<td>-</td>
<td>0.1</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>D244</td>
<td></td>
<td>T-59 (Mod)</td>
<td>-</td>
<td>Positive</td>
</tr>
<tr>
<td>Percent Light Transmittance</td>
<td>See Note 4.</td>
<td></td>
<td></td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Test on Emulsion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point, COC, °F</td>
<td>D92 Flash and Fire Points by Cleveland Open Cup</td>
<td>T-48</td>
<td></td>
<td>385</td>
<td>-</td>
</tr>
<tr>
<td>Viscosity @ 140°F (60°C), cSt</td>
<td>D445 Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)</td>
<td>-</td>
<td></td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Asphaltenes, % Wt.</td>
<td>D2006-70 Method of Test for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method (Discontinued 1975)</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Maltene Distribution Ratio5</td>
<td>D2006-70</td>
<td></td>
<td></td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>PC/S Ratio5</td>
<td>D2006-70</td>
<td>-</td>
<td></td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Saturated Hydrocarbons, S5</td>
<td>D2006-70</td>
<td>-</td>
<td></td>
<td>21</td>
<td>28</td>
</tr>
</tbody>
</table>

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 2-ounces (50-grams) sample to 300°F (149°C) until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244 except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.
3. Test procedure identical with ASTM D244 except that distilled water shall be used in place of two-percent sodium olate solution.
4. Test according to Attachment “Standard Procedure for Determining Percent Light Transmittance of Maltene Rejuvenator, Restorative Seal, and PCE Material” in TxDOT Special Provision to Item 300 for Maltene Rejuvenator (Waco District).
5. Chemical composition by ASTM Method D2006-70: 
   \[(PC + A1)/(S + A2)\]
   PC=Polar Compounds A1=First Acidaffins
   A2= Second Acidaffins S=Saturated Hydrocarbons

### 302.3.7. Emulsion for In-Place Asphalt Recycling

Emulsion shall be designed to be a recycling agent to be mixed at ambient temperature with existing in-place asphalt, native or selective material and or Recycled Asphalt Pavement (RAP) material. Product shall be a water miscible emulsion. Asphaltene, Resins, Cyclics, Saturates content must be specifically formulated based on laboratory data of existing material in relation to rejuvenation demand and any added RAP material. Product shall meet minimums and fall within the ranges specified in Table 302.3.7.(a) Emulsion Requirements for In-Place Asphalt Recycling.
Table 302.3.7.(a) Emulsion Requirements for In-Place Asphalt Recycling

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Methods, Test Parameters</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>Test on Emulsion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity</td>
<td>Saybot Furol, 122°F</td>
<td>-</td>
</tr>
<tr>
<td>Sieve %</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Particle Charge</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Specific Gravity @ 77°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement Mixing Test</td>
<td>ASTM D244</td>
<td>0.910</td>
</tr>
<tr>
<td>Distillation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue; % from Distillation @ 325°F</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Test on Residue from Distillation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, 77°F Extrapolation function</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>Asphaltene, %</td>
<td></td>
<td>3.1</td>
</tr>
<tr>
<td>Resins, % wt.</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>Cyclics</td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td>Saturates</td>
<td></td>
<td>2.8</td>
</tr>
<tr>
<td>Flash Point C.O.C.</td>
<td></td>
<td>400°F</td>
</tr>
</tbody>
</table>

302.4. FIBROUS REINFORCEMENT FOR ASPHALT

302.4.1. General. At the CITY’s option, fibrous reinforcement may be used unless otherwise shown on the plans or in the contract documents. Fibrous reinforcement shall not be used as a replacement for any reinforcement required for structural purposes.

302.4.2. Material and Tests. Fibers for reinforcement of asphalt shall be cellulose tested by the methods and meeting the criteria in Table 302.4.2.(a) Cellulose Fiber Requirements.

Table 302.4.2.(a) Cellulose Fiber Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Methods</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method A</td>
<td>Alpine Sieve Analysis¹</td>
<td>0.25” (maximum)</td>
</tr>
<tr>
<td>Fiber Length</td>
<td>Mesh Screen Analysis²</td>
<td>70% (±10%)</td>
</tr>
<tr>
<td>Passing No. 100 sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method B</td>
<td></td>
<td>0.25” (maximum)</td>
</tr>
<tr>
<td>Fiber Length</td>
<td></td>
<td>85% (± 10%)</td>
</tr>
<tr>
<td>Passing No. 20 sieve</td>
<td></td>
<td>65% (±10%)</td>
</tr>
<tr>
<td>Passing No. 40 sieve</td>
<td></td>
<td>30% (±10%)</td>
</tr>
<tr>
<td>Passing No. 140 sieve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash Content</td>
<td>See Note 3.</td>
<td>18% (± 5%) non-volatiles</td>
</tr>
<tr>
<td>pH</td>
<td>See Note 4.</td>
<td>7.5 (± 1.0%)</td>
</tr>
<tr>
<td>Oil Absorptions</td>
<td>See Note 5.</td>
<td>5.0 (± 1.0%) (times fiber weight)</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>See Note 6.</td>
<td>&lt; 5% (by weight)</td>
</tr>
</tbody>
</table>

1. Method A - Alpine Sieve Analysis. This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14-minutes at a controlled vacuum of 11-psi. The portion remaining on the screen is weighed.
2. Method B - Mesh Screen Analysis. This test is performed using standard No. 20, 40, 60, 80, 100, 140 sieves, nylon brushes and a shaker. A representative 10-gram sample of fiber is sieved, using a shaker and 2 nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated. Repeatability of this method is suspect and needs to be verified.
3. Ash Content. A representative 2- to 3-gram sample of fiber is placed in a tared crucible and heated between 1100°F and 1200°F for not less than 2-hours. The crucible and ash are cooled in a desiccator and reweighed.
4. pH Test. 5-grams of fiber is added to 100-ml of distilled water, stirred and let sit for 30-minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.
5. Oil Absorption Test. 5-grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5-minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5-square-millimeter hole size) and shaken on a wrist action shaker for 10-minutes (approximately 1¼-inch motion at
240-shakes-per-minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times its own weight) the fibers are able to absorb.

6. Moisture Content. 10-grams of fiber is weighed and placed in a 250°F forced air oven for 2-hours. The sample is then reweighed immediately upon removal from the oven.

302.4.3. Rejection. Fibrous reinforcement for asphalt may be rejected for failure to meet any of the requirements of this specification.

302.5. STORAGE, HEATING AND APPLICATION TEMPERATURE OF BITUMINOUS MATERIALS

Asphalt materials should be applied at the temperature that provides proper and uniform distribution. Within practical limits, higher temperatures than necessary should be avoided. Satisfactory application should be obtained within the recommended ranges shown in Table 302.5.(a) Requirements for Storage, Heating and Application Temperature. No material shall be heated above the maximum temperature shown. Performance graded asphalt binders containing particulate or polymer modifiers may be susceptible to separation of the modifier. Appropriate circulation or agitation in storage shall be provided if separation of the modifier is expected or suspected, and in every case when the modified binder will be stored at elevated temperatures for more than one day before use.

Table 302.5.(a) Requirements for Storage, Heating and Application Temperature

<table>
<thead>
<tr>
<th>Material Type-Grade</th>
<th>Application and Mixing</th>
<th>Heating and Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended Range °F (°C)</td>
<td>Maximum Allowable °F (°C)</td>
</tr>
<tr>
<td>All PG Binders</td>
<td>275-375 (135-191)</td>
<td>375 (191)</td>
</tr>
<tr>
<td>AC-3, 5, 10, 20</td>
<td>275-325 (135-163)</td>
<td>350 (177)</td>
</tr>
<tr>
<td>Emulsions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-1, SS-1 h, SS-1 P, CSS-1 h</td>
<td>50-130 (10-54)</td>
<td>140 (60)</td>
</tr>
<tr>
<td>RS-2, RS-2h, MS-2, CRS2h, CRS-2P, CMS-2, CMS-2s, HFRS-2, HFRS-2P, AES-300</td>
<td>110-160 (43-71)</td>
<td>170 (77)</td>
</tr>
<tr>
<td>PCE, Restorative Seal or Maltene Rejuvenator</td>
<td>Ambient = 72-130 (22-54)</td>
<td>140 (60)</td>
</tr>
</tbody>
</table>

302.6. EMULSIFIED ASPHALT TREATMENT

302.6.1. Description. Emulsified asphalt treatment shall consist of one or more applications of a mixture of emulsified asphalt of the proportion and type specified on the plans and water. The mixture shall be applied at the rate specified on the plans. It is to be used as a base treatment, earthwork seal, prime coat or dust preventative. This mixture may be applied to the base course, subgrade, shoulders or detours at the locations and to the extent shown on plans or as directed by the CITY.

302.6.2. Materials. The amount of emulsified asphalt in the mixture, expressed as a percent by volume of the total mixture, shall be within the limits specified on the plans. When tested by approved laboratory methods, the emulsified asphalt used shall meet the requirements of Item 302.3.4. Emulsified Asphalt or Item 302.3.5. Emulsions for Priming, Curing, and Erosion Control (PCE) or Item 302.3.6. Specialty Emulsions.

The water used shall be clear, free from industrial wastes and other objectionable matter.

302.6.3 Construction Methods. Asphalt materials shall be handled in accordance with Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials.

The emulsified asphalt and water mixture shall be applied by a self-propelled sprinkler meeting the requirements of Item 203.8. Dust Control so operated as to uniformly distribute the mixture in the quantity determined by the CITY.
The emulsion and water may be mixed in the sprinkler tank. The CONTRACTOR shall make suitable provisions for agitating the two materials sufficiently to produce a uniform blend. The sprinkler tank shall have been recently calibrated, and the CITY shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the emulsion applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the CITY before proceeding with the work.

302.7. PRIME COAT

302.7.1. Description. This Item shall consist of application of asphaltic materials on the completed base course and/or other approved area, which shall be applied in accordance with these specifications and as shown on the plans.

302.7.2. Materials. The asphaltic material used for the prime coat shall be of the type and grade as stated in the contract and when tested by approved laboratory methods shall meet the requirements of Item 302.3.4. Emulsified Asphalt or Item 302.3.5. Emulsions for Priming, Curing, and Erosion Control (PCE) or Item 302.3.6. Specialty Emulsions.

302.7.3. Equipment. All storage tanks, piping, retorts, booster tanks and distributors used in storing and handling asphaltic material shall be kept clean and in good condition at all times. Equipment shall be operated in such a manner that there shall be no contamination of the asphaltic material with foreign material. It shall be the responsibility of the CONTRACTOR to provide and maintain in good working order a recording thermometer at the storage heating unit at all times. The distributor shall have been recently calibrated and the CITY shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the asphaltic material applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the CITY before proceeding with the work.


Prime coat shall not be applied when the air temperature is below 50°F (10°C) and falling, but it may be applied when the air temperature is above 40°F (5°C) and rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the CITY, are not suitable.

When, in the opinion of the CITY, the base is thoroughly dry and is satisfactory to receive the prime coat, the surface shall be cleaned by sweeping or other approved methods. The asphaltic material shall be applied to the cleaned base at the approximate rate of 0.15- to 0.25-gallons-per-square-yard (0.75- to 1.25-L-per-m²) of surface area. The application shall be made with an approved type of self-propelled pressure distributor so constructed and operated as to distribute the material evenly and smoothly in the quantity specified or directed. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distribution, for determining the rate at which it is applied, and for securing uniformity at the junction of two distributor loads.

The CITY shall select the temperature of application within the limits recommended in Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials based on the temperature-viscosity relationship that shall permit application of the asphalt. The CONTRACTOR shall apply the asphalt at a temperature within 15°F (3°C) of the temperature selected.

No traffic, hauling or placing of subsequent courses shall be permitted over the freshly applied prime coat until authorized by the CITY.

The CONTRACTOR shall be responsible for the maintenance of the surface until the work is accepted by the CITY.
302.8. ASPHALT BASE COURSE

302.8.1. Description. Asphalt base course shall consist of a compact mixture of mineral aggregates and asphaltic material mixed hot in a mixing plant. It may be a base course, subbase course, or foundation course. It is made of larger aggregate than Hot-Mix Coarse Base (A) as shown in Table 302.9.3.(a) Dense Graded Hot Mix Master Grading.


302.8.2.1. Asphaltic Cement. Asphalt for the mixture shall be of the types of asphalt cement as determined by the CITY and shall meet the requirements of Item 302.3.2. Performance-Graded (PG) Asphalt Binders or Item 302.3.3. Asphalt Cement. The grade of asphalt to be used shall be determined by the CITY after design tests have been made using the mineral aggregate approved for use in the construction. If more than one type of asphaltic cement mixture is specified for the project, only one grade of asphalt shall be required for all types of mixture unless otherwise shown on the plans. The CONTRACTOR shall notify the CITY of the source of asphaltic material prior to production of the asphaltic mixture, and this source shall not be changed during the course of the project, except by written permission of the CITY.

302.8.2.2. Tack Coat. The liquid asphalt material used for tack coat should be MS-2 or SS-1 in Item 302.3.4. Emulsified Asphalt, Restorative Seal in Item 302.3.6. Specialty Emulsions or one of the other various grades of materials (selected by the CITY) listed under Item 302.3.4. Emulsified Asphalt.

302.8.2.3. Mineral Aggregate. The material shall be crushed and screened as necessary to meet the requirements hereinafter specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

Unless otherwise specified, the grading of the mineral aggregate shall conform to the limitations as shown in Table 302.8.2.3.(a). Asphalt Base Course Aggregate Grades.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 3/4-inch</td>
<td>100.0</td>
</tr>
<tr>
<td>1 1/2-inch</td>
<td>90.0-100.0</td>
</tr>
<tr>
<td>1-inch</td>
<td>90.0-100.0</td>
</tr>
<tr>
<td>3/8-in.</td>
<td>45.0-70.0</td>
</tr>
<tr>
<td>No. 4</td>
<td>30.0-55.0</td>
</tr>
<tr>
<td>No. 40</td>
<td>15.0-30.0</td>
</tr>
</tbody>
</table>

Testing of the mineral aggregate shall be in accordance with the test methods in Table 302.8.2.3.(b) Aggregate Tests.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Soil Constants</td>
<td>Tex-101-E Preparing Soil and Flexible Base Materials for Testing</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>ASTM D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>ASTM D4318 (same as above)</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>ASTM D4318 (same as above)</td>
</tr>
<tr>
<td>Sieve Analysis</td>
<td>ASTM C136 Sieve Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>Wet Ball Mill</td>
<td>Tex-116-E Ball Mill Method for Determining the Disintegration of Flexible Base Material</td>
</tr>
<tr>
<td>Sand Equivalent</td>
<td>ASTM D2419 Sand Equivalent Value of Soils and Fine Aggregate</td>
</tr>
</tbody>
</table>
Unless otherwise specified on the plans, the mineral aggregate for Grades 1, 2 and 3 shall meet the limits of Table 302.8.2.3.(c) Aggregate Physical Requirements. Mineral aggregate for Grade 4 shall meet the physical requirements shown on the plans.

Table 302.8.2.3.(c) Aggregate Physical Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Ball Mill</td>
<td>50 Max.</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>15 Max.</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>40 Max.</td>
</tr>
<tr>
<td>Sand equivalent</td>
<td>~40</td>
</tr>
</tbody>
</table>


Mixing plants may be either the weight-batching type plant, the continuous mixing type plant, or the drum mixing type plant as described in Item 302.9.5. Mixing Plants except that requirements for Type “B” and “D” mixtures of fine graded surface course are deleted.

Equipment for storage, weighing and heating of materials shall be as described in Item 302.9.4. Equipment.

The CITY shall designate the asphalt content to be used in the mixture after design tests have been made with the aggregates to be used in the project. When tests as determined by the CITY are made, samples of the mixture shall not vary from the asphalt content designated by the CITY by more than 0.5-percent dry weight (based on total mixture). The asphaltic material will form typically 4- to 9-percent of the mixture by weight.

The mixture shall consist of a uniform mixture of mineral aggregates and asphaltic material.

The asphaltic mixtures for the weight-batching type plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in TxDOT Test Method Tex-208-F Test for Stabilometer Value of Bituminous Mixtures (Part I or Part III as applicable), shall have laboratory density and stability as indicated in Table 302.8.3.(a) Stability of Asphalt Base Course. If the mixture produced does not have the specified qualities, the mixture shall be changed until it conforms to the specified qualities.

Table 302.8.3.(a) Stability of Asphalt Base Course

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (%)</td>
<td>96 ±2</td>
</tr>
<tr>
<td>Stability (%) Hveem Stabilometer</td>
<td>Not less than 40 except when otherwise shown on the plans</td>
</tr>
</tbody>
</table>

302.9. HOT-MIX ASPHALT PAVEMENT

302.9.1. Description. This Item shall govern pavement consisting of a binder course, a leveling up course, a surface course or any combination of these courses as shown on the plans. Each course shall be composed of a compacted mixture of mineral aggregate and asphaltic material mixed hot in a mixing plant; and shall be constructed on the previously completed and approved subgrade, subbase course, base course, existing pavement, or in the case of a bridge, on the prepared floor slab, all in accordance with these specifications and in conformity with the lines, grades, quantities and typical sections as stated in the contract, plans and/or established in the field by the CITY.

302.9.2. Materials. The materials proposed to be used may be inspected and tested at any time during the preparation of the work.

302.9.2.1. Aggregates. Mineral aggregates shall consist of a fine aggregate, coarse aggregate and, when required, a mineral filler all in accordance with Item 302.2. Aggregates for Hot-Mix Asphalt Pavement and approved by the CITY. Representative samples of the materials proposed to be used in the mixture shall be submitted for tests in the quantities required by the CITY. No material that has in any way become unfit for use after approval shall be used in the work. Approval of both the materials and sources of supply must be obtained from the CITY prior to delivery of the material.

302.9.2.2. Asphaltic Materials. Material shall conform to the applicable paragraphs of Item 302.3. Bituminous Materials. Only one grade of asphalt shall be required for all the types of mixtures unless otherwise shown on the plans or required by the CITY.
302.9.2.2.1. **Paving Mixture.** Asphaltic materials for the paving mixture shall be the type and grade specified, shown on the plans, or as designated by the CITY after design tests have been made, using the mineral aggregates proposed to be used in the mixture, and shall meet the requirements of Item 302.3.2. Performance Graded (PG) Asphalt Binders or Item 302.3.3. Asphalt Cement. If more than one type of asphaltic pavement mixture is specified for the project, only one grade of asphalt shall be required for all types of mixtures, unless otherwise shown on the plans. The CONTRACTOR shall notify the CITY of the source of asphaltic material prior to production of the asphaltic mixture and prior to the paving of this course of the project except on written permission of the CITY.

302.9.2.2.2. **Prime Coat.** Prime coat shall conform to the provisions of Item 302.7. Prime Coat.

302.9.2.2.3. **Tack Coat.** The liquid asphalt material used for tack coat should be MS-2 or SS-1 in Item 302.3.4. Emulsified Asphalt, Restorative Seal in Item 302.3.6. Specialty Emulsions or one of the other various grades of materials (selected by the CITY) listed under Item 302.3.4. Emulsified Asphalt.

302.9.2.3. **Cellulose Fiber.** Cellulose fiber may be used in the mixture to prevent excessive draindown. The cellulose fiber shall be of the type shown on the plans and shall meet the requirements of Item 302.4. Fibrous Reinforcement for Asphalt.

302.9.3. **Paving Mixture.** The paving mixture shall consist of a uniform mixture of coarse aggregate, fine aggregate, mineral filler, when required, and asphaltic material, accurately proportioned by weight. The grading of each constituent shall be such as to produce, when properly proportioned, a mixture conforming to the following limitations for grading the type specified. The exact proportions of each constituent producing the total aggregate within these limits shall be as directed by the CITY, and when tested by standard laboratory methods, the mixture shall meet the requirements listed in Tables 302.9.3.(a) through (f). The CITY shall specify or approve a mixture within the specified limits for all types of mixtures, which shall be suitable for the work in which the asphaltic pavement shall be used. The percentages of asphalt shall not vary more than 0.4-percent from the proportions established by the CITY.

**Table 302.9.3.(a) Dense Graded Hot Mix\(^1\) Master Grading**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Type of</th>
<th>A Coarse Base</th>
<th>B Fine Base</th>
<th>C Coarse Surface</th>
<th>D Fine Surface</th>
<th>F Fine Mixture</th>
<th>CMHB – C Coarse Surface</th>
<th>CMHB – F Fine Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent Passing by Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ½&quot;</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1¼&quot;</td>
<td>95-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>~&quot;</td>
<td>70-90</td>
<td>95-100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>~&quot;</td>
<td>75-95</td>
<td>95-100</td>
<td></td>
<td>95 –100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>½&quot;</td>
<td>50-70</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>~&quot;</td>
<td>60-80</td>
<td>70-85</td>
<td>85-100</td>
<td>100</td>
<td>50-70</td>
<td>85 - 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¼&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>30-50</td>
<td>40-60</td>
<td>43-63</td>
<td>50-70</td>
<td>30 - 45</td>
<td>40 - 60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 40</td>
<td>5-20</td>
<td>10-25</td>
<td>10-25</td>
<td>11-26</td>
<td>6 – 20</td>
<td>6 – 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 80</td>
<td>2-12</td>
<td>3-13</td>
<td>3-13</td>
<td>4-14</td>
<td>6 – 18</td>
<td>6 – 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 200</td>
<td>2 - 8</td>
<td>2 - 8</td>
<td>2 - 8</td>
<td>2 - 8</td>
<td>5 - 8</td>
<td>5 - 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

1. These mixtures shall be designed using a Texas Gyratory Compactor (TGC) and in accordance with Test Method Tex-204-F Design of Bituminous Mixtures. Design must be researched and based on intended use.
### Table 302.9.3.(b) Superpave Hot Mix¹ Master Grading

<table>
<thead>
<tr>
<th>Sieve Size, inches (centimeters)</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (5.08)</td>
<td>100.0</td>
</tr>
<tr>
<td>1 ½ (3.81)</td>
<td>90.0 – 100.0</td>
</tr>
<tr>
<td>1 (2.54)</td>
<td>90.0 – 100.0</td>
</tr>
<tr>
<td>¾ (1.90)</td>
<td>90.0 – 100.0</td>
</tr>
<tr>
<td>½ (1.27)</td>
<td>90.0 – 100.0</td>
</tr>
<tr>
<td>3/8 (0.95)</td>
<td>90.0 – 100.0</td>
</tr>
<tr>
<td>No. 4</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>15.0 - 41.0</td>
</tr>
<tr>
<td>No. 16</td>
<td>19.0 - 45.0</td>
</tr>
<tr>
<td>No. 30</td>
<td>23.0 - 49.0</td>
</tr>
<tr>
<td>No. 50</td>
<td>28.0 - 58.0</td>
</tr>
<tr>
<td>No. 100</td>
<td>32.0 - 67.0</td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>11</td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>12</td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>13</td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>14</td>
</tr>
<tr>
<td>VMA % minimum</td>
<td>15</td>
</tr>
</tbody>
</table>

1. These mixtures shall be designed using a Superpave Gyratory Compactor (SGC) and in accordance with the AASHTO Standard Practice for Designing Superpave Hot Mix Asphalt (PP28-99). Design must be researched and based on intended use.

### Table 302.9.3.(c) Superpave – Plant Produced Mixture Requirements

<table>
<thead>
<tr>
<th>VMA (MIN)</th>
<th>VFA</th>
<th>Dust/Asphalt Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0%</td>
<td>64 – 77 %</td>
<td>0.6 – 1.8 %</td>
</tr>
<tr>
<td>12.0%</td>
<td>67 – 77 %</td>
<td>0.6 – 1.6 %</td>
</tr>
<tr>
<td>13.0%</td>
<td>69 – 80 %</td>
<td>0.6 – 1.6 %</td>
</tr>
<tr>
<td>14.0%</td>
<td>71 – 80 %</td>
<td>0.6 – 1.6 %</td>
</tr>
<tr>
<td>15.0%</td>
<td>73 – 80 %</td>
<td>0.6 – 1.6 %</td>
</tr>
</tbody>
</table>
Table 302.9.3.(d) Cellulose Modified Mixtures Master Grading

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Stone Mastic Asphalt (SMA)</th>
<th>Permeable Friction Course (PFC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>¾”</td>
<td>½”</td>
</tr>
<tr>
<td>Coarse Surface</td>
<td>100.0</td>
<td>99.0-100.0</td>
</tr>
<tr>
<td>Fine Surface</td>
<td>70.0-85.0</td>
<td>70.0-90.0</td>
</tr>
<tr>
<td>No. 4</td>
<td>30.0-42.0</td>
<td>30.0-50.0</td>
</tr>
<tr>
<td>No. 8</td>
<td>20.0-33.0</td>
<td>20.0-30.0</td>
</tr>
<tr>
<td>No. 16</td>
<td>21.0 max</td>
<td>18.0 max</td>
</tr>
<tr>
<td>No. 30</td>
<td>20.0-33.0</td>
<td>20.0-30.0</td>
</tr>
<tr>
<td>No. 100</td>
<td>18.0 max</td>
<td>15.0 max</td>
</tr>
<tr>
<td>No. 200</td>
<td>8.0-11.0</td>
<td>8.0-12.0</td>
</tr>
</tbody>
</table>

1. These mixtures shall be designed using a Superpave Gyratory Compactor (SGC) and in accordance with the AASHTO Standard Practice for Designing Superpave Hot Mix Asphalt (PP28-99). Design must be researched and based on intended use.

Table 302.9.3.(e) Cellulose Modified Mixture Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stone Mastic Asphalt (SMA)</td>
</tr>
<tr>
<td>Air Voids, %</td>
<td>4.0 (Lab Molded)</td>
</tr>
<tr>
<td>Cellulose Fibers, %</td>
<td>0.4</td>
</tr>
<tr>
<td>VMA, Percent (Min.)</td>
<td>17.0 (Plant); 17.5 (Design)</td>
</tr>
<tr>
<td>VCA¹ (Mix), Percent</td>
<td>Less Than VCA (DRC)</td>
</tr>
<tr>
<td>TSR, Percent</td>
<td>80.0 Min. (Tex-531-C)</td>
</tr>
<tr>
<td>Draindown @ Production Temp., %</td>
<td>0.30 Max. (T305)</td>
</tr>
<tr>
<td>Asphalt Content, Percent</td>
<td>6.0 Min.</td>
</tr>
<tr>
<td>N(Des)</td>
<td>100</td>
</tr>
</tbody>
</table>

1. See NCHRP Report 425 for definition and calculation of VCA (Voids in Coarse Aggregate).

302.9.3.1. Extraction Test. When required by the CITY, samples of the asphaltic mixture may be taken from the plant, trucks or finished pavement for check tests. The minimum weight of the test specimen in grams shall be 3000 times the maximum size of aggregate in inches, and when tested in accordance with Recovery of Asphalt from Solution by Abson Method and Quantitative Extraction of Bitumen from Bituminous Paving Mixtures, ASTM Designations D1856 and D2172, respectively, it shall not vary from the grading proportions specified for the mixture being used by more than 5-percent.

302.9.3.2. Stability. The asphaltic mixture from the weight-batching plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in the TxDOT Test Method Tex-208-F Test for Stabilometer Value of Bituminous Mixtures, shall have the laboratory density and stability indicated in Table 302.9.3.(f) Asphalt Pavement Mixture Stability. If the mixture produced does not have the specified qualities, the mixture shall be changed until it conforms to the specified qualities.

Table 302.9.3.(f) Asphalt Pavement Mixture Stability

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (%)</td>
<td>96 ±1</td>
</tr>
<tr>
<td>Stability (%) Hveem Stabilometer</td>
<td>Unless otherwise shown on the plans,</td>
</tr>
<tr>
<td></td>
<td>Not less than 40 applied on arterials with truck traffic, and</td>
</tr>
<tr>
<td></td>
<td>Not less than 35 for residential applications</td>
</tr>
</tbody>
</table>

302.20
302.9.4. Equipment. All equipment necessary for the construction of the hot-mix asphalt pavement shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. All equipment shall be maintained in good repair and operating condition.

302.9.4.1. Bins. Bin storage shall be provided with tight cut-off gates to prevent leakage of aggregates or mineral filler into the weight box. The weight box for aggregates shall be of sufficient capacity to hold a complete batch of aggregates and mineral filler without wasting or leveling and shall be so designed that it shall quickly discharge the entire batch into the mixer. The weight box shall be provided with a close fitting and quick operating cut-off gate so that there shall be no leakage of the aggregates into the mixer and shall be satisfactorily attached to the batching scales.

302.9.4.2. Scales. Scales used for weighing different grades of mineral aggregates may be either the springless dial type or the multi-beam type. All scales must be a tare beam for balancing. The beam scales must also be equipped with a telltale indicator of the springless dial type indicating over-and-under loads of at least 50-pounds (23-kg). Scales shall be accurate within 4-pounds-per-1000-pounds (2-kg-per-454-kg). If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration.

302.9.4.3. Material Bucket. The asphaltic material bucket shall be of sufficient size to hold the necessary asphaltic material for one batch. If the material is measured by weight, the bucket shall be properly attached to the scales herein specified. If the proportioning is by volume based on weight, the measuring bucket used shall be of the overflow type and shall meet the requirements of the CITY.

302.9.4.4. Asphalt Storage. Asphalt storage shall be sufficient to meet the requirements of the plant. Asphalt in storage shall be heated by steam coils, absolutely tight to prevent leakage of moisture into the asphalt; the steam for heating shall not be at a temperature in excess of 400°F (204°C); direct fire heating of the asphalt shall not be permitted. Agitating asphalt with steam or air shall not be permitted.

302.9.4.5. Steam Heating Systems. The steam heating system shall insure the maintaining of the asphalt at a uniform draw-off temperature at the asphalt bucket of between 275°F and 375°F (135°C - 190°C). The temperature shall be maintained with an efficient positive control of heat at all times as directed or approved by the CITY. Asphalt heated beyond 375°F (190°C) either before or during mixing with the mineral aggregate shall be rejected. The draw-off at the asphalt bucket shall be of a quick cut-off type which shall not leak. The asphalt supply line shall be of circulating type, and equipped with a recording thermometer indicating the temperature of the asphalt at the draw-off valve. This thermometer may be combined with the one used in recording the temperature of the aggregate.

302.9.4.6. Weight Bucket. The asphalt weight bucket shall be of an approved type. The scales of weighing the asphalt shall be either the springless dial type or the multi-beam type. The dial type shall be arranged for rapid adjustment at zero and shall be provided with a pointer to indicate the weight of the asphalt required in one batch. The beam type shall have a tare beam for balancing and shall be equipped with a telltale indicator of the springless dial type. If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration. The asphalt shall be sprayed into the mixer through an approved spray bar that shall distribute the asphalt uniformly throughout the length of the mixer.

302.9.4.7. Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1,000-pounds (450-kg) in a single batch. The number of blades and their positions shall give a uniform and complete circulation of the batch. A mixer that segregates mineral aggregate or fails to secure a thorough and uniform mixing with the asphalt and mineral filler shall not be permitted to be used. The adequacy of the mixer to produce a successful mix shall be determined by mixing the standard batch for the required time, then dumping the batch, and taking samples from different parts of the batch; the samples shall be tested by the extraction test and shall show that the batch is uniform throughout.

All mixers shall be provided with an automatic time lock on the discharge gates of the mixer and the weigh box; and shall be locked for a period of 45-seconds after all the mineral aggregates have been introduced into the mixer. When discharged, the mixture shall have a temperature of 225°F to 350°F (107°C - 177°C). The dump doors of the mixer shall be tight to the dry mineral aggregate or dust so that there shall be no spilling from the pugmill or drum. In introducing the batch into the mixer, all mineral aggregates shall first be introduced. Aggregates shall be thoroughly mixed for a period of 5- to 10-seconds before the asphalt is added; then the total mixture shall be mixed for the time required to produce a homogeneous mixture, in which all particles of the aggregates are uniformly coated.

302.9.4.8. Spreading and Finishing Machine. The spreading and finishing machine shall be of a type approved by the CITY and capable of producing a surface that shall meet the requirements of the typical cross section and surface test.
302.9.4.9. **Rollers.** Rollers shall meet the governing specifications for Item 301.1.2. Rolling of Embankment, Subgrade or Flexible Base.

302.9.4.10. **Straightedges.** The **CONTRACTOR** shall provide acceptable 16-ft. (5m) straightedges for the surface testing. Satisfactory templates shall be provided as required by the **CITY.**

302.9.4.11. **Vehicles for Transporting Mixture.** Asphaltic concrete shall be transported from the plant to the site of the work in tight vehicles with metal bottoms previously cleaned of all foregoing substances. The **CITY** may require that the vehicles be suitably insulated, and each load shall be covered with canvas or other suitable material of sufficient size to protect the asphaltic concrete from the weather and to prevent loss of material.

302.9.5. **Mixing Plants.** Mixing plants may be either the weight-batching plant, the continuous mixing type plant or the drum mixing type plant as hereinafter described. All types of plants shall be equipped with satisfactory conveyors, power units, aggregates handling equipment, hot-aggregates screens and bins and dust collectors.

Temporary storing or holding of the asphaltic mixture by a surge-storage system is permitted during the normal day's operation. Overnight storage shall not be permitted.

302.9.5.1. **Weight Batching Plant.** The proportioning of the various materials entering into the asphaltic mixture shall be as approved or directed by the **CITY.** The **CITY** shall have access at all times to all parts of the paving plant. The plant shall be of the batch type provided with separate storage bins and chambers for heating and mixing the materials.

The various sizes of mineral aggregates as received shall be stored or stockpiled separately, and the feeding of all sizes of mineral aggregates to the dryer shall be done by mechanical means that shall give a uniform and continuous feed to each of the sizes incorporated in order to give a control of the temperature and grading of the mineral aggregates.

The drying of the mineral aggregates shall be done in such a manner that the finer particles shall not escape with the furnace gases. If forced draft is used, a dust collector system shall be installed. If natural draft is used, the **CITY** may require a dust collector system to prevent loss of the finer particles. The aggregate shall be heated in a suitable apparatus that continuously agitates the aggregate during the heating and in which the temperature can be efficiently and positively controlled so that the aggregates shall not be damaged and the mixture produced shall have a temperature between 225°F and 350°F (107°C and 177°C).

A recording thermometer shall be provided which shall record the temperature of the aggregates as they leave the dryer. The recording thermometer shall be provided with a 24-hour chart and may be so equipped that it shall record both the temperature of the aggregates and the temperature of the asphalt incorporated into the batch. The drying apparatus shall be of sufficient size to dry and heat the amount of aggregates required to maintain the plant in continuous operation.

The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregates required to properly operate the plant and keep the plant in continuous operation at full capacity. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregates shall be separated into at least four bins when producing Type “B” mixtures and at least three bins when producing Type “D” mixtures. If mineral filler is needed, an additional bin shall be provided. These bins shall contain the sizes of aggregates as shown in Table 302.9.3.(a) Dense Graded Hot Mix Master Grading.

302.9.5.2. **Continuous Mixing Plant.** Cold-aggregates bin and proportioning devices, dryer, and screening and proportioning shall conform to the requirements hereinabove for the weight-batching type of plant. The hot-aggregates proportioning device shall be so designed that when properly operated, a uniform and continuous flow of aggregates into the mixer shall be maintained.

An accurate asphaltic material meter shall be installed in the asphalt line leading to the spray bar, so that the amount of asphalt being used can be accurately determined. The asphaltic material spray bar shall be so designed that the asphalt shall be uniformly and continuously sprayed into the mixture.

The mixer shall be of the pugmill continuous type and shall have a capacity of not less than 40-tons-perhour (1,450-metric-tons-per-hour) of mixture. Any mixer that segregates the aggregates or fails to secure a thorough and uniform mixing of the aggregates or fails to secure a thorough and uniform mixing of the aggregates with the asphaltic material shall not be used. This shall be determined by taking samples from different parts of a truckload and testing by the extraction test. These tests must show that the load is uniform throughout.

The amount of aggregates and asphaltic material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and asphalt content shall be produced. The mixture shall not vary from the specified mixture by more than the specified tolerances.
The asphaltic mixture shall be at a temperature of between 225°F and 350°F (107°C and 177°C) when dumped from the mixer. The CITY shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this determined temperature and 30°F (17°C) higher.

302.9.5.3. Drum Mixing Plant. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt in the drum mixer. The plant shall be equipped with satisfactory conveyors, power units, aggregates-handling equipment and feed controls and shall consist of the following essential pieces of equipment.

The number of compartments in the cold-aggregates bin shall be equal to or greater than the number of stockpiles of individual materials to be used. The bin shall be of sufficient size to store the amount of aggregates required to keep the plant in continuous operation and of proper design to prevent overflow of material from one compartment to another. The feed system shall provide a uniform and continuous flow of aggregates in the desired proportion to the drum mixer.

A surge-storage system shall be required. It shall be adequate to minimize the production interruptions during the normal day’s operations and shall be constructed to minimize segregation. A device such as gob hopper or other similar device approved by the CITY to prevent segregation in the surge-storage bin shall be required.

The system shall provide positive weight measurement of the combined cold-aggregates feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 302.9.4. Equipment. When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50-percent and 100-percent of its rated capacity. Belt scale operation below 50-percent of the rated capacity may be allowed by the CITY if accuracy checks show the scale to meet the requirements of Item 302.9.4. Equipment at the selected rate, and it can be satisfactorily demonstrated to the CITY that the mixture uniformity and quality have not been adversely affected.

An asphaltic material measuring device meeting the requirements of Item 302.9.4. Equipment shall be placed in the asphalt line leading to the drum mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of measuring device output. The asphalt measuring device and line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and measuring device near the temperature specified for the asphaltic material. Unless otherwise shown on the plans, the temperature of the asphaltic material entering the measuring device shall be maintained at ±10°F (±5.5°C) of the temperature at which the asphalt measuring device was calibrated and set.

The asphaltic material feed-control shall be coupled with the total aggregate weight measuring device in such manner as to automatically vary the asphalt-feed rate as required to maintain the required proportion. A scalping screen shall be required, unless otherwise shown on the plans, and shall be located ahead of any weighing device.

The asphaltic mixture shall be at a temperature of between 225°F and 350°F (107°C and 177°C) when dumped from the mixer. The CITY shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this lowest determined temperature and 30°F (17°C) higher. The drum mix system shall be of the type that continually agitates the aggregates and asphalt mixture during heating and in which the temperature can be so controlled that aggregates and asphalt shall not be damaged in the necessary drying and heating operations required to obtain a mixture of the specified temperature. A continuously recording thermometer shall be provided which shall indicate the temperature of the mixture as it leaves the drum mixer.

Scales may be standard platform truck scales, belt scales or other equipment such as weigh hopper (suspended) scales approved by the CITY. All scales shall conform to Item 302.9.4. Equipment. If truck scales are used, they shall be placed at a location approved by the CITY. If other weighing equipment is used, the CITY may require weight checks by truck scales for the basis of approval of the equipment.

302.9.5.4. Special Instructions for Cellulose Fiber. A separate dry storage area or silo shall be required for cellulose fiber. All equipment used in the storage and handling of cellulose fibers shall be kept a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

Cellulose fibers shall be added at 0.3% ±0.1 % by mass of the mixture. Drainage shall be tested according to Tex-235-F Determination of Draindown Characteristics in Bituminous Materials. Draindown shall not exceed 0.3%-per-hour.
The cellulose fiber feed system shall supply the proper amount of cellulose fiber to the weigh box. Feeding of the cellulose fiber shall be performed in a manner such that the fibers are not damaged during the feeding and mixing processes and in a manner such that a uniform and constant flow of materials in the required proportions is maintained. The cellulose fiber storage capacity shall be ample to meet the requirements of the plant. Cellulose fiber shall not be allowed in the hot bins.

Mixing system shall control temperature so that the cellulose fiber will not be damaged in drying, heating and mixing operations.

302.9.5.4.1. Weight Batching Plant. Cellulose fiber shall be introduced into the pugmill during the dry mixing of the aggregates, prior to injection of the asphalt.

In introducing the batch into the mixer, all aggregates and then all cellulose fiber shall be introduced first and shall be mixed thoroughly for a minimum period of 5-seconds to uniformly distribute the various sizes of the aggregate and cellulose fiber throughout the batch before asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15-seconds. The mixing period shall be increased if, in the opinion of the Engineer, the mixture is not uniform or the aggregates are not properly coated.

302.9.5.4.2. Continuous Mixing Plant. The mixing requirements shall be the same as is required for a standard Weigh-Batch Plant.

302.9.5.4.3. Drum-Mix Plant. Cellulose fiber shall be added to the mixture during the dry mixing process, unless otherwise approved by the Engineer. Cellulose fiber shall be uniformly dispersed in the mixture. The amount of aggregate, cellulose fiber and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading, cellulose fiber content and asphalt content is produced.


The prime coat, tack coat or the asphaltic mixture shall not be placed when the air temperature is below 50°F (10°C) and is falling but may be placed when the air temperature is above 40°F (5°C) and is rising, the temperature being taken in the shade and away from artificial heat; with the provision that the asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the CITY, are suitable.

302.9.6.1. Prime Coat. If required, a prime coat shall be applied to the completed subgrade, subbase or base, in accordance with Item 302.7. Prime Coat. The type and grade of asphaltic material and the application rate shall be as shown on the plans or as directed by the CITY.

302.9.6.2. Tack Coat. A tack coat shall be applied when the surface to be paved is Portland cement concrete, brick or asphaltic pavement. When a tack coat is required, it shall consist of an application of the asphaltic material indicated and shall be at the rate specified on the plans or as directed by the CITY, but not to exceed 1/10 (0.10) gallons-per-square-yard (0.5-L-per-m²) of surface area. The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphaltic mixes shall be painted with a thin, complete coating of asphaltic material to provide a closely bonded, watertight joint.

302.9.6.3. Compacted Thickness of Hot-Mix Asphalt Pavement Surface Courses and Base Courses.

302.9.6.3.1. Base Courses. The compacted thickness or depth of each base course shall be as shown on the plans. Where the plans require a depth or thickness of the course greater than 4-in. (10cm), same shall be accomplished by constructing multiple lifts of approximately equal depth, each of which shall not exceed 4-in. (10cm) compacted depth. If, in the opinion of the CITY, an additional tack coat is considered necessary between any of the multiple lifts, it shall be applied as in Item 302.9.6.2. Tack Coat and at the rate as directed.

302.9.6.3.2. Surface Courses. The compacted thickness or depth of the asphalt pavement surface course shall be as shown on the plans. Where the plans require a depth or thickness of the surface course greater than 2-in. (5cm) compacted depth, same shall be placed in multiple courses of equal depth, each of which shall not exceed 2-in. (5cm) compacted depth. If, in the opinion of the CITY, an additional tack coat is considered necessary between any of the multiple courses, it shall be applied as in Item 302.9.6.2. Tack Coat and at the rate as directed.

302.9.6.4. Transporting Hot-Mix Asphalt Pavement Material. The mixture shall be hauled to the job site in tight vehicles previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered shall be placed and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers may be required. The inside of the truck body may be given a light coating of an approved release agent, if necessary, to prevent the mixture from adhering to the body.

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302.9.6.5. **Temperature.** The hot-mix asphalt mixture shall be at a temperature between 275° and 350°F (135° to 177°C) when dumped from the mixer. The CITY shall determine the temperature, within the above limitations. The mixture when dumped from the mixer shall not vary from this selected temperature more than 30°F (17°C). Restrictions on maximum mixture temperatures placed by environmental regulatory agencies supersede the maximum temperature listed above.

302.9.6.6. **Placing.** The hot-mix asphalt mixture shall be placed on the approved base course with the specified spreading and finishing machine in such manner that, when properly compacted, the finished course shall comply with the maximum thickness requirements, be smooth and of uniform density, and meet the requirements of the typical cross sections and the surface test. During the placing and spreading of the hot-mix asphalt material, care shall be taken to prevent the spilling of the material onto adjacent pavement, gutters or structures. In small areas, which are inaccessible to the spreading and finishing machine, hand spreading may be authorized by the CITY, provided an acceptable surface can be obtained.

302.9.6.7. **Compaction.** Rolling with the 3-wheel and tandem roller shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Rolling with the pneumatic tire roller shall be done as directed by the CITY. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic surface material. If displacement should occur, it shall be corrected at once by the use of rakes and fresh asphaltic mixtures where required. The roller shall not be allowed to stand on the surface course when it has not been fully compacted and allowed to cool. To prevent adhesion of the surface course to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted. All rollers must be in good mechanical condition. All necessary precautions shall be taken to prevent the dripping of gasoline, oil, grease or other foreign matter on the surface course while the rollers are in motion or when standing. In areas where the surface course cannot be compacted with the rollers, hand tamps, lightly oiled, shall be used to secure the required compaction.

With approval by the CITY, the vibratory steel wheel roller may be substituted for the 3-wheel roller and tandem roller. Each course, after final compaction, shall have a relative density of not less than 92-percent. The relative density will be determined using Tex-207-F Determining Density of Compacted Bituminous Mixtures and Tex-227-F Theoretical Maximum Specific Gravity of Bituminous Mixtures.

302.9.6.8. **Surface Tests.** The finished surface of the pavement after compression shall be smooth and true to the established line, grade and cross section. When tested with a 16-ft. (5m) straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of $\frac{1}{16}$-in-per-foot (5-mmper-m) from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed ¼-in. (6mm) at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

302.9.6.9. **Pavement Thickness Test.** Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the CITY or its authorized representative unless otherwise specified in the special provisions or in the plans. The number and location of tests shall be at the discretion of the CITY. The cost for the initial pavement thickness test shall be at the expense of the CITY. In the event a deficiency in thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the CONTRACTOR’S expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.
ITEM 303. PORTLAND CEMENT CONCRETE PAVEMENT

303.1. DESCRIPTION
This item shall consist of finished pavement constructed of Portland cement concrete on the prepared subgrade or other base course, in conformity with the plans, as herein specified and as supplemented and/or amended by special provisions and to the lines and grades as established by the CITY. Concrete shall be considered of satisfactory quality, provided it is:

1. Made of materials acceptable to the job and meeting the requirements of Item 303.2. Portland Cement Concrete Materials and special provisions and amendments thereto;
2. In the proportions approved by the CITY; and
3. Mixed, placed, finished and cured in accordance with the requirements of these specifications and any special provisions.

303.2. PORTLAND CEMENT CONCRETE PAVEMENT MATERIALS

303.2.1. Aggregates for Portland Cement Concrete Pavement.

303.2.1.1. General Requirements.
Aggregates for Portland cement concrete shall conform to the requirements contained in this Item and shall be approved by the CITY prior to use. Aggregates shall be of such character that it shall be possible to produce workable concrete within the limits contained in this specification.

303.2.1.1.1. Storage.
The manner of handling and storage of aggregates shall be such as to prevent intrusion of foreign materials and segregation of sizes. If materials are stored on the ground, the stockpile sites shall be grubbed, cleaned of all vegetation and leveled. In this case, the bottom six-in. layer of aggregate shall not be disturbed and shall not be used in the work.

Where two or more sizes or types of aggregates are delivered to the job, each size or type shall be stored separately.

Aggregates shall be stockpiled on the job or at a central batching plant for a minimum of 24-hours prior to use in the project. At the plant, the aggregate shall be wetted to a uniform moisture content of not less than three-percent below saturated surface dry condition before or while being loaded for shipment. Care shall be exercised to maintain this uniformity of moisture until the aggregates are used in the mix. Wetting of stockpiles to maintain the required percent moisture shall be performed at least 12-hours prior to use.

At the time of use, the aggregates shall be free from frozen material and foreign matter. All grass, wood, sticks, burlap, paper or other material which may have become mixed with the aggregates while stockpiled or in handling must be removed.

303.2.1.1.2. Aggregate Measuring.
The fine and coarse aggregates shall be measured loose and separately.

By Weight. Aggregate weighing equipment shall conform to the requirements of ASTM C94 Standard Specification for Ready-Mixed Concrete and shall be approved by the CITY prior to use.

By Volume. The volume measuring equipment shall consist of approved boxes, pans or mechanical devices, which, while in operation, shall give the required volumes of the different kinds of aggregates required for the several classes of concrete. Equipment shall also be so marked and designed that the CITY can accurately and conveniently check the quantities of each aggregate being used.

Concrete made by continuous mixing shall conform to ASTM C685 Concrete Made by Volumetric Batching and Continuous Mixing.

303.2.1.1.3. Tests. Test of aggregates shall be made in accordance with the applicable current ASTM standards, listed in Table 303.2.1.1.3.(a) Aggregate Tests.
### Table 303.2.1.1.3.(a) Aggregate Tests

<table>
<thead>
<tr>
<th>ASTM Designation</th>
<th>Standard Specification or Standard Test Method (Title)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C29</td>
<td>Bulk Density (“Unit Weight”) and Voids in Aggregate</td>
</tr>
<tr>
<td>C33</td>
<td>Concrete Aggregates</td>
</tr>
<tr>
<td>C40</td>
<td>Organic Impurities in Fine Aggregates for Concrete</td>
</tr>
<tr>
<td>C88</td>
<td>Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate</td>
</tr>
<tr>
<td>C123</td>
<td>Lightweight Particles in Aggregate</td>
</tr>
<tr>
<td>C125</td>
<td>Terminology Relating to Concrete and Concrete Aggregates</td>
</tr>
<tr>
<td>C127</td>
<td>Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate</td>
</tr>
<tr>
<td>C128</td>
<td>Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate</td>
</tr>
<tr>
<td>C131</td>
<td>Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine</td>
</tr>
<tr>
<td>C136</td>
<td>Sieve Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>C142</td>
<td>Clay Lumps and Friable Particles in Aggregates</td>
</tr>
<tr>
<td>C330</td>
<td>Lightweight Aggregates for Structural Concrete</td>
</tr>
<tr>
<td>C535</td>
<td>Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine</td>
</tr>
<tr>
<td>C641</td>
<td>Staining Materials in Lightweight Concrete Aggregates</td>
</tr>
<tr>
<td>D8</td>
<td>Terminology Relating to Materials for Roads and Pavements</td>
</tr>
<tr>
<td>D75</td>
<td>Sampling Aggregates</td>
</tr>
<tr>
<td>D422</td>
<td>Particle-Size Analysis of Soils</td>
</tr>
<tr>
<td>D4318</td>
<td>Liquid Limit, Plastic Limit, and Plasticity Index of Soils</td>
</tr>
<tr>
<td>D2217</td>
<td>Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants</td>
</tr>
</tbody>
</table>

### 303.2.1.2. Fine Aggregates

Fine aggregate shall consist of natural sand, manufactured sand or a combination of the two, with or without mineral filler. The sand, or mixture of sand, comprising a single fine aggregate, shall consist of clean, hard, durable, uncoated grains and shall be essentially free from clay lumps.

### 303.2.1.2.1. Foreign Material and Deleterious Substances

The maximum permissible percentage, by weight, of deleterious substances shall not exceed the amounts in Table 303.2.1.2.1.(a) Deleterious Substances in Fine Aggregates.

The fine aggregate shall be free from an excess amount of salt or alkali and at the time of use shall be free from frozen and/or all foreign material.

#### Table 303.2.1.2.1.(a) Deleterious Substances in Fine Aggregates

<table>
<thead>
<tr>
<th>Substance</th>
<th>Maximum % by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material removed by decantation</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other deleterious substances such as coal, shale, coated grains and soft flaky particles</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

1. An additional loss of two-percent by decantation may be allowed, provided this new additional loss is material of the same quality as specified for fine aggregate or mineral filler.
303.2.1.2.2. Gradation. The fine aggregate shall be well graded from fine to coarse and when tested by standard laboratory sieves shall meet the requirements of Table 303.2.1.2.2.(a) Grading Requirements for Fine Aggregates.

Table 303.2.1.2.2.(a) Grading Requirements for Fine Aggregates

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>--in. sieve (9.5mm)</td>
<td>100%</td>
</tr>
<tr>
<td>No. 4 sieve (4.75mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>No. 8 sieve (2.36mm)</td>
<td>80 to 100%</td>
</tr>
<tr>
<td>No. 16 sieve (1.18mm)</td>
<td>50 to 85%</td>
</tr>
<tr>
<td>No. 30 sieve (600um)</td>
<td>25 to 65%</td>
</tr>
<tr>
<td>No. 50 sieve (300um)</td>
<td>10 to 30%</td>
</tr>
<tr>
<td>No. 100 sieve (150um)</td>
<td>0 to 10%</td>
</tr>
<tr>
<td>No. 200 sieve (75um)</td>
<td>0 to 3%</td>
</tr>
</tbody>
</table>

303.2.1.2.3. Mineral Filler. Stone dust or crushed sand may be added as a mineral filler, if so directed by the CITY. Amounts of mineral filler shall not exceed 5-percent of the fine aggregate to improve the workability or quality specified for fine or coarse aggregates. When tested by standard laboratory sieves shall meet the requirements of Table 303.2.1.2.3.(a) Fine Aggregate Mineral Filler.

Table 303.2.1.2.3.(a) Fine Aggregate Mineral Filler

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 30 sieve (600um)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>No. 100 sieve (150 um)</td>
<td>70 to 100%</td>
</tr>
</tbody>
</table>

303.2.1.2.4. Rejection. Fine aggregates which fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY.

Fine aggregates sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the CITY. Such rejection shall incur no cost to the CITY.

303.2.1.3. Coarse Aggregates. Coarse aggregates shall consist of durable particles of crushed gravel, crushed stone, crushed blast furnace slag meeting the requirements of ASTM C989 (Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars) Grade 100 or 120, recycled crushed Portland cement concrete, or a combination of these.

303.2.1.3.1. Foreign Material and Deleterious Substances. The maximum permissible percentage, by weight, of deleterious substances shall not exceed the amounts in Table 303.2.1.3.1.(a) Deleterious Substances in Coarse Aggregates.

Aggregates shall be free from injurious amounts of salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. At the time of their use, aggregates shall be free from frozen and/or all foreign material that may have become mixed with them in the stockpile.

Table 303.2.1.3.1.(a) Deleterious Substances in Coarse Aggregates

<table>
<thead>
<tr>
<th>Substance</th>
<th>Maximum % by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material removed by decantation</td>
<td>1.0%</td>
</tr>
<tr>
<td>Shale, slate or other similar material</td>
<td>1.0%</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>0.25%</td>
</tr>
<tr>
<td>Soft fragments</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other deleterious substances, including friable, thin, elongated or laminated pieces</td>
<td>3.0%</td>
</tr>
<tr>
<td>The sum of all deleterious substances, exclusive of material removed by decantation</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

303.2.1.3.2. Gradation. Coarse aggregates shall be well graded in size from coarse to fine. When tested by standard laboratory methods, coarse aggregates shall meet the requirements in Table 303.2.1.3.2.(a) Grading Requirements for Coarse Aggregates for percentage passing each sieve by weight.
Coarse aggregates of different characteristics, though tested and approved, shall not be mixed with other aggregates; but shall be stored, batched and weighed separately.

The difference in percent passing between two adjacent sieve sizes shall not exceed 20%.

Maximum Size Aggregate. The maximum size aggregate is defined as the clear space between the sides of the smallest square openings through which 95-percent of the weight of the aggregate can be passed. The maximum size of aggregates for paving concrete shall not exceed 1½-inches, and shall be reduced in size to meet the following conditions:

1. one-fifth of the least dimension between forms of that part of the structure in which concrete is to be placed;
2. three-fourths of the clear space between reinforcement; and
3. one-third the depth of the slab.

### Table 303.2.1.3.2.(a) Grading Requirements for Coarse Aggregates

<table>
<thead>
<tr>
<th>Size No.</th>
<th>Nominal Size (Sieve with Square Openings)</th>
<th>100 mm (4 in)</th>
<th>90 mm (3½ in.)</th>
<th>75 mm (3 in.)</th>
<th>63 mm (2½ in.)</th>
<th>50 mm (2 in.)</th>
<th>37.5 mm (1½ in.)</th>
<th>25.0 mm (1 in.)</th>
<th>19.0 mm (¾ in.)</th>
<th>12.5 mm (½ in.)</th>
<th>9.5 mm (⅜ in.)</th>
<th>4.75 mm (⅞ in.)</th>
<th>2.36 mm (No. 4)</th>
<th>1.18 mm (No. 8)</th>
<th>0.30 mm (No. 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90 to 37.5 mm (3½ to 1½ in.)</td>
<td>100</td>
<td>90</td>
<td>25 to 60</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>63 to 37.5 mm (2½ to 1½ in.)</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>50 to 25.0 mm (2 in.)</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>37.5 to 19.0 mm (1½ to ¾ in.)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>25.0 to 12.5 mm (1 to ½ in.)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>19.0 to 9.5 mm (½ in. to No. 4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>12.5 to 4.75 mm (¾ in. to No. 16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>9.5 to 2.36 mm (No. 8)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>4.75 to 1.18 mm (No. 16)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>90 to 35</td>
<td>0 to 15</td>
<td>0 to 5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. Although size 9 aggregate is defined in ASTM C125 Standard Terminology Relating to Concrete and Concrete Aggregates as a fine aggregate, it is included as a course aggregate when it is combined with a size 8 material to create a size 89, which is a course aggregate as defined by ASTM C125.

303.2.1.3.3. Tests. Results of tests performed according to the applicable standard test methods listed in Table 303.2.1.1.3.(a) Aggregate Tests shall meet the criteria specified by the CITY. Coarse Aggregates shall have a percent wear of not more than 45 when tested by abrasion and impact in the Los Angeles machine, ASTM C131 and C535.

303.2.1.3.4. Rejection. Coarse aggregates which fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY.

Coarse aggregate sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the CITY. Such rejection shall incur no cost to the CITY.

303.2.2. Portland Cement. Cement shall be either Type I, II, III or Type IP (ASTM C595 Blended Hydraulic Cements), of a standard brand of Portland cement which shall conform to the requirements of ASTM C150 Portland Cement, or other applicable test methods of the ASTM.

303.2.2.1. Delivery. Cement delivered in bags shall be legibly marked on the bag with brand and name of the manufacturer, shall be in good condition at the time of delivery, and shall contain 94-pounds (43kg) net. Bags of cement varying more than 5-percent from the specified weight may be rejected, and if the average net weight in any shipment, as determined by weighing 50 bags taken at random, is less than 94-pounds (43kg), the entire shipment may be rejected. Cement salvaged from discarded or used bags shall not be used.

Cement delivered in bulk may be used, provided the manner and method of handling is approved by the CITY. When delivered in bulk, the brand name of the manufacturer contained in the shipping information...
accompanying the shipment shall be furnished to the CITY prior to the use of the cement. Bulk cement shall be weighed on approved scales.

Cement from different manufacturers, although tested and approved, shall not be mixed, except as approved by the CITY.

The CONTRACTOR, when required, shall furnish to the CITY, with each shipment of cement, a statement as to the specific surface of the cement expressed in square-centimeters-per-gram.

303.2.2.2. Cement Weighing Equipment. Bulk cement shall be batched by weight. The scales shall be either the beam or springless dial type, of substantial construction with a maximum allowable error of 0.5-percent of the net load and with minimum gradations of not greater than 5-pounds (2.5kg). Provisions shall be made for indicating to the operator that the required load in the weigh box or container is being approached, which device shall indicate at least the last 50-pounds (23kg) of the load. Dial type scales shall be provided with a pointer to the dial.

When a closed-type cement box is used, the cement-weighing scales shall be provided with a springless dial indicator or tare beam to indicate when the weigh box is empty. This indicator for the empty condition of the weigh box shall be in continuous operation. The weigh box shall be fitted with an approved vent and a tightly covered inspection opening of not less than 12-sq.in. (77-cm²). The weigh box and scales shall be maintained in a satisfactory condition to meet the requirements for accuracy for weight.

303.2.2.3. Volume and Weight of Bag of Cement. A bag of cement as packed by the manufacturer and weighing 94-pounds (43kg) shall be considered 1-cubic-foot (0.28m³).

303.2.2.4. Storage. Cement shall be stored in a suitable weathertight building which shall protect the cement from dampness, and placed in such manner that shall permit easy access for proper inspection and identification of each shipment.

303.2.2.5. Rejection. Cement may be rejected for failure to meet any of the requirements of this specification and shall be rejected under the following specific conditions:

1. any bag of cement which has partially set or which contains any lumps or cakes;
2. all cement salvaged from torn, discarded or used bags; or
3. bulk cement which has partially set or which contains any lumps or cakes.

303.2.3. Chemical Admixtures. Unless otherwise provided in the plans or special provisions, approved types of chemical admixtures to minimize segregation, to improve workability or to reduce the amount of mixing water may be used in the rate of dosage specified by the CITY and in accordance with the manufacturer’s recommendations.

Admixtures shall be dispensed in a form by an accurate mechanical dispenser designed for convenient confirmation of the accuracy of measurement. Dispensers shall have sufficient capacity to measure at one time the full quantity required for each batch. Two or more admixtures of different types, such as a water-reducing and air-entraining admixture, may not be compatible when mixed together. Where different admixtures are used, they should be added to the batch separately unless it is known that they can be mixed together satisfactorily. Dosage of admixtures shall not vary from the dosage order by the CITY by more than 5-percent. In addition:

1. Chemical admixtures shall conform to ASTM C494 Chemical Admixtures for Concrete, Types “A”, “D,” “F” and “G” for concrete dosages in accordance with manufacturer’s recommendations as specified by the CITY.

   Water-reducing admixtures conforming to ASTM C494, Types “A” and “F”, shall be used to improve quality of concrete by obtaining specified strength at lower cement content and to increase slump without increasing water-cement ratio and may also be utilized in improving properties of concrete containing aggregates that are harsh or poorly graded.

   Water-reducing, set retarding admixtures, conforming to ASTM C494, Type “D” and “G”, may be used during hot weather concrete placement, so as to keep concrete workable during the entire placing period, in order that succeeding placements may be made without development of cold joints or discontinuities in the structural unit.

2. CITY’S option: High range water-reducing admixtures, super-plasticizers conforming to ASTM C494, Type “F” and “G”, may be used to greatly reduce water content to obtain dense concrete with higher early strengths and maintain high slump or flowing concrete while maintaining low water-cement ratio for concrete that must be placed under difficult conditions such as pump or tremie methods, etc.

3. Air-entraining admixtures shall conform to ASTM C260 Air-Entraining Admixtures for Concrete. Dosage shall conform to recommendations of manufacturer, as specified by CITY, and determined by field testing of concrete mixture by qualified testing personnel in accordance with ASTM C94 Ready-Mixed Concrete. The CONTRACTOR shall secure the approval of the CITY for the particular admixture which it proposes to incorporate into the concrete prior to actual use of the admixture. The CONTRACTOR shall furnish such information

303.5
and evidence that the CITY may require in its determination of the acceptability of the proposed admixture. When the CONTRACTOR proposes to use an air-entraining admixture which has been previously approved by the CITY, it shall submit a certification stating that the admixture is the same as that previously approved.

Either prior to or at any time during construction, the CITY may require that the air-entraining admixture selected by the CONTRACTOR be tested to determine its effect upon the strength of the concrete. When so tested, a 7-day compressive strength of concrete, made with cement and aggregates in proportions to be used in the work and containing the admixture in an amount sufficient to produce from 3- to 6-percent entrained air in the plastic concrete, shall be no less than 85-percent of the strength of concrete, made with the same materials and with the same cement content and consistency but without the admixture.

Any other admixtures for whatever purpose shall have the approval of the CITY prior to incorporation into the concrete mix.

**303.2.4. Mineral Admixtures.** Fly ash shall conform to the requirements of ASTM C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete, with the exception that the “Loss on Ignition” requirements shall be a maximum of 3-percent. Fly ash shall be sampled and tested at a frequency schedule in accordance with the requirements of ASTM C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete. All sources of fly ash for use in Portland cement concrete shall conform to the requirements of Texas Department of Transportation (TxDOT) Material Specification DMS-8900 Fly Ash.

With the approval of the CITY, fly ash may be used in all classes of concrete to replace a portion of the Portland cement in a mix design. Unless otherwise approved by the CITY, the maximum cement reduction shall not exceed 25-percent by weight per cubic-yard of concrete. If historical data and general practice in locality of usage substantiates fly ash concrete using higher percentages, CONTRACTOR may submit written request to CITY for review. Fly ash replacement shall be on a weight basis. The minimum replacement ratio shall be 1.0-pounds of fly ash per 1.0-pounds (1 kg-per-1 kg) of cement replaced.

The water-cement ratio of the concrete mix shall be based on total cementitious (cement plus fly ash) materials. Proposed concrete mix designs with materials certification data and laboratory or field mix test results on the properties of the fresh or hardened concrete shall be submitted to the CITY for approval.

**303.2.5. Mineral Filler.** Mineral filler shall consist of stone dust, crushed sand or other inert material approved by the CITY. Mineral filler may be added in amounts not to exceed 10-percent of the weight of the sand or mixture of sands to improve the workability or plasticity of the concrete mix. Such mineral filler shall be of the quality specified for fine or coarse aggregate, and when tested by laboratory methods shall meet the requirements of Table 303.2.5(a) Mineral Filler.

Where mineral filler is used, it shall be measured by volume or weighed andbatched separately.

<table>
<thead>
<tr>
<th>Table 303.2.5(a) Mineral Filler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve</strong></td>
</tr>
<tr>
<td>No. 30 sieve (600um)</td>
</tr>
<tr>
<td>No. 200 (75 um)</td>
</tr>
</tbody>
</table>

**303.2.6. Fibrous Reinforcement.** At the CITY’s option, fibrous reinforcement in concrete may be used unless otherwise shown on the plans or in the contract documents. Fibrous reinforcement shall not be used as a replacement for any reinforcement required for structural purposes.

**303.2.6.1. Material.** Fibers for reinforcement of concrete shall be in accordance with materials specified in ASTM C1116 Fiber-Reinforced Concrete and Shotcrete.

**303.2.6.2. Length and Size.** The fibers shall be length and size as specified in ASTM C1116.

**303.2.6.3. Testing.** Test methods ASTM C995 Time of Flow of Fiber-Reinforced Concrete Through Inverted Slump Cone, and ASTM C1018 Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading) in addition to applicable ASTM methods for the testing of concrete shall be used to test the fiber-reinforced concrete. Performance of fiber-reinforced concrete shall meet all requirements as specified in Section 21 of ASTM C1116.

**303.2.6.4. Rejection.** Fibrous reinforcement or fiber-reinforced concrete may be rejected for failure to meet any of the requirements of this specification or ASTM C1116.

**303.2.7. Water.** Water for use in concrete shall be reasonably clean and free of oil, acid, alkali, organic matter or other deleterious substances. Water which is suitable for drinking or ordinary household uses may be accepted for use without being tested.
303.2.7.1. **Source.** Water shall be obtained preferably from a domestic water supply. Where other source of supply is proposed, the approval of the CITY must be obtained prior to using the water.

303.2.7.2. **Measuring Devices.** The device for measuring the quantity of water shall indicate the quantity in gallons or pounds and fractions thereof. The operating mechanism shall regulate the quantity required for any given batch within one(1)-percent. The supply inlet shall be cut off automatically when the water is discharged into the mixer.

Upon approval of the CITY, the water for any one batch in the mixer may be measured in approved cans, buckets or other containers, and no more than the required amount of water shall be introduced into the mixer. The measuring devices shall be checked at the beginning of each job.

303.2.7.3. **Tests.** If the water is of questionable quality, it shall be tested in accordance with the standard Method of Test of Quality of Water to be used in concrete, AASHTO T26.

303.2.7.4. **Rejection.** Water for use with cement may be rejected for failure to meet any of the requirements of this specification.

303.2.8. **Dowel Bars.** Dowel and tie bars shall be either straight or bent, smooth or deformed, as shown on the plans and shall conform to the requirements of Item 303.2.9. Steel Reinforcement. The dowel bars shall be coated with either hot asphalt or an alternate coating, as designated on the plans, to the extent shown on the plans.

303.2.8.1. **Dowel Caps.** Caps for slip dowel bars shall be of the length shown on the plans and shall have an internal diameter sufficient to permit the cap to freely slip over the bar. In no case shall the internal diameter exceed the bar diameter by more than ~-in. (0.3cm), and one end of the cap shall be rightly closed. The cap shall be installed to allow the bar to move not less than 1¼-in. (3cm) in either direction.

303.2.9. **Steel Reinforcement.** Concrete reinforcement is the metal (rods or fabric) imbedded in concrete in such a manner that the reinforcement and concrete act together in resisting forces.

303.2.9.1. **Material.** Unless otherwise specified or designated on the plans, the metal for all bar reinforcement shall be one of the following:

- **303.2.9.1.1. New billet steel.** New billet steel shall meet the requirements of ASTM A615/A615M Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- **303.2.9.1.2. Axle steel.** Axle steel shall meet the requirements of ASTM A996/A996M Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
- **303.2.9.1.3. Rail steel.** Axle steel shall meet the requirements of ASTM A996/A996M Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

The use of rail steel or axle steel shall not be permitted where bending of the bar is required.

Unless otherwise designated on the plans, all reinforcement steel bars shall be deformed in accordance with the requirements of ASTM A615/A615M or A996/A996M, as appropriate. Twisted bars are not considered deformed and shall not be used. The deformed bars shall provide a net sectional area at all points equivalent to that of plain square or round bars of equal nominal size.

Bars for spiral reinforcement shall be plain bars rolled from billets directly reduced from ingots and shall conform to the requirements of ASTM A615/A615M.

303.2.9.2. **Sizes and Weights.** The size and weight of reinforcing bars shall conform to the requirements of ASTM A615/A615M.

303.2.9.3. **Bending.** Reinforcement bars shall be bent cold to the shapes indicated on the plans. All bending of hard grade new billet steel shall be done in the shop. Bends shall be true to the shapes indicated, and irregularities shall be caused for rejection. Unless otherwise shown on the plans, bends for stirrups and ties shall be made around a pin having a diameter not less than two times the minimum thickness of the bar. Other bends shall be made according to the latest code of Standard Practice of the Reinforcing Steel Institute.

303.2.9.4. **Storage.** Reinforcement shall be stored above the ground surface upon skids, platforms or other supports, and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, painting, oil or other foreign material.

303.2.9.5. **Rejection.** Reinforcement may be rejected for failure to meet any of the requirements of this specification, and specifically for the following:

1. reinforcement exceeding the allowable variations,
2. reinforcement not bent in accordance with the details,
3. reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
4. twisted bars.
303.2.10. Steel Wire Reinforcement. At the CITY’s option the use of welded wire fabric may be used in lieu of deformed reinforcement bars unless otherwise shown on the plans or in the contract specifications. Welded wire fabric shall be delivered to the job site in sheets. Rolls of wire fabric shall not be permitted. The size of welded wire fabric shall be 12 x 12- W 4 x W 4 with a nominal diameter in inches of 0.225 and a nominal weight 0.136 lbs/linear foot.

303.2.10.1. Material. Wire for fabric reinforcement shall be cold-drawn from rods hot-rolled from billets and shall conform to the requirements of ASTM A82 Steel Wire, Plain, for Concrete Reinforcement. Welded wire fabric shall conform to the requirements of ASTM A185 Steel Welded Wire Reinforcement, Plain, for Concrete.

303.2.10.2. Sizes and Weights. The properties of wire fabric shall conform to the requirements of ASTM A82 or ASTM A185, as appropriate.

303.2.10.3. Storage. Reinforcement shall be stored above the ground surface upon skids, platforms or other supports, and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, paint, oil or other foreign materials.

303.2.10.4. Rejection. Reinforcement may be rejected for failure to meet any of the requirements of this specification, and specifically for the following:

1. reinforcement exceeding the allowable variations,
2. reinforcement not bent in accordance with the details,
3. reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
4. twisted bars.

303.2.11. Reinforcement Bar Chairs. Reinforcement bar chairs or supports shall be of adequate strength (if specified) to support the reinforcement bars and shall not bend or break under the weight of the reinforcement bars or CONTRACTOR’s personnel walking on the reinforcing bars.

Bar chairs may be made of metal (free of rust), precast mortar or concrete blocks or plastic. Pre-cast mortar or concrete blocks must be approved by the CITY; and the CONTRACTOR shall supply test data showing the strength of the mortar or concrete blocks.

For approval of plastic chairs, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5-percent solution of sodium hydroxide for 120-hours.

303.2.11.1. Rejection. Bar chairs may be rejected for failure to meet any of the requirements of this specification.

303.2.12. Joint Filler. Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete.

303.2.12.1. Material. Expansion joint materials shall consist of boards or a premolded asphalt board tested in accordance with ASTM D545 Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).

Boards for expansion joint filler shall be of the required size, shape and type indicated in the plans or required in the specifications. Boards shall be of selected stock of redwood, cypress, gum, southern yellow pine, or Douglas fir timber. The boards shall be sound heartwood and shall be free from sapwood, knots, clustered birdseyes, checks and splits. Occasional sound or hollow birdseyes, when not in clusters, shall be permitted, provided the board is free from any other effects that shall impair its usefulness as a joint filler. With the exception of redwood and cypress, all boards shall be preservative treated according to American Wood-Preservers’ Association (AW PA) Standards.

Asphalt boards for expansion joint filler shall be of the required size and uniform thickness and, when used in transverse joints, they shall conform approximately to the shape of the pavement crown shown on the plans and details. Asphalt boards shall consist of two liners of 0.016 asphalt impregnated kraft paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout, and shall be sufficiently rigid to permit ease of installation. Boards shall be furnished in lengths equal to the width between longitudinal joints, and may be furnished in strips or scored sheet of the required shape.

Asphalt boards, when tested in accordance with the following described methods, shall not deflect from the horizontal more than ¾-inches in 3½-inches (2cm in 9cm). A sample of the board, 2-in. (5cm) wide and 6-in. (15cm) long, flat, straight and cut with its length parallel to the lay of the fiber, shall be clamped between two blocks in the direction of its thickness in such manner that 3¼-in. (9cm) length of the sample shall extend unsupported and at right angles from the common plane of the block faces. The samples and clamp so assembled shall be maintained at a temperature of 180°F (82°C) for 2-hours, with the length and width of the clamped portion of the sample horizontal after which the deflection from the horizontal of the unclamped portion shall be immediately measured.
303.2.13. Curing Materials. This specification shall govern the materials to be used in the curing of concrete. The materials when applied as elsewhere specified shall retain the moisture, present in the concrete at the time of application of curing material, within specified limits for the curing period.

303.2.13.1. Material. Materials for the curing of concrete shall conform to the following requirements:

303.2.13.1.1. Membrane-Forming Compounds. The membrane curing compound shall conform to the requirements of ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, white pigmented compound, unless otherwise specified or indicated. It shall be of such nature that it shall not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete.

The compound shall produce a firm, continuous uniform moisture-impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete surface at the specified rate of coverage, dry to touch in one (1) hour and dry through in not more than 4 hours under normal conditions suitable for concrete operations. It shall adhere in a tenacious film without running off or appreciably sagging. It shall not disintegrate, check, peel or crack during the required curing period.

The compound shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.

The compound shall be delivered to the job site in the manufacturer’s original containers only, which shall be clearly labeled with the manufacturer’s name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the liquid membrane-forming compound shall restrict the loss of water present in the test specimen at the time of application of the curing compound to not more than 0.55-grams-per-square-centimeter (0.01-oz.-per-in²) of surface.

303.2.13.1.2. Cotton Mats. The cotton mats used for curing shall meet the following requirements: Each mat shall have a finished width of approximately 5-ft. 6-in. (1.7m); and after shrinkage shall be at least 6-in. (15cm) longer than the width of the concrete to be cured.

The mats shall be composed of a single layer of cotton filler, completely enclosed in a cover of cotton cloth. The cotton filler shall be of low-grade cotton, cotton linters of such shall contain not less than ¾-pound (0.34kg) of cotton filler per square-yard of mat, uniformly distributed. The cotton cloth used for covering material shall be Osnaburg, weighing not less than 6³⁄₄-ounces-per-square-yard (0.21-kg-per-sq.-m).

All mats shall be stitched longitudinally with continuous parallel rows of stitching at intervals of not more than 4-in. (10cm) or shall be tufted both transversely and longitudinally at intervals of not more than 3-in. (7.6cm). The sewing or tufting shall not be done so tightly that the mat shall not contact the surface of the concrete at all points when saturated with water.

To insure the complete covering of the concrete where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be at least 6-in. (15cm) in width.

303.2.13.1.3. Waterproof Paper. Waterproof paper shall consist of two sheets of plain kraft paper cemented together with a bituminous material in which are imbedded cords or strands of fiber running in both directions of the paper, not more than 1¾-in. (3cm) apart. The paper shall be light in color; shall be free of visible defects; and shall have a uniform appearance. It shall be sufficiently strong and tough to permit its use under the conditions existing on streets and structural work without tearing or otherwise becoming unfit for the use for which it is intended. The paper shall conform to specifications for ASTM C171 Sheet Materials for Curing Concrete.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the paper shall restrict the loss of water present in the test specimen at the time of application of the waterproof paper to not more than 0.055-grams-per-square-centimeter of surface.

303.2.13.1.4. Polyethylene Film. Polyethylene film shall be opaque pigmented white in color; and shall be manufactured from virgin resin without additives or scrap. The film shall have a minimum thickness of 4-mils (0.004-in.). The permissible moisture loss from the concrete, when tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, shall not exceed 0.055-grams-per-square-centimeter of surface. The film shall be sufficiently strong and tough to permit its use under the conditions existing on paving or structural projects without being torn or otherwise rendered unfit for the use intended during the curing period. It shall be of uniform thickness throughout, free of pinholes and other blemishes.
303.2.13.2. Rejection. Concrete curing materials may be rejected for failure to meet any of the requirements of this specification.

303.2.14. Joint Sealant. Joint sealing compound shall consist of hot poured polymer or ready-mixed cold applied sealant, or other material approved by the CITY. It shall not crack or break when exposed to low temperatures. The cured sealant must not pick up or “track” at elevated road temperature.


303.2.14.1.1. Hot Poured Polymer. The joint sealing compound shall melt to the proper consistency for pouring and shall solidify on cooling to atmospheric temperatures. At no time shall the material be heated to temperature exceeding 450°F (232°C); any material heated above 450°F shall be rejected.

Hot poured polymer shall be tested in accordance with TxDOT Test Method Tex-525-C Tests for Asphalt and Concrete Joint Sealers and shall meet the requirements in Table 303.2.14.1.1.(a) Hot Poured Polymer Sealant Requirements.

Table 303.2.14.1.1.(a) Hot Poured Polymer Sealant Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Parameters</th>
<th>Required Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration</td>
<td>32°F (0°C), 7-oz. (200-grams), 60-sec.</td>
<td>Minimum 0.1-in. (0.25-cm)</td>
</tr>
<tr>
<td></td>
<td>77°F (25°C), 5-oz. (150-grams), 5-sec.</td>
<td>0.45- to 0.3-in. (1.1- to 0.75-cm)</td>
</tr>
<tr>
<td>Flow</td>
<td>5-hours, 140°F (60°C), 75° incline</td>
<td>Maximum 0.2-in. (0.5-cm)</td>
</tr>
<tr>
<td>Bond extension</td>
<td>15°F (-9°C), 5-cycles</td>
<td>no cracking of the joint sealing material or break in the bond between the joint sealer material and the mortar pieces</td>
</tr>
</tbody>
</table>

303.2.14.1.2. Ready-Mixed Cold-Applied. This sealant shall be a single component and shall consist of a homogeneous blend of asphalt emulsion, polymer, and inert filler. The material shall be a resilient, adhesive compound capable of effectively sealing properly cleaned joints and cracks in concrete and asphalt pavements against infiltration of moisture throughout repeated cycles of contraction and expansion and which shall not be picked up by vehicle tires, particularly at summer temperatures.

This Item covers an emulsion composed principally of a semi-solid asphalt base, water and emulsifying agent suitable for sealing cracks at ambient temperatures of 40°F (4°C) and higher. The material shall be tested for a polymer and shall be smooth and homogeneous, with no evidence of polymer separation.

The cold-applied crack sealant shall meet the requirements in Table 303.2.14.1.2.(a) Cold-Applied Sealant Requirements. Material shall be free-flowing down to 40°F (4°C), such that routine pavement joints and cracks are filled to a depth of 1½-in. (3.8cm) without the addition of heat.

The material shall be furnished in 55-gallon drums.

Table 303.2.14.1.2.(a) Cold-Applied Sealant Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method Required</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity*, Brookfield, 77°F</td>
<td>ASTM D2196 Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer; Method A</td>
<td>6,000 Centipoise</td>
<td>25,000 Centipoise</td>
</tr>
<tr>
<td>Storage Stability Test, One-Day</td>
<td>AASHTO T59</td>
<td>-</td>
<td>1-Percent</td>
</tr>
<tr>
<td>Sieve Test</td>
<td>AASHTO T59</td>
<td>-</td>
<td>0.10-Percent</td>
</tr>
<tr>
<td>Evaporation* and Tests on Residue</td>
<td>See Note 2</td>
<td>65-Percent</td>
<td>-</td>
</tr>
<tr>
<td>Residue</td>
<td>AASHTO T49</td>
<td>35 (0.1-mm)</td>
<td>75 (0.1-mm)</td>
</tr>
<tr>
<td>Penetration test on Residue, 77°F, 100g, 5-seconds</td>
<td>AASHTO T53</td>
<td>140°F (60°C)</td>
<td>-</td>
</tr>
<tr>
<td>Ductility test on Residue, 39.2°F, 5 cm/Min</td>
<td>AASHTO T51</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. CITY may require Viscosity Profile in lieu of single-spindle viscosity test, in which case the apparent viscosity shall be 10,000.
2. Residue may be obtained by the following evaporation procedure: Mass 200g of sealant into a 1000-ml beaker or a 1-quart can and place in a heating mantle designed for a 1000-ml beaker. During the evaporation the sealant should be stirred frequently to prevent foam-over or local overheating. The temperature shall be maintained between 260°F and 300°F (125°C and 150°C) for 3- to 5-minutes after the material is water free. Pour required specimen.
303.2.14.1.3. Thermoplastic Cold-Applied. If approved by the CITY, thermoplastic cold-applied jointing material may be used according to manufacturer’s recommendations.

303.2.14.2. Rejection. Materials may be rejected for failure to meet any of the requirements of this specification.

303.2.15. Elastomeric Materials. This material shall conform to the requirements of the TxDOT Item 435 Elastomeric Materials. This item shall govern for the materials, testing and fabrication of elastomeric materials, except as otherwise covered in other specifications or on the plans.

303.2.15.1. Rejection. Elastomeric materials may be rejected for failure to meet any of the requirements of this specification.

303.3. MIX DESIGN AND MIXING CONCRETE FOR PAVEMENT

303.3.1. Description. This section shall govern for the concrete in pavements.

303.3.2. Equipment. All machinery and equipment necessary for the prosecution of the work specified herein shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin operations on which the machinery or equipment is to be used. All machinery and equipment shall be maintained in good condition to insure the completion of the work without excessive delays for repairs and replacements.

303.3.3. Concrete Mix Design and Control. At least 10-days prior to the start of concrete paving operations, the CONTRACTOR shall submit to the CITY a design of the concrete mix it proposes to use together with samples, if requested, of all materials to be incorporated into the mix and a full description of the source of supply of each material component. The proposed batch designs must be submitted to the Engineer on the approved form.

The design of the concrete mix shall produce a quality concrete complying with these specifications and meet the requirements of ACI 318 (1992) - PART 3 Construction Requirements, CHAPTER 5, Concrete Quality, except as amended by these provisions. The concrete mix design shall include the following information:

1. Design Requirements and Design Summary
2. Material source
3. Dry weight of cement/cu. yd. and type
4. Dry weight of fly ash/cu. yd. and type, if used
5. Saturated surface dry weight of fine and coarse aggregates/cu. yd.
7. Quantities, type, and name of admixtures with manufacturer's data sheets
8. Current strength tests or strength tests in accordance with ACI 318
9. Current Sieve Analysis and -200 Decantation of fine and coarse aggregates and date of tests
10. Fineness modulus of fine aggregate
11. Specific Gravity and Absorption Values of fine and coarse aggregates
12. L.A. Abrasion of coarse aggregates

All material samples submitted to the CITY shall be sufficiently large to permit laboratory batching for the construction of test specimens to check the adequacy of the design. When the CITY has approved the design mix, there shall be no change or deviation from the proportions thereof or sources of supply except as hereinafter provided. No concrete may be placed on the job site until the mix design has been approved by the CITY in writing to the CONTRACTOR.

303.3.4. Quality of Concrete.

303.3.4.1. Consistency. In general, the consistency of concrete mixtures shall be such that:

1. the mortar shall cling to the coarse aggregate,
2. the aggregate shall not segregate in concrete when it is transported to the place of deposit,
3. the concrete, when dropped directly from the discharge chute of the mixer, shall flatten out at the center of the pile, but the edges of the pile shall stand and not flow,
4. the concrete and mortar shall show no free water when removed from the mixer,
5. the concrete shall slide and not flow into place when transported in metal chutes at an angle of 30° with the horizontal, and
6. the surface of the finished concrete shall be free from a surface film or laitance.
7. The concrete shall be uniform and workable.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only; and shall be held to a minimum amount. The concrete shall be workable, cohesive, possess satisfactory finishing qualities
and be of the stiffest consistency that can be placed and vibrated into a homogeneous mass. Excessive bleeding shall be avoided.

If the strength or consistency required for the class of concrete being produced is not secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the CONTRACTOR may use, or the CITY may require, an approved cement dispersing agent (water reducer); or the CONTRACTOR shall furnish additional aggregates, or aggregates with different characteristics, or the CONTRACTOR may use additional cement in order to produce the required results. The additional cement may be permitted as a temporary measure, until aggregates are changed and designs checked with the different aggregates or cement dispersing agent.

The CONTRACTOR is solely responsible for the quality of the concrete produced. The CITY reserves the right to independently verify the quality of the concrete through inspection of the batch plant, testing of the various materials used in the concrete and by casting and testing concrete cylinders or beams on the concrete actually incorporated in the pavement.

**303.4.2. Standard Classes.** Unless otherwise shown on the plans or detailed specifications, the Standard Classes of Pavement Concrete shown in Table 303.4.2.(a) shall be used.

Streets, alleys, driveways, and inlets shall be constructed in accordance with these specifications using the classes of concrete, machine or hand finished, whichever is appropriate. Mass pour medians, noses, and islands shall use hand-finished concrete.

The testing does not in any way change the penalties imposed on the CONTRACTOR for deficient strength outlined elsewhere in these specifications.

---

### Table 303.4.2.(a) Standard Classes of Pavement Concrete.

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Minimum Cementitious Lb./CY</th>
<th>28 Day Min. Compressive Strength psi</th>
<th>28 Day Min. Beam Strength psi&lt;sup&gt;2,3&lt;/sup&gt;</th>
<th>Maximum Water/Cementitious Ratio</th>
<th>Coarse Aggregate Maximum Size&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&lt;sup&gt;5&lt;/sup&gt;</td>
<td>470</td>
<td>3000</td>
<td>500</td>
<td>0.58</td>
<td>1½”</td>
</tr>
<tr>
<td>C</td>
<td>564</td>
<td>3600</td>
<td>600</td>
<td>0.53</td>
<td>1½”</td>
</tr>
<tr>
<td>P1&lt;sup&gt;*&lt;/sup&gt;</td>
<td>517</td>
<td>4000</td>
<td>N/A</td>
<td>0.49</td>
<td>1½”</td>
</tr>
<tr>
<td>P2&lt;sup&gt;7&lt;/sup&gt;</td>
<td>564</td>
<td>4500</td>
<td>N/A</td>
<td>0.45</td>
<td>1½”</td>
</tr>
<tr>
<td>M</td>
<td>As directed by the OWNER or as shown on the plans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. All exposed horizontal concrete shall have entrained – air.
2. Minimum Strength Required by CITY [Compressive or Flexural]
3. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is Used
4. Smaller nominal maximum size aggregate may be used if strength requirement is satisfied
5. Sidewalks, separate curb and gutter, and 4-inch thick median pavement
6. Machine Finished
7. Hand Finished
303.3.4.3. Performance Classes. Performance Classes of structural concrete shall meet the requirements in Table 303.3.4.3.(a) Performance Classes of Pavement Concrete.

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Minimum Cementitious Lb./CY</th>
<th>28-Day Compressive Strength psi</th>
<th>28-Day Flexural Strength $^{2,3}$ psi</th>
<th>Maximum Water/Cementitious Ratio $^4$</th>
<th>Coarse Aggregate Maximum Size $^5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>423</td>
<td>3000$^6$</td>
<td>425</td>
<td>0.58</td>
<td>1½&quot;</td>
</tr>
<tr>
<td>PC</td>
<td>517</td>
<td>3600$^6$</td>
<td>510</td>
<td>0.53</td>
<td>1½&quot;</td>
</tr>
<tr>
<td>PP$^7$</td>
<td>517</td>
<td>4000</td>
<td>N/A</td>
<td>0.48</td>
<td>1½&quot;</td>
</tr>
<tr>
<td>PP2$^8$</td>
<td>564</td>
<td>4500</td>
<td>N/A</td>
<td>0.44</td>
<td>1½&quot;</td>
</tr>
<tr>
<td>PM</td>
<td>As directed by the CITY or as shown on the plans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. All exposed horizontal concrete shall have entrained – air.
2. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is used
3. For early form removal
4. Consistent with ACI 211.1 Table 6.3.4(a) Relationship between water-cementitious materials ratio and compressive strength of concrete
5. Smaller nominal maximum size aggregate may be used if Strength requirement is satisfied
6. Calculated Average Required Compressive Strength Considering ACI 318 - Sec. 5.3.2.1 shall be strength shown times 1.15
7. Machine Finish
8. Hand Finish

303.3.4.4. Slump. Slump requirements for pavement and related concrete shall be as specified in Table 303.3.4.4.(a) Pavement Concrete Slump Requirements. No concrete shall be permitted with slump in excess of the maximums shown. Any concrete mix failing to meet the above consistency requirements, although meeting the slump requirements, shall be considered unsatisfactory, and the mix shall be changed to correct such unsatisfactory conditions.

<table>
<thead>
<tr>
<th>Concrete Use</th>
<th>Avg. Slump (in.)</th>
<th>Max. Slump (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip Form Paving</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Hand formed paving</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sidewalk, Separate Curb and Gutter, and Other Miscellaneous Concrete</td>
<td>As specified by CITY</td>
<td></td>
</tr>
</tbody>
</table>

303.3.5. Mixing and Delivery. The concrete shall be produced in an approved method conforming to the requirements of this specification and ASTM C94/C94M Standard Specification for Ready-Mixed Concrete or National Ready-mixed Concrete Association (NRMCA). Ready-mix concrete shall be permitted in lieu of the paver-mixer. When ready-mix concrete is used, sampling provisions of ASTM C94 Alternate Procedure 2 shall govern. If fiber-reinforced concrete is used, mixing shall be in accordance with ASTM C1116 Fiber-Reinforced Concrete and Shotcrete. All materials for concrete placed in pavements shall conform to the requirements of the governing item of this specification.

303.3.5.1. Batch Mixing. The concrete shall be mixed in a batch mixer and only in such quantities as are required for immediate use. The mixing of each batch, after all materials are in the drum, shall continue until it produces a thoroughly mixed concrete of uniform mass as determined by established mixer performance ratings and inspection, or appropriate uniformity tests as described in ASTM C94. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch. Retempering or remixing shall not be permitted.

303.3.5.1.1. Mixer. The mixer shall produce concrete of uniform consistency and appearance.

303.3.5.1.2. Cleaning. The mixer shall be cleaned thoroughly each time when out of operation for more than 30 minutes.

303.3.5.2. Transit Mixing. When transit mixing is used, the transit mixer shall be of an approved revolving drum or revolving blade type so constructed as to produce a thoroughly mixed concrete with a uniform
distribution of the materials throughout the mass and shall be equipped with a discharge mechanism which shall insure the discharging of the mixed concrete without segregation.

303.3.5.2.1. Prevention of Leaking. The mixer drum shall be watertight when closed and shall be equipped with a locking device that shall automatically prevent the discharging of the mixer prior to receiving the required number of revolutions.

303.3.5.2.2. Mixing. The entire quantity of mixing water shall be accurately measured by a visible calibrated mechanism. Leaking water valves shall be considered as ample reason for condemnation of the mixer unit and removal from the job by the CITY. Each batch shall be mixed not less than 70 nor more than 100 revolutions at the rate of rotation specified by the manufacturer as mixing speed. Any additional mixing shall be done at a slower speed specified by the manufacturer for agitation and shall be continuous until the batch is discharged.

303.3.5.2.3. Counters. Truck mixers shall be equipped with actuated counters by which the numbers of revolutions of the drum may be readily verified. The counters shall be actuated at the time of starting mixing at mixing speeds.

303.3.5.2.4. Delivery. The rate of delivery of the mixed concrete shall be such that the interval between loads shall not exceed 10-minutes. The concrete shall be delivered to the site of the work and discharged from the mixer before the drum has been revolved 300 revolutions, after the introduction of the mixing water with the dry materials.

303.3.5.3. Central Mixing Plant. A central mixing plant shall be allowed, provided the method of mixing and handling has first been approved by the CITY.

303.3.5.4. Commercial Concrete Plants. In the event the CONTRACTOR elects to use concrete produced by a commercial concrete plant, an agreement shall be drawn and executed by the responsible executive management of said plant granting the CITY ingress and egress to all parts of the plant with full authority to make any and all required tests of aggregates and to regulate and control all batching plant and/or central mixing plant operations. This regulatory control shall be applicable only to the concrete produced by the commercial plant for the payment herein specified.

303.3.5.5. Delivery Tickets. For transit mix operations, the manufacturer of the concrete shall, before unloading, furnish to the purchaser with each batch of concrete at the site a delivery ticket on which is printed, stamped, or written, the following information to determine that the concrete was proportioned in accordance with the approved mix design:

- **Name of concrete supplier**
- **Serial number of ticket**
- **Date**
- **Truck number**
- **Name of purchaser**
- **Specific designation of job (name and location)**
- **Specific class, design identification and designation of the concrete in conformance with that employed in job specifications**
- **Amount of concrete in cubic yards (or cubic meters)**
- **Time loaded or of first mixing of cement and aggregates**
- **Water added by receiver of concrete and his/her initials**
- **Weight of cement**
- **Weight of fly ash**
- **Type and amount of admixtures**
- **Information necessary to calculate the total mixing water added by the producer (total mixing water includes free water on the aggregates, water and ice batched at the plant, and water added by the truck operator from the mixer tank)**
- **Maximum size of aggregate**
- **Weights of fine and coarse aggregate**

For on-site concrete plant operations, the CONTRACTOR shall supply to the CITY a batch ticket with the following information and for each continuous paving operation, provide receipts and invoices to substantiate the amounts of cement and fly ash used in the placement.

1. At the beginning of each day's placement, a list of the actual batch weights to be used shall be given to the CITY.
2. When any changes are made, a new list of weights shall be given to the CITY.
303.4. EQUIPMENT

303.4.1. General. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used.

303.4.2. Field Laboratory. A field laboratory structure shall be required only when specifically required and provided for in the special provisions.

303.4.3. Slip Form Paver. Slip form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape and strength so as to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section. The equipment shall spread, consolidate, screed and float-finish the freshly placed concrete in such a manner as to provide a dense and homogeneous pavement.

303.4.4. Forms. The side forms shall be metal, of approved cross section and bracing, of a height not less than the prescribed edge thickness of the concrete section, and a minimum of 10-ft. (3m) in length for each individual form. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they shall withstand the impact and vibration of equipment imposed thereupon without appreciable springing or settlement. In no case shall the base width be less than 8-in. (20cm) for a form 8-in. (20cm) or more in height. The forms shall be free from warps, bends or kinks and shall show no variation from the true plane for face or top. Each 10-ft. (3m) length of forms shall be provided with at least 3 pins for securely staking in position. Sufficient forms shall be provided for satisfactory prosecution of the work. 10-ft. (3m) metal form sections shall be used in forming curves with a 250-ft. (75m), and larger radius. For curves with a radius of less than 250-ft. (75m), acceptable flexible metal forms or wood forms may be used upon approval by the CITY.

303.4.5. Mechanical Vibratory Equipment. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the transverse finishing machine and designed to vibrate the concrete internally and/or from the surface. Unless otherwise shown on the plans, vibrators of the surface-pan type shall be used for full-depth placement. Both types of vibrators shall be furnished and may be used concurrently at the discretion of the CITY. Vibratory members shall extend across the pavement practically to, but shall not come in contact with, the side forms. Mechanically-operated vibrators shall be mounted in such a manner as not to interfere with the transverse or longitudinal joints.

The internal-type vibrators shall be spaced at not more than 24-in. (61cm) and shall be equipped with synchronized vibratory units. Separate Vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire width of the pavement. The frequency in air of the internal spudtype Vibratory units shall be not less than 8,000-cycles-per-minute and not less than 5,000-cycles-per-minute for tube types. The method of operation shall be as directed by the CITY. The CONTRACTOR shall have a satisfactory tachometer available for checking the vibratory elements.

The pavement vibrators shall not be used to level or spread the concrete but shall be used only for purposes of consolidation. The vibrators shall not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement, except for the first lift of concrete where the double strike-off method of placement is employed. The vibrators shall not be operated for more than 15-seconds while the machine upon which they are installed is still.

The pan-type vibrator units shall apply the vibrating impulses directly to the surface of the concrete. The operating frequency shall not be less than 3,500-cycles- nor more than 4,200-cycles-per-minute in air. The CONTRACTOR shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

Approved hand manipulated mechanical vibrators shall be furnished in the number required for provision of proper consolidation of the concrete along the forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.

Complete and satisfactory consolidation of the concrete pavement is a most important requirement of this specification. Cores taken as required by Item 303.8. Pavement Testing shall be carefully examined for voids, honeycombing or other evidence of incomplete consolidation. If such evidence is present, changes in the consolidation procedures and/or equipment shall be made to insure satisfactory consolidation.

303.4.6. Vibrating Screed. The mechanically vibrated screed shall be provided with a template adjusted to the crown of the concrete section. The template shall be power vibrated, adjustable in height and mounted to ride on the forms. The mechanical vibration of one of the screeds on the transverse finishing machine specified in Item 303.4.7. Transverse Finishing Machine shall be acceptable.

303.4.7. Transverse Finishing Machine. The transverse finishing machine shall be provided with two screeds accurately adjusted to the crown of the pavement, shall be power driven and mounted in a substantial frame equipped to ride on the forms. The machine shall be so designed and operated as to strike off and consolidate the concrete.
Finishing machines shall be maintained in a tight and good operating condition, accurately adjusted to the required crown or profile and free from deflection, wobble or vibration tending to affect the surface finish. Machines failing to meet these requirements shall be rejected by the CITY, and the CONTRACTOR shall provide approved equipment.

303.4.8. Miscellaneous Finishing Equipment. The CONTRACTOR shall furnish a broom of the push broom type not less than 18-in. (45cm) in width with stiff bristles for the final surface finish of concrete base or as the CITY directs.

The CONTRACTOR shall furnish a sufficient number of bridges equipped to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. The CONTRACTOR shall furnish, operate and maintain at least two standard 10-ft. (3m) steel straightedges and all necessary finishing and edging tools as may be required to complete the pavement in accordance with the plans and specifications.

303.5. CONSTRUCTION METHODS

303.5.1. Subgrade. When manipulation or treatment of subgrade is required on the plans, the work shall be performed in proper sequence with the preparation of the subgrade for pavement.

The roadbed shall be excavated and shaped in conformity with the typical sections and to the lines and grades shown on the plans or established by the CITY. Material excavated in the preparation of the roadbed in excess of that needed to properly construct the subgrade, shoulders, slopes or parkway shall be wasted. If additional material is required, it shall be secured from sources indicated on the plans or designated by the CITY. All holes, ruts and depressions shall be filled with suitable material and, if required, the subgrade shall be thoroughly wetted and reshaped. Irregularities of more than ½-in. (13-mm), as shown by straightedge or template, shall be corrected. The subgrade shall be uniformly compacted to at least 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)). Moisture content shall be within minus-2%- to plus-4%-of-optimum. The prepared subgrade shall be wetted down sufficiently in advance of placing the pavement to insure its being in a firm and moist condition for at least 2-in. (5cm) below the surface. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work. No hauling or equipment shall be permitted on the finished subgrade.

The CONTRACTOR shall notify the CITY at least three working days in advance of its intention to place concrete pavement.

Density tests must be taken no more than 72-hours prior to placement of concrete. After the specified moisture and density are achieved, the CONTRACTOR shall maintain the subgrade moisture and density in accordance with Item 301. Subgrade, Subbase, and Base Preparation until the pavement is placed. In the event that rain or other conditions may have adversely affected the condition of the subgrade or base, additional tests may be required as directed by the CITY.

303.5.2. Placing and Removing Forms. Forms shall be set to line and grade at least 200-ft. (60m), where practicable, in advance of the paving operations. Forms shall be adequately staked with at least three pins per 10-ft. (3m) section and capable of resisting the pressure of concrete placed against them and the thrust and the vibration of the construction equipment operating upon them without appreciable springing or settlement. Forms shall be jointed neatly and tightly and set with exactness to the established grade and alignment. Forms must be in firm contact with the subgrade throughout their length and base width. If the subgrade becomes unstable, forms shall be reset, using heavy stakes, or other additional supports may be necessary to provide the required stability.

303.5.2.1. Settling. When forms settle over ~-.05-in. (3mm) under finishing operations, paving operations shall be stopped, the forms reset to line and grade and the pavement then brought to the required section and thickness.

303.5.2.2. Cleaning and Oiling. Forms shall be thoroughly cleaned after each use and well oiled before reuse.

303.5.2.3. Removal. Forms shall remain in place until the concrete has taken its final set. At the time the forms are removed, earth shall be banked against the sides of the slab and immediately and thoroughly wetted.

303.5.2.4. Curb. Superimposed or monolithic curb shall be formed from the flowline of the gutter to the top of the curb. All expansion joints in the curbs shall conform to the joint locations in the slab.

303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars. When reinforcing steel, welded wire mesh, tie bars, dowels, etc., are required, they shall be placed as shown on the plans. All reinforcing shall be clean, free from rust in the form of loose or objectionable scale, and of the type, size and dimensions shown on the plans. Reinforcing bars shall be securely wired together at the alternate intersections and all splices and shall be
securely wired to each intersection dowel and load-transmission unit intersected. All bars shall be installed in their required position as shown on the plans.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, where permitted, such storage shall be limited to quantities and distribution that shall not induce excessive stresses.

303.5.3.1. Installation. All reinforcing bars and bar mats shall be installed in the slab at the required depth below the finished surface and supported by and securely attached to bar chairs installed on prescribed longitudinal and transverse centers as shown by sectional and detailed drawings on the plans. After the reinforcing steel is securely installed above the subgrade, as specifically required by plans and as herein prescribed, there shall be no loading imposed upon (or walking upon) the bar mats or individual bars before or during the placing or finishing of the concrete.

303.5.3.2. Welded Wire Mats. Where welded wire fabric reinforcement mats are required by the plans, or permitted as an alternate by the CITY, the concrete shall be placed and struck off by means of a template to the depth below the finished surface as specified for the location of the mesh. Welded wire mats, conforming to the specified side lap and end splice requirements as detailed on the plans, shall be placed upon the struck surface. The remainder of the concrete shall be placed thereupon with finishing operations proceeding immediately. There shall be no loading imposed upon the mesh mats after installation in the slab concrete.

303.5.3.3. Assembly. Expansion joints or dummy joints which may require an assembly of parts supported by special devices shall be completely assembled and rigidly supported in the correct position well in advance of the placing of concrete.

303.5.4. Joints.

303.5.4.1. Joint Dimensions. The width of the joint shall be shown on the plans, creating the joint sealant reservoir. The depth of the joint shall be shown on the plans. Dimensions of the sealant reservoir shall be in accordance with manufacturer's recommendations. Normal width/depth ratios are 1 to 1, not to exceed 1 to 1½. After curing, the joint sealant shall be --in. (3mm) to ¼-in. (6mm) below the pavement surface at the center of the joint.

303.5.4.2. Expansion Joints. Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the plans.

303.5.4.2.1. Joint Filler. Joint filler shall be as specified in Item 303.2.12. Joint Filler, as approved by City, of the size and shape shown on the plans.

Board joint material with less than 25-percent of moisture at the time of installation shall be thoroughly wetted on the job. Green lumber of much higher moisture content is desirable and acceptable.

The joint filler shall be appropriately drilled to admit the dowel bars when required. The bottom edge of the filler shall extend to or slightly below the bottom of the slab. The top edge shall be held approximately ½-in. (13mm) below the finished surface of the pavement in order to allow the finishing operations to be continuous. Where the joint filler is of a premolded asphaltic type, the top edge shall be protected, while the concrete is being placed and finished, by a metal cap of at least 10 gauge material having flanges not less than 1½-in. (38mm) in depth. The channel cap may remain in place during the joint finishing operations to serve as a guide for tooling the edges of the joint.

After the removal of the side forms, the ends of the joints at the edges of the slab shall be carefully opened for the entire depth of the slab.

303.5.4.2.2. Curb. Where a superimposed curb or a separate curb and gutter may be used, the expansion joints therein shall coincide and be continuous with the pavement joint and of the same size and type.

303.5.4.2.3. Proximity to Existing Structures. When the pavement is adjacent to or around existing structures, expansion joints shall be constructed in accordance with the details shown on the plans.

303.5.4.2.4. Dowel Bars. Dowel bars, where required on the plans, shall be installed through the predrilled joint filler and rigidly supported in true horizontal and vertical positions by an assembly of bar chairs and dowel holders welded to transverse bars extending across the slab and placed on each side of the joint. The chair assembly shall be similar and equal to that shown on the plans and shall be approved by the CITY prior to extensive fabrication.

303.5.4.3. Contraction Joints. Contraction or dummy joints shall be installed at the locations and at the intervals shown on the plans in accordance with this section and Item 402.2. Sawing. The joints shall be constructed by sawing to a ¼-in. (6mm) width and to a depth of ¼ of the pavement thickness, or deeper if so indicated on the plans. Unless otherwise specified on the plans, joints shall be sawed into the completed pavement surface as soon after initial concrete set as possible so that some raveling of the green concrete is observed in order for the sawing process to prevent uncontrolled shrinkage cracking. If sharp edge joints are being obtained, the sawing process shall be sped up to the point where some raveling is observed. Damage by blade action to the slab surface and to the concrete immediately adjacent to the joint shall be minimized.
Any portion of the curing membrane which has been disturbed by sawing operations shall be restored by spraying the areas with additional curing compound. The sawed groove shall immediately be thoroughly cleaned for the full depth and width of the joint and filled. The type of equipment and method for performing this work shall be approved by the CITY.

303.5.4. Construction Joints. Construction joints formed at the close of each day’s work or when the placing of concrete has been stopped for 30-minutes or longer shall be constructed by use of metal or wooden bulkheads cut true to the section of the finished pavement and cleaned and oiled. Wooden bulkheads shall have a thickness of not less than 1½-in. (38mm). Longitudinal bars shall be held securely in place in a plane perpendicular to the surface and at right angles to the centerline of the pavement. Edges shall be rounded to ¼-in. (6mm) radius. Any surplus concrete on the subgrade shall be removed upon the resumption of the work.

In no case shall an emergency construction joint be placed within 8-ft. (2.4m) following a regular installation of expansion or contraction joint. If the emergency construction joint should fall within this limitation, the concrete shall be removed back to the previously installed joint.

303.5.4.5. Longitudinal Parting Strips. Longitudinal parting strips or planes of weakness, when required, shall be accurately placed as shown on the plans.

303.5.4.6. Longitudinal Construction Joints. Longitudinal construction joints shall be of the type shown on the plans. Longitudinal joints shall be constructed accurately to required lines in order to coincide with traffic lane lines. No width between longitudinal construction joints shall exceed 24-ft. (7.2m), unless specifically authorized or directed by the CITY in writing.

303.5.4.7. Random Drying Shrinkage Cracks and Stress Cracks. Random drying shrinkage cracks or stress cracks of widths greater than 0.025-inches (0.6mm) in recently placed reinforced Portland cement concrete pavement placed on stabilized subbase or slabs on grade are subject to being removed and replaced at the discretion of the CITY. Random drying shrinkage cracks or stress cracks of any nature in recently placed non-reinforced Portland cement concrete pavement placed on non-stabilized subbase or slabs on grade are subject to being removed and replaced at the discretion of the CITY. Recently placed concrete pavement or slabs on grade are those for which the one-year maintenance bond has not expired. Routing, by any means, and sealing random cracks will not be permitted. When Portland cement concrete pavement or slabs on grade must be removed and replaced, the area of removal must extend from the nearest contraction or dummy joint or construction joint a minimum distance of 10-feet (3m), measured parallel to the longitudinal axis of the pavement, and include that portion of the concrete pavement or slab on grade containing the random crack. A sawed dummy joint will be required to be sawed across the opposing, non-damaged, slab in line with the saw cut made for the removal of the damaged slab. The area of removal and replacement of slabs containing longitudinal random cracks will be determined by the CITY or its representative. Randomly cracked Portland cement concrete sidewalks will require removal and replacement of only the five-feet long section or sections containing random cracks.

303.5.4.8. Joint Sealing. Routine pavement joints shall be filled to a depth of 1½-in. (3.8cm). Materials shall generally be handled and applied according to the manufacturer’s recommendations, with additional requirements as stated herein.

303.5.4.8.1. Hot Poured Polymer. The sealing filler shall be melted in an approved oil-batch kettle with continuous mechanical agitation. The kettle shall be equipped with temperature indicators. The CITY shall determine the optimum temperature for proper pouring fluidity, and the CONTRACTOR shall maintain the material within close range of optimum temperature. At no time shall the temperature exceed 450°F (232°C). Joint sealing compound shall not be poured at atmospheric temperatures below 32°F (0°C).

303.5.4.8.2. Ready-Mixed Cold-Applied. Permeation of joints shall principally be achieved without the task of squeegeeing. However, squeegeeing is recommended to assist permeation and to allow sealant to become rapidly tack-free. Sealant shall “set” in a fixed position within 40-minutes after application, to where traffic may be restored to the pavement without the effects of “tracking.” “Tracking” shall be averted without the use of topping materials such as sand.

303.5.5. Placing Concrete. Unless otherwise shown on the plans, the concrete shall be placed using either forms or slipform paver. The concrete shall be rapidly deposited on the subgrade in successive batches and shall be distributed to the required depth and for the entire width of the pavement by shoveling or other approved methods. Any concrete not placed as herein prescribed within the time limits specified in Table 303.5.5.(a) Concrete Placement will be rejected.
Table 303.5.5 (a) Concrete Placement
Temperature – Time Requirements

<table>
<thead>
<tr>
<th>Concrete Temp (at point of placement)</th>
<th>Max Time - minutes (no retarding agent)</th>
<th>Max Time – minutes (with retarding agent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All temperatures</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>Agitated Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 90°F</td>
<td>45</td>
<td>75</td>
</tr>
<tr>
<td>Above 75°F thru 90°F</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>75°F and Below</td>
<td>90</td>
<td>120</td>
</tr>
</tbody>
</table>

1. Normal dosage of retarder

Where bar mats or wire mesh reinforcing is specified, method of concrete placement shall be in accordance with Item 303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars. Rakes shall not be used in handling concrete. The placing operation shall be continuous. At the end of the day, or in case of unavoidable interruption or delay of more than 30-minutes, a transverse construction joint shall be placed in accordance with Item 303.5.4.4. Construction Joints.

303.5.5.1. Honeycombing. Special care shall be taken in placing and spading the concrete against the forms and at all joints and assemblies so as to prevent honeycombing. Excessive voids and honeycombing in the edge of the pavement, revealed by the removal of the side forms, may be cause for rejection of the section of slab in which the defect occurs.

303.5.5.2. Weather Conditions. Except by specific written authorization of the CITY, no concrete shall be placed when the air temperature is less than 40°F (4°C) and falling but may be placed when the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade away from artificial heat. When and if such permission is granted, the CONTRACTOR shall furnish sufficient protective material and devices to enclose and protect the fresh concrete in such a way as to maintain the temperature of the air surrounding the fresh concrete at not less than 50°F (10°C) for a period of at least 5-days. It is to be distinctly understood that the CONTRACTOR is responsible for the quality and strength of the concrete placed under any weather conditions. No concrete shall be placed on a frozen subgrade.

303.5.5.3. Time. Concrete shall not be placed before the time of sunrise and shall not be placed later than shall permit the finishing of the pavement during sufficient natural light.

303.5.6. Finishing.

303.5.6.1. Machine. When the concrete has been deposited, it shall be approximately leveled and then struck off to such elevation that, when mechanically screeded and tamped, the concrete shall be thoroughly compacted and finished to the required line, grade and section with all surface voids filled. Where bar mats or wire mesh reinforcing is specified, method shall be in accordance with Item 303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars.

303.5.6.1.1. Tolerance Limits. While the concrete is still workable, it shall be tested for irregularities with a 10-ft. (3m) straightedge placed parallel to the centerline of the pavement so as to bridge depressions and to touch all high spots. Ordinates measured from the face of the straightedge to the surface of the pavement shall at no place exceed 1/16 inch-per-foot (1-mm-per-20-cm) from the nearest point of contact. In no case shall the maximum ordinate to a 10-ft. (3m) straightedge be greater than --in. (3mm). Any surface not within the tolerance limits shall be reworked and refinished.

303.5.6.1.2. Edging. The edges of slabs and all joints requiring edging shall be carefully tooled with an edger of the radius required by the plans at the time the concrete begins to take its “set” and becomes nonworkable. All such work shall be left smooth and true to lines.

303.5.6.1.3. Stamp or Die. All concrete including curbs, curb with gutter, sidewalks, alleys, driveways and structures shall be marked by means of a substantial stamp or die so designed to make an impression in the finish of the concrete. The stamp or die shall designate the firm name or CONTRACTOR and the month and year in which the work was done. The design of the stamp or die shall be approved by the Engineer.

303.5.6.2. Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. The addition of one-sack of cement per cubic-yard shall be required for all hand finish concrete.

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when
consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation the strike template shall be moved forward with a combined longitudinal and transverse motion and so manipulated that neither end of the template is raised from the forms during the striking off process. A slight excess of material shall be kept in front of the cutting edge at all times.

The straightedge and joint finishing shall be as hereinafore prescribed.

**303.5.7. Curing.** The curing of concrete pavement shall be thorough and continuous throughout the entire curing period. Failure to provide proper curing as herein prescribed shall be considered as sufficient cause for immediate suspension of the paving operations. The curing method as herein specified does not preclude the use of any of the other commonly used methods of curing, and the CITY may approve another method of curing if so requested by the CONTRACTOR. If any selected method of curing does not afford the desired results, the CITY shall have the right to order that another method of curing be instituted. Immediately after the finishing of the surface, the pavement shall be covered with a continuous, uniform water-impermeable coating of the type specified in Item 303.2.13. Curing Materials. After removal of the side forms, the sides of the slab shall receive a like coating before earth is banked against them. The solution shall be applied, under pressure with a spray nozzle, in such a manner as to cover the entire surfaces thoroughly and completely with a uniform film.

The rate of application shall be such as to insure complete coverage and shall not exceed 200-square-feet-per-gallon of curing compound. When thoroughly dry, it shall provide a continuous and flexible membrane, free from cracks or pinholes, and shall not disintegrate, check, peel or crack during the curing period. If for any reason the seal is broken during the curing period, it shall be immediately repaired with additional sealing solution.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the curing compound shall provide a film which shall have retained within the test specimen a percentage of the moisture present in the specimen when the curing compound was applied according to Table 303.5.7.(a) Water Retention by Curing Materials.

<table>
<thead>
<tr>
<th>Time</th>
<th>Minimum Retained Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 24-hours</td>
<td>97%</td>
</tr>
<tr>
<td>After 3-days</td>
<td>95%</td>
</tr>
<tr>
<td>After 7-days</td>
<td>91%</td>
</tr>
</tbody>
</table>

**303.5.8. Opening Pavement to Traffic.** All traffic shall be excluded from the pavement for a period of not less than 14-days or until field cured test specimens indicate concrete meets at least 75% of design strength, or as otherwise approved by the CITY. In all cases the pavement shall be cleaned and joints shall be filled and trimmed before being opened to traffic.

**303.5.8.1. Traffic Access.** When it is necessary to provide for traffic across the pavement, the CONTRACTOR shall, at its own expense, construct suitable and substantial crossings over the concrete which shall be adequate for the traffic using same.

**303.5.8.2. Time.** Opening pavement to traffic shall not relieve the CONTRACTOR of responsibility for the work and shall not in any way affect the time charge on the entire project. The number of days stated in the contract shall govern for the completion of the entire work covered by the contract.

**303.5.9. Monolithic Curb.** Concrete for monolithic curb shall be the same as for the pavement and, if carried back from the paving mixer, shall be placed within 20-minutes after being mixed. Concrete may be placed from the separate mixer if desired but in any case must be placed while the pavement concrete is still plastic. After the concrete has been struck off and sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden flat. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans. When the concrete in the curb has been sufficiently set, the inside form shall be carefully removed and the surface may be plastered with a mortar consisting of one part of Portland cement and two parts fine aggregate. The mortar shall be applied with a template or “mule” made to conform to curb dimensions. All exposed surfaces of curb shall be brushed to a smooth and uniform surface.

**303.5.10. Superimposed Curb.** When sawed joints are used, curbs shall be doweled as shown on the plans and poured after sawing. Dowelled curbs which are placed with an extrusion machine shall have a mixture that conforms to Item 303.3. Mix Design And Mixing Concrete For Pavement.

**303.5.11. Slip Form Paving.** At the option of the CONTRACTOR, and with the approval of the CITY, concrete pavement may be constructed by the use of slip form paving equipment.

303.20
The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse vibrating units or with a series of longitudinal vibrating units loaded with the specified thickness of pavement section and at a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

Final finishing for slip form pavement construction shall be to the tolerance as specified in Item 303.5.6. Finishing.

**303.6. ALLEY PAVING**

Alley paving shall be constructed in accordance with the specifications for street paving hereinbefore described, in accordance with the details shown on the plans, and with the following additional provisions:

Alley paving shall be constructed to one of the typical cross sections shown on the plans.

Transverse expansion joints of the type shown on the plans shall be constructed at the property line on each end of the alley with a maximum spacing of 600-ft. (180m). Transverse contraction and dummy joints shall be placed at the spacing shown on the plans. Contraction and dummy joints shall be formed in such a manner that the required joints shall be produced to the satisfaction of the CITY. All joints shall be filled with top seal in accordance with the requirements of Item 303.5.4. Joints.

**303.7. PAVEMENT LEAVEOUTS**

Pavement leaveouts as necessary to maintain and provide for local traffic shall be provided at location indicated on the plans or as directed by the CITY. The extent and location of each leaveout required and a suitable crossover connection to provide for traffic movements shall be determined in the field by the CITY. Left or rightturn lanes and median openings shall not be considered as pavement leaveouts.

**303.8. PAVEMENT TESTING**

**303.8.1. Testing of Materials.** Samples of all materials for test shall be made at the expense of the CITY, unless otherwise specified in the special provisions or in the plans. In the event the initial sampling and testing does not comply with the specifications, all subsequent testing of the material in order to determine if the material is acceptable shall be at the CONTRACTOR'S expense at the same rate charged by the commercial laboratories. All testing shall be in accordance with applicable ASTM Standards and concrete testing technician must be ACI certified or equivalent.

**303.8.2. Pavement Thickness Test.** Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the CITY. The number of tests and location shall be at the discretion of the CITY, unless otherwise specified in the special provisions or on the plans. The cost for the initial pavement thickness test shall be the expense of the CITY. In the event a deficiency in the thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the CONTRACTOR'S expense. The cost for additional coring test shall be at the same rate charged by commercial laboratories.

Where the average thickness of pavement in the area found to be deficient in thickness by more than 0.20-in. (5mm), but not more than 0.50-in. (12.5 mm), payment shall be made at an adjusted price as specified in Table 303.8.2.(a) Concrete Pavement Deficiency.

<table>
<thead>
<tr>
<th>Deficiency in Thickness Determined by Cores</th>
<th>Proportional Part of Contract Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>mm</td>
</tr>
<tr>
<td>0.00 — 0.20</td>
<td>0.0 — 5.0</td>
</tr>
<tr>
<td>0.21 — 0.30</td>
<td>5.3 — 7.5</td>
</tr>
<tr>
<td>0.31 — 0.40</td>
<td>7.8 — 10.0</td>
</tr>
<tr>
<td>0.41 — 0.50</td>
<td>10.3 — 12.5</td>
</tr>
</tbody>
</table>

Any area of pavement found deficient in thickness by more than 0.50-in. (12.5mm) but not more than 0.75-in. (19mm) or \( \frac{1}{2} \) of the plan thickness, whichever is greater, shall be evaluated by the CITY. If, in the judgment of the CITY, the area of such deficiency should not be removed and replaced, there shall be no payment for the area retained. If, in the judgment of the CITY, the area of such deficiency warrants removal, the area shall be
removed and replaced, at the CONTRACTOR's entire expense, with concrete of the thickness shown on the plans. Any area of pavement found deficient in thickness by more than 0.75-in. (19mm) or more than $\frac{1}{10}$ of the plan thickness, whichever is greater, shall be removed and replaced, at the CONTRACTOR's entire expense, with concrete of the thickness shown on the plans.

No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by the plans.

303.8.3. Pavement Strength Test.

303.8.3.1. For Standard Classes of Concrete. During the progress of the work, the CONTRACTOR shall cast test cylinders, in accordance with ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field, to maintain a check on the compressive strengths of the concrete being placed.

In accordance with ASTM C31 and ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete, four test cylinders shall be taken from a representative portion of the concrete being placed for every 150-cubic yards of concrete pavement placed, but in no case shall less than 2 sets of cylinders be taken from any one day's placement.

After the cylinders have been cast, they shall remain on the job site and then transported, moist cured, and tested by the CITY in accordance with ASTM C31 and ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

In each set, one of the cylinders shall be tested at 7-days, two cylinders shall be tested at 28-days, and one cylinder shall be held or tested at 56-days, if necessary.

If the 28-day test results indicate deficient strength, the CONTRACTOR may, at its option and expense, core the pavement in question and have the cores tested by an approved laboratory, in accordance with ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete and ACI 318 protocol, except the average of all cores must meet 100% of the minimum specified strength, with no individual core resulting in less than 90% of design strength, to override the results of the cylinder tests.

The CONTRACTOR shall be responsible for the proper storage, maintenance, and any required curing of concrete test samples made by the CITY. The CONTRACTOR shall provide and maintain curing facilities for the purpose of curing concrete test specimens on site in accordance with ASTM C31. The cost of all materials used in test specimens and the cost of storing, maintaining and of providing and maintaining curing facilities will not be paid for as a separate contract pay item, and the costs thereof shall be considered incidental to the contract pay items provided.

Cylinders and/or cores must meet minimum specified strength. Pavement not meeting the minimum specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR's expense as shown in Table 303.8.3.1.(a) Standard Class Concrete Deficiency Penalties.

<table>
<thead>
<tr>
<th>Percent Deficient</th>
<th>Percent of Contract Price Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Than 0% — Not More Than 5%</td>
<td>95-percent</td>
</tr>
<tr>
<td>Greater Than 5% — Not More Than 10%</td>
<td>90-percent</td>
</tr>
<tr>
<td>Greater Than 10% — Not More Than 15%</td>
<td>80-percent</td>
</tr>
<tr>
<td>Greater Than 15%</td>
<td>60-percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
</tbody>
</table>

The amount of penalty shall be deducted from payment due to CONTRACTOR; such penalty deducted is to defray the cost of extra maintenance.

The strength requirements for structures and other concrete work are not altered by this special provision. No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.

303.8.3.2. For Performance Classes of Concrete. During the progress of the work, the CONTRACTOR shall cast test cylinders, in accordance with ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field, to maintain a check on the compressive strengths of the concrete being placed.

In accordance with ASTM C31 and ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete, four test cylinders shall be taken from a representative portion of the concrete being placed for every 150-cubic yards of concrete pavement placed, but in no case shall less than 2 sets of cylinders be taken from any one day's placement.
After the cylinders have been cast, they shall remain on the job site and then transported, moist cured, and tested by the CITY in accordance with ASTM C31 and ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

In each set, one of the cylinders shall be tested at 7-days, two cylinders shall be tested at 28-days, and one cylinder shall be held or tested at 56-days, if necessary.

If the 28 day test results indicate deficient strength, the CONTRACTOR may, at its option and expense, core the pavement in question and have the cores tested by an approved laboratory, in accordance with ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete and ACI 318 protocol, to override the results of the cylinder tests.

The CONTRACTOR shall be responsible for the proper storage, maintenance, and any required curing of concrete test samples made by the CITY. The CONTRACTOR shall provide and maintain curing facilities for the purpose of curing concrete test specimens on site in accordance with ASTM C31. The cost of all materials used in test specimens and the cost of storing, maintaining and of providing and maintaining curing facilities will not be paid for as a separate contract pay item, and the costs thereof shall be considered incidental to the contract pay items provided.

Cylinders and/or cores must meet the specified strength in accordance with ACI 318 protocol. Pavement not meeting the specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR'S expense as shown in Table 303.8.3.2.(a) Performance Class Concrete Deficiency Penalties.

<table>
<thead>
<tr>
<th>Percent Deficient</th>
<th>Percent of Contract Price Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Than 0% — Not More Than 5%</td>
<td>95-percent</td>
</tr>
<tr>
<td>Greater Than 5% — Not More Than 10%</td>
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<td>80-percent</td>
</tr>
<tr>
<td>Greater Than 15%</td>
<td>60-percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
</tbody>
</table>

The amount of penalty shall be deducted from payment due to CONTRACTOR; such penalty deducted is to defray the cost of extra maintenance.

The strength requirements for structures and other concrete work are not altered by this special provision. No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.
ITEM 304. SOLID CONCRETE INTERLOCKING PAVING UNITS

304.1. DESCRIPTION
This item shall govern the construction of concrete pavements and medians utilizing interlocking paving units according to lines, grades, locations, and designs as indicated on the plans and specifications, or as established by the Engineer.

304.2. GENERAL
Concrete Interlocking Paving Units are to be used on a site-specific basis only. The Engineer shall specify the special material and construction requirements for each location. Each site-specific application requires proper engineering design for the anticipated traffic volumes and vehicle loads.

304.3. MATERIALS

304.3.1. Concrete Paving Units. Interlocking paving unit construction shall conform to ASTM C936 Solid Interlocking Concrete Paving Units.

Pigment in concrete paving units shall conform to ASTM C979 Pigments for Integrally Colored Concrete.

All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction.

304.3.1.1. Sampling and Testing Units. Manufacturer shall provide access to lots ready for delivery to the CITY for testing in accordance with ASTM C936 for sampling of material prior to commencement of paving unit placement.

Manufacturer shall provide data showing manufactured products meet or exceed ASTM C936 when tested in compliance with ASTM C140 Sampling and Testing Concrete Masonry Units.

304.3.2. Base. The Engineer shall specify the site-specific requirements for each use. Base for pavements may consist of a reinforced concrete base, asphalt, flexible base or stabilized subgrade. Base for medians shall be site specific and according to design parameters of the Engineer.

304.3.3. Bedding and Joint Sand. Bedding and joint sand shall be clean, non-plastic, and free from deleterious or foreign matter. The sand shall be natural or manufactured from crushed rock. When concrete paving units are subject to vehicular traffic, the sands shall be as hard and angular as practically available. Limestone screenings or stone dust shall not be used. Unevenly graded sand with an excess amount of material passing the No. 200 (75-μm) sieve shall not be used.

Sand that is suitable for the manufacturing of concrete is typically suitable for bedding. Grading of sand samples for the bedding course and joints shall be done according to ASTM C136 Method for Sieve Analysis for Fine and Coarse Aggregate. Bedding sand shall conform to the grading requirements of ASTM C33 Concrete Aggregates as shown in Table 304.3.3.(a) Bedding Sand Gradation.

Table 304.3.3.(a) Bedding Sand Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>--in. (9.5-mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75-mm)</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 8 (2.36-mm)</td>
<td>85 to 100</td>
</tr>
<tr>
<td>No. 16 (1.18-mm)</td>
<td>50 to 85</td>
</tr>
<tr>
<td>No. 30 (600-μm)</td>
<td>25 to 60</td>
</tr>
<tr>
<td>No. 50 (300-μm)</td>
<td>10 to 30</td>
</tr>
<tr>
<td>No. 100 (150-μm)</td>
<td>2 to 10</td>
</tr>
</tbody>
</table>

1. Bedding sand may be used for joint sand. However, extra effort in sweeping and compacting the paving units shall be required to fill the joints completely.

If joint sand other than bedding sand is used, it shall conform to the grading requirements of ASTM C144 Aggregate for Masonry Mortar as shown in Table 304.3.3.(b) Joint Sand Gradation. Joint sand shall not be used for bedding sand. Mason sands are typically acceptable only for joint sand provided they meet grading requirements as shown in Table 304.3.3.(b) Joint Sand Gradation.
Table 304.3.3.(b) Joint Sand Gradation (Natural Sand)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>70 to 100</td>
</tr>
<tr>
<td>No. 30 (600 μm)</td>
<td>40 to 75</td>
</tr>
<tr>
<td>No. 50 (300 μm)</td>
<td>10 to 35</td>
</tr>
<tr>
<td>No. 100 (150 μm)</td>
<td>2 to 15</td>
</tr>
<tr>
<td>No. 200 (75 μm)</td>
<td>0</td>
</tr>
</tbody>
</table>

304.3.4. Curbs and Gutters. Edge restraint is a critical design component of interlocking unit pavement. Curbs and gutters for concrete pavement units shall meet the requirements of Item 305.1. Concrete Curb and Gutter with any deviations indicated on the plans or instructed by the Engineer.

304.4. CONSTRUCTION METHODS

Construction methods for each type unit shall be provided by the manufacturer and approved by the Engineer based on the site-specific use. Delivery and paving schedule shall be coordinated to minimize interference with normal use of buildings adjacent to paving.

304.4.1. Delivery, Storage and Handling. Concrete paving units shall be delivered to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by fork lift or clamp lift. Paving units shall be unloaded at job site in such a manner that no damage occurs to the product.

Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. The covering shall be secured in place.

304.4.2. Environmental Conditions. Paving units shall not be installed during heavy rain or snowfall over frozen base materials. Sand shall not be wet or frozen.

304.4.3. Construction Procedure.

304.4.3.1. Base. Construction methods shall follow the requirements of the selected base as contained in these specifications with any deviations indicated on the plans or instructed by the Engineer.

304.4.3.2. Bedding. Sand shall be spread evenly over the base course and screed to a nominal 1-in. (25mm) thickness, not exceeding 1.5-in. (40mm) thickness. The screeded sand shall not be disturbed. Sufficient sand shall be placed to stay ahead of the laid paving units. Bedding sand shall not be used to fill depressions in the base surface. The material shall be of uniform moisture content when spread.

304.4.3.3. Paving Units and Joints. Paving units shall be free of foreign materials before installation.

Jointed shall be made according to manufacturer recommendations. Typically, joints between the paving units will be between 1/16-in. and 1/8-in. (2mm to 5mm) wide except where paving unit shapes require a larger joint.

Gaps at the edges of the paved area shall be filled with cut paving units or edge units. Cuts shall be made with a mounted masonry saw. Units cut no smaller than one-third of a whole paving unit when feasible are recommended along edges subject to vehicular traffic. Areas not feasible shall be neatly grouted and pointed up.

A low amplitude, high frequency plate vibrator shall be used to vibrate the paving units into the sand. The size of compaction equipment shall be selected according to Table 304.4.3.3.(a) Compaction Equipment.

Table 304.4.3.3.(a) Compaction Equipment

<table>
<thead>
<tr>
<th>Paving Unit Thickness</th>
<th>Minimum Centrifugal Compaction Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4-in. (60mm)</td>
<td>3000-lbs. (13-kN)</td>
</tr>
<tr>
<td>3.1-in. (80mm)</td>
<td>5000-lbs. (22-kN)</td>
</tr>
</tbody>
</table>

Dry joint sand shall be swept into the joints and vibrated until joints are full. This will require at least two or three passes with the vibrator. All work to within 3-ft. (1m) of the laying face must be left fully compacted with sand-filled joints at the completion of each day. Excess sand shall be swept off and removed when the job is complete.

The final surface elevation of paving units after removal of excess sand shall conform to the plans, shall not deviate more than ~1-in. (10mm) under a 10-ft. (3m) long straightedge, and shall be ~1-in. to ¼-in. (3- to 6-mm) above adjacent drainage inlets, curb and gutters, concrete collars or channels.

The CONTRACTOR shall resand paving unit joints as necessary for a period of 90-days after completion of work.
305.1. HAND Poured CONCRETE CURB AND GUTTER

305.1.1. Description. Curb and gutter shall be of the type specified and shall be constructed to the size, shape, lines and grade as shown on the plans or as directed by the CITY. Variations in size and shape may be made to fit individual special conditions.

305.1.2. Materials. All materials used in concrete herein specified shall conform to the requirements of the applicable sections of Item 303. Portland Cement Concrete Pavement of these specifications and to additional requirements herein included.

305.1.3. Construction Methods.

305.1.3.1. Excavation. Excavation shall be as provided in Item 203.4. Unclassified Street Excavation, and as shown on the plans. Asphalt millings or extra depth concrete shall be used to correct grade deficiencies identified after subgrade has been checked.

305.1.3.2. Reinforcing Steel. All steel reinforcement shall be accurately placed as shown on the plans and held in place during progress of concreting by such effective means that it shall not be moved out of true position. All bars shall be wired at their intersections and at all laps or splices. All bars at splices shall be lapped a minimum of 20-diameters of the bar or 12-in. (30cm), whichever is greater.

All reinforcement necessary for a section of concrete shall be placed and approved by the CITY before any concrete is deposited in the section. All steel must be free from paint and oil and all loose scale, rust, dirt and other foreign substances shall be completely removed before using.

305.1.3.3. Forms. All forms shall be of wood or steel, straight, free of warp and framed, braced or staked in a substantial and approved manner so as to insure perfect alignment and grade. All forms shall be clean and shall be oiled immediately before concreting. Care shall be taken in removing forms to prevent marring or spalling of the concrete. Forms shall extend the full depth of concrete and be a minimum of 1 7/8-in. (41 mm) in thickness or equivalent when wooden forms are used, or be of a gauge that shall provide equivalent rigidity and strength when metal forms are used.

For curves with a radius of less than 250-ft. (75m), acceptable flexible metal or wood forms shall be used.

All forms showing a deviation of -in. (3mm) in 10-ft. (3m) from a straight line shall be rejected.

305.1.3.4. Expansion Joints. Expansion joints shall be constructed using expansion joint material of an approved type. Expansion joints shall be placed in the curb and gutter at 40 ft. (61 m) intervals and at intersection returns and other rigid structures, or as otherwise specified by the CITY. Tooled joints shall also be placed at 15-ft. (4.5m) intervals or matching abutting sidewalk joints and pavement joints to a depth of ¾ the thickness of the curb. Expansion joints shall also be placed at all intersections with concrete driveways, curbs, buildings and other curbs and gutters. All expansion joints shall be not less than ½-in. (13mm) in thickness, extending the full depth of the concrete and shall be perpendicular and at right angles to the face of the curb. Any expansion material extending above the finished work shall be neatly trimmed to the surface of the finished work. The expansion joints in concrete pavement shall coincide with the expansion joints in the curb and gutter and sidewalk. Longitudinal dowels, across the expansion joints in the curb and gutter, shall be required. There shall be three No. 4 round, smooth bars for dowels at each expansion joint, spaced in accordance with standard reinforcement steel specifications. The dowel shall be a minimum of 24-in. (0.6m) in length. One-half of the dowel shall be coated with asphalt and terminated with an expansion cap. The cap shall provide a minimum of 1-in. (25mm) free expansion. Dowels shall be supported by an approved method to provide a true horizontal and longitudinal alignment.

In the event that concrete pavement is to be placed in the street, the contraction (dummy) joints in the curb, gutter and/or combined curb and gutter shall be in strict alignment with the contraction (dummy) joints in the pavement and may be marked with an approved tool to the design by the CITY. If the joints are not constructed by marking, they shall be sawed at the time of sawing joints in the concrete slab and to the same depth as those in the slab. Expansion joints of the size of those in the pavement shall be placed through the curb and gutter at the point of, and in strict alignment with, expansion joints in the pavement.

All joints through the gutters (not curb) shall be sealed with hot-poured polymer sealer unless otherwise specified.

All joints shall be constructed in a neat and workmanlike manner, with edges rounded, in conformity with the plans and specifications and at location as shown on the plans or as designated by the CITY.

305.1.3.5. Concrete Placement. No concrete shall be placed when the air temperature is less than 35°F (1.7°C), unless permission to do so is granted by the CITY in writing. When such permission is granted, the CONTRACTOR shall furnish sufficient protective material and devices to enclose and protect the fresh concrete in
such a way as to maintain the temperature of the air surrounding the fresh concrete at not less than 45°F (7.2°C) for a period of at least 5-days.

Concrete shall be deposited so as to maintain a horizontal surface and shall be thoroughly and continuously worked into all spaces and around any reinforcement so as to form a dense voidless mass. The coarse aggregate shall be worked away from contact with the forms so as to form a smooth, hard exposed concrete surface.

The concrete for curb and gutter shall preferably be placed continuously between expansion joints. If construction joints are allowed at other locations by the CITY, they shall be properly constructed with wooden bulkheads so as to completely separate adjacent concrete sections.

Integral curb, with or without gutter, when designated in the plans or specifications, shall be placed while the concrete in the base or pavement is still plastic and shall be spaded and consolidated with the concrete slab in order that a thorough bond shall be obtained.

Integral curb, with or without gutter, shall be placed in sections equal to the adjoining concrete slab length, with expansion joints provided as specified herein.

Where curb and gutter is not adjacent to new pavement, 2-in. (5cm) of sand cushion shall be used. After the fine grading has been completed, a 2-in. (5cm) layer of sand or suitable gravel cushion shall be evenly spread over the subgrade for curb and gutter, thoroughly wetted and tamped into place to the satisfaction of the CITY. The forms shall be placed upon this sand or gravel base. A screed shall be used to shape the sand cushion to fit a plane parallel to the top of gutter. A curb and gutter machine may be used, if approved by the CITY.

305.1.3.6. Finishing. After the concrete has been struck off and while it is still plastic, the exposed surfaces may be plastered with ¼-in. (6mm) mortar topping. The mortar topping shall be applied with a steel “mule,” or a finishing tool or method which produces results equivalent to that obtained with the mule. All exposed surfaces shall then be floated or troweled and lightly brushed as required by the CITY to produce a smooth and uniform finish. Excess working of the surfaces shall be avoided. Excess water, laitance and inert materials shall be removed from the surfaces.

The top of all the work and the face of all curbs shall be checked for irregularities as soon as the surface is finished, using a 10-ft. (3m) straightedge, and the maximum distance from the straightedge to the concrete shall not exceed ¼-in. (6mm). All variations greater than ¼-in. (6mm) shall be immediately corrected. All honeycombed areas disclosed by removal of forms shall be immediately chipped out and patched with Portland cement mortar.

305.1.3.7. Curing. After finishing operations are completed, the concrete surface shall be sprayed with concrete curing compound. The surface of the concrete shall be kept thoroughly damp between the completion of the finishing operations and the application of the curing compound. The curing compound shall be applied under pressure, by means of a spray nozzle, at a rate not to exceed 200-sq.-ft.-per-gallon (4.9-m²-per-L). A minimum of 72-hours curing time shall be required.

Forms shall remain in place at least 24-hours after completion of the concrete placement for the curb and gutter. Should the CONTRACTOR elect to remove the forms before the minimum curing time has elapsed, it shall apply curing compound to the newly exposed vertical faces. Forms for inside curb faces may be removed in approximately 3-hours, provided that the concrete has set sufficiently to permit form removal without curb damage.

305.1.3.8. Finishing Exposed Surfaces. Exposed surfaces of curb and gutter shall receive the type of finish as specified by the CITY in accordance with Item 702.4.13. Finishing Exposed Surfaces.

305.2. CONCRETE SIDEWALKS, DRIVEWAY APPROACHES, AND BARRIER FREE RAMPS

305.2.1. Description. This item shall govern the construction of barrier free access ramps, concrete sidewalks, driveways and approaches conforming to the lines, grades, locations and designs as indicated on the plans and specifications or as established by the CITY.

305.2.2. Materials.

305.2.2.1. Concrete. All materials and requirements for concrete shall conform to the requirements of Item 305.1. Concrete Curb and Gutter.
305.2.2. Reinforcement. Driveway approaches No. 3, 12-in O.C.E.W or 6-in x 6-in #10-in wire mesh only when approved by the City of Temple Engineer. Sidewalk reinforcing (except in driveway approach) may be No. 3 bars on 16-in O.C.E.W. or 6-in x 6-in #10 wire mesh.

305.2.3. Construction Methods.

305.2.3.1. General. Concrete sidewalks shall have a minimum thickness of 4-in. (10cm), except that sidewalks constructed in driveway approach sections shall have a minimum thickness equal to that of driveway approach or as called for by plans and specifications within the limits of the driveway approach. Standard slope for walks shall be ¼-in.-per-ft. (20-mm-per-m) in the direction of the curb or street with a tolerance of ⅛-in.-per-ft. (10-mm-per-m). The construction of the driveway approach shall include the variable height radius curb in accordance with the plans and details.

Ramps shall comply with provisions of Texas Accessibility Standards including location, slope, width, shapes, texture and coloring.

At the locations shown on the plans or at locations designated by the CITY, the separate curb, integral curb or curb and gutter shall be laid down to a uniform width of not less than the specified height of the curb from the back of the curb line for access to future driveways. The return radii and partial curb return shall be built from the face of the curb to the back of the curb lay-down.

Where a driveway approach or ramp is to be constructed at a location where there exists a separate curb and gutter, said curb and gutter shall be removed for the full width of the gutter to the nearest joint or to a sawed point at the point of radius. On concrete pavement with monolithic curb, the breakout line shall be 12-in. (300mm) from the face of the curb line and shall be parallel to it and form a right angle with the concrete surface. The breakout line shall be a sawed groove in accordance with the requirements of Item 402.2. Sawing. Alternately, the CITY may approve use of equipment designed to cut concrete curbs. All faces and edges exposed as a result of cutting shall be smoothed.

305.2.3.2. Excavation. Excavation required for the construction of sidewalks and driveways shall be to the lines and grades as established by the CITY or as shown on the plans.

305.2.3.3. Fine Grading. The CONTRACTOR shall do all necessary filling, leveling and fine grading required to bring the subgrade to the exact grades specified and compacted to at least 90-percent of maximum density as determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)). Moisture content shall be within minus-2- to plus-4-of-optimum. Any over-excavation shall be repaired to the satisfaction of the CITY.

305.2.3.4. Forms. Forms shall be of wood or metal, of a section satisfactory to the CITY, straight, free from warp and of a depth equal to the thickness of the finished work. Forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

305.2.3.5. Reinforcement. Steel bar reinforcement, when required, shall be placed according to the methods in Item 303.2.9. Steel Reinforcement. If wire fabric is permitted, it shall be placed in accordance with Item 303.2.10. Steel Wire Reinforcement.

305.2.3.6 Concrete Placement. Concrete placement shall be in accordance with the relevant provisions of Item 305.1. Concrete Curb and Gutter.

305.2.3.7. Finishing. Concrete sidewalks and driveway approaches shall be finished to a true, even surface. They shall be troweled and then brushed transversely to obtain a smooth uniform brush finish. Joint and sides shall be edged with suitable tools.

305.2.3.8. Joints. Expansion joints for sidewalks and driveways shall be formed using expansion joint material of an approved type and shaped to the section. Expansion joints shall be placed in the sidewalk at 40-ft. (12m) intervals or as otherwise specified by the CITY. Expansion joints shall also be placed at all intersections, sidewalks with concrete driveways, curbs, formations, other sidewalks and other adjacent old concrete work. Similar material shall be placed around all obstructions protruding into or through sidewalks or driveways. All expansion joints shall be ⅛-in. (13mm) in thickness. Edges of all construction and expansion joints and outer edges of all sidewalks shall be finished to approximately a ⅛-in. (13mm) radius with a suitable finishing tool. Sidewalks shall be marked at intervals equal to the width of the walk with a marking tool. When sidewalk is against the curb, expansion joints and tool grooves shall match those in the curb.

305.2.3.9. Curing. Sidewalks and driveways shall be cured in accordance with the requirements of Item 305.1. Concrete Curb and Gutter.
305.3. CONCRETE MEDIANS

305.3.1. Description. This item shall consist of concrete medians in accordance with these specifications and in conformance with the lines and grades established by the CITY and details shown on the plans.

305.3.2. Materials. All material requirements for constructing concrete medians shall conform to the requirements of Item 305.1. Concrete Curb and Gutter. Where a monolithic concrete median is indicated, concrete and reinforcement shall match the adjacent pavement.

305.3.3. Construction Methods.

305.3.3.1. Excavation. Excavation and fine grading shall be done according to Item 203.4. Unclassified Street Excavation, and shall be subsidiary to the item.

305.3.3.2. Forms. Forms, where required, shall conform to the requirements of Item 305.1. Concrete Curb and Gutter and shall be of a depth equal to the depth of the required section. Forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

305.3.3.3. Concrete Placement. Concrete placement shall be in accordance with the relevant provisions of Item 305.1. Concrete Curb and Gutter.

305.3.3.4. Finishing. The surface shall be finished with a float and lightly brushed to obtain a uniform finish. Tooled joints shall be placed longitudinally and transversely at intervals not to exceed 6-ft. (1.8m) center to center, as shown on the plans, or as directed by the CITY. Joints in the median shall coincide with joints in curb and gutter. Expansion joint material shall be placed between the median and the back of curb and around all obstructions protruding through the concrete median.

305.4. REINFORCED CONCRETE HEADERS

305.4.1. Description. This item shall govern the construction of reinforced concrete header to the size, shape and at the location shown on the plans.

305.4.2. Materials. Material requirements shall be the same as those for Item 303. Portland Cement Concrete Paving.

305.4.3. Construction Methods. Concrete header shall be constructed at the location(s) shown on the plans and shall be constructed as shown on the plans in accordance with Item 303. Portland Cement Concrete Paving.
## DIVISION 400
### ROADWAY MAINTENANCE AND REHABILITATION

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ITEM 401. CRACK SEALING

401.1. GENERAL
Crack sealing compound shall consist of hot poured polymer or ready-mixed cold-applied sealant, or other material approved by the CITY. It shall not crack or break when exposed to low temperatures. The cured sealant must not pick up or "track" at elevated road temperature.

401.2. MATERIALS
401.2.1. Hot Poured Polymer. The sealing compound shall meet the requirements of Item 303.2.14.1.1. Hot Poured Polymer.
401.2.2. Ready-Mixed Cold-Applied. This sealant shall meet the requirements of Item 303.2.14.1.2. Ready-Mixed Cold-Applied.
401.2.3. Thermoplastic Cold-Applied. If approved by the CITY, thermoplastic cold-applied jointing material may be used according to manufacturer’s recommendations.
401.2.4. Rejection. Materials may be rejected for failure to meet any of the requirements of this specification.

401.3. METHODS
Routine pavement cracks shall be filled to a depth of 1½-in. (3.8cm). Materials shall generally be handled and applied according to the manufacturer’s recommendations, with additional requirements as stated herein.
401.3.1. Hot Poured Polymer. The sealing compound shall be melted in an approved oil-batch kettle with continuous mechanical agitation. The kettle shall be equipped with temperature indicators. The CITY shall determine the optimum temperature for proper pouring fluidity, and the CONTRACTOR shall maintain the material within close range of optimum temperature. At no time shall the temperature exceed 450°F (232°C). The sealing compound shall not be poured at atmospheric temperatures below 32°F (0°C).
401.3.2. Ready-Mixed Cold-Applied. Permeation of cracks shall principally be achieved without the task of squeegeeing. However, squeegeeing is recommended to assist permeation and to allow sealant to become rapidly tack-free. Sealant shall "set" in a fixed position within 40-minutes after application, to where traffic may be restored to the pavement without the effects of "tracking." "Tracking" shall be averted without the use of topping materials such as sand.
402.1. GENERAL REQUIREMENTS

Also refer to Standard Drawing 3070 for more information.

402.1.1. Marking. All pavement cut repairs shall be marked with the CONTRACTOR’S name if required by the CITY.

402.1.2. Thoroughfares. No interference with traffic flow on the thoroughfares shall be permitted during the hours of 6:30 a.m. to 9:30 a.m. and 3:30 p.m. to 6:30 p.m., Monday through Friday, unless directed otherwise by the CITY. Emergency closures during these hours shall be with the approval of the CITY.

Streets shall be maintained in accordance with Item 203.2. Maintenance of Streets During Construction. When work is stopped for the day, all lanes of arterial or collector streets shall be opened to traffic in accordance with the traffic control plan. A traffic lane shall be considered satisfactorily open if it is paved with hot-mix or cold-mix asphalt paving, or paved with another suitable material approved by the CITY, or covered.

If the cut is to be covered, the CONTRACTOR shall use steel plates of sufficient strength and thickness to support all the traffic. A transition of hot-mix or cold-mix asphalt conforming to the requirements of Item 302. Asphalt Pavement shall be constructed from the top of the steel plate to the existing pavement to create a smooth riding surface.

Exceptions to these specifications must be approved by the CITY.

402.1.3. Minimum Size of Repair. Sidewalks shall be removed and replaced to the nearest existing joint. No horizontal dimension of any cut shall be less than 4-ft. in a paved street or alley. Except for sidewalks, where saw-cut locations coincide with or fall within 3-ft. (0.9m) of the present location of either dummy joints, cold joint, construction joints, expansion joints, or edge, breakout shall be to the existing joint or edge, there not being a requirement to cut an additional groove. For sidewalks, if a saw cut falls within 18-in. (0.46m) of a construction joint, cold joint, expansion joint or edge, the materials to be removed shall be removed to the joint or edge.

No sidewalk or driveway section to be replaced shall be smaller than 30-in. (0.75m) in either length or width unless otherwise approved by the CITY.

402.2. SAWING

402.2.1. Description. This Item shall apply in the removal of bituminous or concrete pavement, curb, gutter, sidewalk or driveways. This item shall also govern for the sawing of weakened plane joints (contraction joints). Sawing shall be in accordance with the requirements of this item unless otherwise shown on the plans or in the special provisions.

The removal and replacement of portions of permanent pavement (Portland cement concrete or hot-mix asphalt), drives, slabs, sidewalks, etc. shall require a breakout groove to be sawed by the use of an approved power-driven concrete saw in accordance with this specification or as directed by the CITY.

402.2.2. Equipment. The saw shall be suitable for the work to be performed including dust control and shall be maintained in good operating condition.

Saw blades shall make a clean, smooth cut, producing a groove -in. (3mm) to ¼- in. (6mm) wide and to the full depth required by these specifications or as shown on the plans.

The saw, with its control devices, shall be mounted on a sturdy frame supported on rubber-tired wheels.

402.2.3. Construction Methods. Provide reasonable dust control based upon project location.

The edge of pavements, curb, gutter, sidewalk and/or driveways shall be neatly sawed. Saw cuts shall be made perpendicularly to the surface to a minimum depth of 1½-in. (38mm) or as directed by the CITY. The edges of pavement and appurtenances damaged subsequent to sawing shall again be saw cut to neat straight lines for the purpose of removing the damaged areas. Such saw cuts shall be parallel to the original saw cut.

Concrete sidewalk or driveway to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk.

402.1
402.3. REPLACING PAVED SURFACES

402.3.1. General. Repairs are to be made as rapidly as possible. Use of fast setting concrete and similar techniques are encouraged. Completion of the job, including replacement of pavement and cleanup, shall normally be accomplished within 10-working-days after the repair work involving the cut is made.

Removal of unsatisfactory work shall begin within 15-days and replacement shall be completed within 30-days of written notification by the CITY.

402.3.2. Temporary Pavement Repair. In the event it is necessary to place a temporary surface on any cut opening, it shall be composed of permanent type paving material, specifically excluding gravel or flexbase as the surface material, unless approved by the CITY. Temporary surfaces shall be adequately compacted and sealed to prevent degradation of the repair during the temporary period. Any temporary surface that fails to provide a nondegraded riding surface shall be removed and replaced at the CONTRACTOR’s expense.

402.3.3. Replacing Curb, Gutter, Sidewalks, Driveways, Etc. Curb, curb with gutter, sidewalks, drives, etc. shall be replaced with Class A or Class PA concrete as specified by the CITY, unless specified otherwise by the CITY.

402.3.3.1. Replacement of Curb, Gutter, Sidewalks, Driveways, Etc. The removal or replacement of curbs, curbs and gutters, sidewalks, driveways, etc. in excess of that specified or approved by the CITY shall be at the expense of the CONTRACTOR approved by the CITY shall be at the expense of the CONTRACTOR.

402.3.4. Replacing Reinforced Concrete Pavement. The existing pavement shall be sawed in accordance with Item 402.2. Sawing and removed to a line 12-in. (30cm) back of the firm banks of the trench. The concrete replacement shall be reinforced with like-size bars as the existing pavement, #3 minimum, lapping 30 diameters on splices, and spaced on a minimum of 24-in. (61cm) centers each way. The replacement concrete shall match the thickness of the existing concrete pavement, minimum of 6-in. (15cm) thick.

The new concrete pavement shall be protected from vehicular traffic for a minimum of 7-days or until a minimum flexural strength of 500-psi (3450-kPa) is obtained or until a compressive strength of 3000-psi (20700 kPa) is obtained.

The concrete shall be Class A or Class PA as specified by the CITY, unless specified otherwise by the CITY. If the limiting trench width occurs within 3-feet (0.9m) of an expansion joint, construction joint or dummy joint, the CITY may order the pavement removed and replaced to the existing joint.

402.3.5. Replacing full depth Hot-Mix Asphalt Pavement with a Concrete Base and Asphalt surface course. The existing pavement shall be removed to a neat line at least 12-in. (30cm) back of the firm banks of the trench. The asphalt surface course over the concrete base shall be hot-mix asphalt pavement of the type, thickness and class as indicated on the plans. The concrete base shall be of the class and thickness as specified on the plans.

402.3.6. Replacing full depth Hot-Mix Asphalt Pavement on a Natural Soil Base with same. Unless otherwise specified by the CITY, the existing hot-mix asphalt shall be cut back to produce a vertical edge for the full depth of the paving. The cut shall extend 12-in. (30cm) back of the firm banks of the trench.

The cut shall be replaced with a natural soil base compacted to 95% Standard Proctor density. All courses of hot-mix asphalt pavement shall be of the types and classes as indicated on the plans.

402.3.7. Replacing Hot-Mix Asphalt Pavement on a Flexible Base with same. Unless otherwise specified by the CITY, the existing hot-mix asphalt shall be sawed 12-in. (30cm) back from the firm banks of the trench. The cut shall be replaced with a compacted flexible base, as specified in Item 301.5. Flexible Subbase or Base (Crushed Stone/Concrete), to match the existing thickness of the base, 6-in. (15cm) minimum.

All courses of hot-mix asphalt pavement shall be of the types and classes as indicated on the plans.
402.3.8. Replacing One- or Two-Course Surface Treatment or Penetration Type Pavement. The pavement shall be replaced as specified by the CITY in accordance with Item 404. Surface Treatments.

402.3.9. Replacing Gravel Pavement on a Dirt Base. The existing gravel pavement shall be replaced with compacted flexible base, as specified in Item 301.5. Flexible Subbase or Base (Crushed Stone/Concrete). The minimum thickness of flexible base shall be 8-in. (20cm) unless otherwise specified by the CITY.
ITEM 403. ASPHALTIC PAVEMENT REPAIR

403.1. DESCRIPTION
Asphaltic Pavement Repair shall be used only for patching utility cuts, potholes and temporary pavement repairs.

403.2. MATERIALS AND MIXING

403.2.1. Performance Guaranty. The supplier of the material shall guarantee the performance of the patching mix to meet the following requirements:

(1) The material shall remain workable, in an uncovered stockpile, if applicable, for a period of not less than 12-months.

(2) Containerized material, if applicable, shall have a shelf life and remain workable for a period of not less than 12-months.

(3) Repaired potholes shall not show any significant signs of shoving, rutting, tracking, kick-up, or ravel-out within a period of 12-months from the time of repair.

403.2.2. Rejection. In the event a material furnished does not meet any of the specified requirements (regardless of weather, test's acceptability, methods of repair, or other conditions), the material shall be removed and replaced at no cost to the CITY.

The Engineer shall determine the quantity of unacceptable material and the supplier shall be required to deliver an equal quantity of acceptable material. The material shall be delivered to the location(s) designated by the Engineer within 14-days from the date of written notification from the Engineer.

In the event that the material supplier cannot provide acceptable material, the Engineer shall determine the quantity of the unacceptable material and the supplier shall reimburse the CITY based on the unit bid price. The reimbursement shall be submitted to the CITY in the form of a cashier’s check within 28-days from the date of written notification from CITY.

403.2.3. Hot-Mix, Cold-Laid Asphaltic Concrete (Cold Mix). Hot-Mix, Cold-Laid Asphaltic Concrete shall consist of surface mix.

403.2.3.1. Asphaltic Mixture. The asphaltic material shall form from 4% to 7.5% of the mixture by weight. Asphalt for the mixture shall be a bituminous material in accordance with Item 302.3. Bituminous Materials as determined by the mix manufacturer and CITY. The grade of asphalt to be used shall be determined by the CITY after design tests have been made using the mineral aggregate approved for use in the construction. The CONTRACTOR shall notify the CITY of asphaltic material source prior to production of the asphaltic mixture, and this source shall not be changed during the course of the project except by written permission of the CITY.

403.2.3.2. Tack Coat. The liquid asphalt material used for tack coat should be MS-2 or SS-1 in Item 302.3.4. Emulsified Asphalt, Restorative Seal in Item 302.3.6. Specialty Emulsions or one of the other various grades of materials (selected by the CITY) listed under Item 302.3.4. Emulsified Asphalt.

403.2.3.3. Primer. When approved by the Engineer, the use of an asphaltic primer will be permitted. When used, the primer shall be added as directed by the Engineer during the mixing.

403.2.3.4. Mineral Aggregate. The material shall be crushed and screened as necessary to meet the requirements hereinafter specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

Unless otherwise specified, the grading of mineral aggregate shall conform to the limitations as shown in Table 403.2.3.4.(a) Aggregate Grading for Cold Mix Asphalt Repair.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>% Aggregate by Weight</th>
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<tbody>
<tr>
<td>Passing -in. sieve</td>
<td>100%</td>
</tr>
<tr>
<td>Passing ¼-n. sieve</td>
<td>80 to 100%</td>
</tr>
<tr>
<td>Passing ¼-in. sieve, retained on No. 10 sieve</td>
<td>27 to 58%</td>
</tr>
<tr>
<td>Total retained on No. 10 sieve</td>
<td>42 to 58%</td>
</tr>
<tr>
<td>Passing No. 10 sieve, retained on No. 40 sieve</td>
<td>6 to 32%</td>
</tr>
<tr>
<td>Passing No. 40 sieve, retained on No. 80 sieve</td>
<td>4 to 32%</td>
</tr>
<tr>
<td>Passing No. 80 sieve, retained on No. 200 sieve</td>
<td>3 to 32%</td>
</tr>
<tr>
<td>Passing No. 200 sieve</td>
<td>1 to 8%</td>
</tr>
</tbody>
</table>
403.2.3.5. Water. Water in an amount not to exceed 3% by weight of the mixture, as determined by ASTM D1641 Practice for Conducting Outdoor Exposure Tests of Varnishes, may be used in preparing the mixture. In the event water is used in the mixing operation, adequate measuring devices as approved by the Engineer shall be used, and the water shall be administered to the mix through an approved spray bar.

When used, the water shall be added as directed by the Engineer during the mixing.

403.2.3.6. Mixture Preparation. The materials may be mixed on the job or at a central mixing plant and shipped ready for use. Mixtures that do not remain workable a sufficient period of time to permit unloading by normal means, proper spreading, blading and rolling shall not be acceptable.

Mixing Plants. Mixing plants may be either the weight-batching type plant, the continuous mixing type plant, or the drum mixing type plant as described in Item 302.9.5. Mixing Plants.

Equipment. Equipment for storage, weighing and heating of materials shall be as described in Item 302.9.4. Equipment.

403.2.4. High Performance Cold Mix Asphaltic Concrete. This specification shall govern for asphaltic concrete mixture intended primarily as a cool to cold wet-weather, high-performance, pothole-patching mix for maintenance. It is primarily crushed stone, asphaltic concrete with asphalt additives.

When shown on the plans or requisition, the mixture shall be provided in airtight, resealable plastic buckets of 4- to 5-gal. (15- to 19-L) capacities.

403.2.4.1. Mixture Performance Criteria. The patching mix shall not require the use of a tack coat or a primer for adherence to the patch area. The mix shall be capable of being placed in air temperatures from -15°F to 100°F (-26°C to 38°C) and shall maintain adhesive qualities in areas that are damp or wet at the time of application. The repaired areas shall remain flexible and cohesive to an air temperature of -15°F (-26 °C) and shall have the capability of immediately being opened to traffic with no kick-up or ravel-out.

403.2.4.2. Mixture Properties. The mixture shall comply with the following requirements.

403.2.4.2.1. Aggregate. Aggregate shall have a maximum particle size of ½-in. (12.7 mm).

403.2.4.2.2. Resistance to Water Damage. Tests shall be conducted according to TxDOT methods. The as-received mix shall be evaluated for resistance to water damage by soaking a 3.5-oz. (100-gram) representative sample of the total mixture in 7-fluid-ounces (200-milliliters) of distilled or deionized water at 140 ± 2°F (60 ± 1°C) for 24 ± 2 hours. The soaking test shall be accomplished in a glass beaker of approximately 14-fluid-ounces (400-milliliters). Upon completion of the 24-hour period, the mixture shall be evaluated while submerged in the testing water. The material shall show no visible evidence of stripping.

403.3. METHODS

If CITY requires base, subbase, and/or subgrade repair by a separate method than the asphaltic patch, the base, subbase, and/or subgrade shall be repaired as specified by the CITY. Otherwise, repair of the base, subbase, and/or subgrade may be accomplished using the asphaltic patch material when it is specifically designed to do so. CONTRACTOR shall use all repair material(s) as instructed by its respective manufacturers.
ITEM 404. SURFACE TREATMENTS

404.1. DESCRIPTION
This Item provides specifications for the construction and quality control required for the proper application of pavement surface treatments.

404.2. GENERAL
404.2.1. Environmental Conditions. Surface treatments shall not be applied when the air temperature is below 60°F (16°C) and is falling but may be applied when the air temperature is above 50°F (10°C) and is rising, the air temperature being taken in the shade and away from artificial heat. If the air temperature does not meet these criteria, the CITY shall evaluate the asphaltic material for applicability. Surface treatments shall not be applied when the temperature of the surface to which the surface treatment is to be applied is below 60°F (16°C). When latex modified asphalt cement is specified, surface treatments shall not be applied when the air temperature is below 80°F (27°C) and is falling, but may be applied when the air temperature is above 70°F (21°C) and is rising and shall not be applied when the temperature of the surface on which the surface treatment is to be applied is below 70°F (21°C). Asphaltic material shall not be placed when, in the opinion of the CITY, general weather conditions are not suitable.

Slurry seal or micro-surfacing shall only be applied between March 1 and December 1. Neither treatment shall be applied under any of the following conditions:

1. In the period following precipitation with water remaining on the surface to be coated
2. In foggy conditions
3. If there is a threat of rain before the treatment can fully cure
4. If there is danger that the finished product will freeze within 24-hours of application
5. If weather conditions could delay opening to traffic beyond the time specified by the Engineer.

404.2.2. Storage and Stockpiling. Precautions shall be taken to insure aggregate does not become contaminated with over-sized rock, clay, silt or excessive amounts of moisture during storage. The stockpile shall be kept in areas that have good drainage. Segregation of aggregates proposed for use and as supplied to the mixing plant shall be avoided.

The CONTRACTOR shall be required to provide a suitable storage facility for all equipment and materials needed to perform the work. This site should be located as close as possible to the area of work being done to reduce turn around time and insure an acceptable rate of work. The Engineer shall subject any site selected to final approval.

Temporary stockpiling of aggregates on the roadways shall be permitted, provided the stockpiles are spaced not less than 1,000-ft. (300m) apart and are so placed that they neither obstruct traffic nor interfere with roadway drainage. The CONTRACTOR shall be responsible for the proper preparation of all stockpile debris necessary for protection of the aggregate and to prevent any combination thereof.

404.3. SLURRY SEALS AND MICRO-(RE)SURFACING
The surface treatment shall consist of a mixture of an approved emulsified asphalt, mineral aggregate, mineral filler, water and specified additives, proportioned, mixed and uniformly spread over a properly prepared surface. The completed slurry seal shall leave a homogenous mat, adhere firmly to the prepared surface and have a skid resistant surface texture.

404.3.1. Laboratory Evaluation. Before work commences, the CONTRACTOR shall submit a signed original of a mix design containing the test results and proportioning of the specific materials to be used on the project. A qualified laboratory must have performed this design. Previous lab reports covering the exact materials to be used may be accepted provided they were made during the calendar year. This initial mix design shall be done at the CONTRACTOR'S expense. Upon receipt of the original mix design, an independent qualified laboratory selected by the CITY shall perform tests using the same materials as used in the initial mix design for verification of the results. This testing shall be done at the CITY'S expense. No work shall begin until all materials and/or mix design proportions have met the specifications as required. Once the materials are approved, no substitution shall be permitted unless first tested and approved by the methods stated above.

404.3.2. Materials.
404.3.2.1. Mineral Filler. Mineral filler shall be a recognized brand of non-air-entrained Type I or II Portland that meets the requirements of ASTM D242 Mineral Filler For Bituminous Paving Mixtures, if required by
the mix design. 0.5% to 2% by dry weight of aggregate shall be the range of mineral filler in the mix design. The mineral filler shall be considered as part of the dry aggregate.

404.3.2.2. Water. All water shall be potable and compatible with the slurry mix. The CONTRACTOR must insure compatibility. The percent of water in the mix design shall be as required to produce proper mix consistency.

404.3.2.3. Additives. The mix design laboratory as part of the mix design shall approve any additive used to accelerate or retard the break-set of the surface treatment materials. The amount and type of additive (if needed) shall be shown on the mix design.

404.3.2.4. Aggregate. The mineral aggregate shall consist of natural or manufactured crushed stone such as granite, slag, limestone or other high quality aggregates or a combination thereof that conforms to the quality requirement of ASTM D1073 Fine Aggregate for Bituminous Paving Mixtures, and shall be free of dirt, organic matter, clay balls, adherent films of clay, dust or other objectionable material. If the CITY accepts aggregate that is not free of dirt, organic matter, clay balls, adherent films of clay, or dust, the CITY shall have the option to evaluate and accept or reject chemical modifiers of the asphaltic material. The aggregate shall contain no free water. Smooth textured sands of less than 1.25-percent water absorption shall not exceed 50-percent (by weight) of the total aggregate blend. For heavy-duty surface requirements, 100% crushed material is required. The aggregate shall meet the gradations as shown in the Table 404.3.2.4.(a) Slurry Seal Aggregate Requirements or Table 404.3.2.4.(b) Micro-Surface Aggregate Requirements, as appropriate, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves or vice versa. The gradation type to be used shall be as designated by the Engineer.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>70-90</td>
</tr>
<tr>
<td>No. 8</td>
<td>45-70</td>
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<td>No. 16</td>
<td>28-50</td>
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<td>No. 30</td>
<td>19-34</td>
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<td>No. 50</td>
<td>12-25</td>
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<td>No. 100</td>
<td>7-8</td>
</tr>
<tr>
<td>No. 200</td>
<td>5-15</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
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<tr>
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<td>99-100</td>
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<tr>
<td>No. 4</td>
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<tr>
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<td>No. 16</td>
<td>25-46</td>
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<td>No. 30</td>
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<tr>
<td>No. 100</td>
<td>7-18</td>
</tr>
<tr>
<td>No. 200</td>
<td>5-15</td>
</tr>
</tbody>
</table>

404.3.2.5. Emulsified Asphalt. The asphalt emulsion shall be homogeneous and show no separation after mixing.

404.3.2.5.1. Slurry Seal. As directed by the Engineer, one of the following two grades of emulsion shall be selected. Grade CQS-1 h (Quick Set) shall be specified on streets where the amount of time the street can be closed is restricted.

Grade SS-1h: Conforming to the requirements specified in ASTM D977 for Emulsified Asphalt.
Grade CQS-1h: Conforming to the requirements specified in ASTM D2397 for Cationic Emulsions (Quick Set).

Any emulsion used for slurry will be with 4% polymer modifier content based on bitumen weight, certified by the emulsion supplier, which shall be milled into the emulsion or blended into the asphalt prior to the
emulsification process. It shall pass all applicable storage and settlement tests. The cement-mixing test shall be waivered.

404.3.2.5.2. Micro-Surface. Emulsified asphalt for micro-surfacing shall be a quick-set polymer modified cationic type CSS-1 h emulsion and conform to the requirements specified in AASHTO M208 and ASTM D2397 Cationic Emulsified Asphalt. It shall pass all applicable storage and settlement tests. A minimum of 3% polymer modifier content based on bitumen weight content, certified by the emulsion supplier, along with special quick-setting emulsifier agents, shall be milled into the asphalt emulsion. The cement mixing test shall be waived. The emulsified asphalt shall be so formulated that when the paving moisture is applied with the relative humidity at no more than 50% and ambient air temperature of at least 75°F (24°C), it will cure sufficiently such that rolling traffic can be allowed in one-hour with no damage to the surface.

404.3.2.6. Mixture Tests. Mixtures shall meet the requirements in Table 404.3.2.6.(a) Slurry Seal Mixture Requirements or Table 404.3.2.6.(b) Micro-Surface Mixture Requirements, as appropriate when tested by the given methods.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set time</td>
<td>ASTM D3910 (same as above)</td>
<td>12-hours maximum</td>
</tr>
<tr>
<td>Cure time</td>
<td>ASTM D3910 (same as above)</td>
<td>24-hours maximum</td>
</tr>
<tr>
<td>Wet stripping test</td>
<td>ISSA TB114</td>
<td>80%-coating minimum</td>
</tr>
<tr>
<td>Wet track abrasion test</td>
<td>ASTM D3910 (same as above)</td>
<td>75-g/ft² maximum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set time</td>
<td>ASTM D6372 Standard Practice for Design, Testing, and Construction of Micro-Surfacing</td>
<td>12-hours maximum</td>
</tr>
<tr>
<td>Cure time</td>
<td>ASTM D6372 (same as above)</td>
<td>24-hours maximum</td>
</tr>
<tr>
<td>Wet stripping test</td>
<td>ISSA TB114</td>
<td>80%-coating minimum</td>
</tr>
<tr>
<td>Wet track abrasion test</td>
<td>ASTM D6372 (same as above)</td>
<td>75-g/ft² maximum</td>
</tr>
<tr>
<td>Hveem stability, exceeding a height twice the maximum aggregate size</td>
<td>ASTM D1560 Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus</td>
<td>35 minimum</td>
</tr>
<tr>
<td>Set Time 30-minute Blotter test</td>
<td>ISSA TB102</td>
<td>No Brown Stain</td>
</tr>
<tr>
<td>Displacement test</td>
<td></td>
<td>No Displacement</td>
</tr>
<tr>
<td>Water resistance test @ 30-Minutes</td>
<td></td>
<td>No Discoloration</td>
</tr>
</tbody>
</table>

404.3.3. Equipment. All methods and equipment employed in performing the work shall be subject to the approval of the Engineer before work is started and whenever found unsatisfactory they shall be changed and improved as required. All equipment must be maintained in a satisfactory condition. The CONTRACTOR will provide suitable crack and pavement cleaning equipment, hand tools and any support equipment as necessary to perform the work.

404.3.3.1. Calibration. Each piece of equipment to be used shall be calibrated in the presence of the Engineer prior to construction. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the calendar year. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

404.3.3.2. Verification. Test strips shall be laid (location to be determined by the Engineer) before construction begins. The Engineer will observe the test strip for verification or rejection according to the specifications. Upon failure of any test, additional test strips will be laid at no cost to the CITY. The squareyards (m²) of the first test strip will be measured and paid for at the contract unit price.
A field test shall be made to check consistency of the surface treatment. If a line made through the surface treatment fills up, the mixture is too wet, which the CONTRACTOR shall correct. If the line stays, the slurry has a proper consistency.

404.3.3.3. Mixing Equipment.

404.3.3.3.1. Slurry Seal. The slurry seal mixing equipment shall be continuous flow mixing unit as to give a uniform and complete circulation of the batch in the mixer, so as not to segregate the aggregates, but will provide a thorough and uniform free flowing mix with the asphalt and water. The units shall be equipped with a water pressure system and nozzle type spray bar adequate for completely fogging the surface with 0.05- to 0.15-gallons-per-square-yard (0.22- to 0.68-L/m²) immediately ahead of the spreader box.

Application rate of aggregate, based on dry weight of aggregate, shall be 15- to 21-lbs-per-squareyard (8.1- to 11.4-kg/m²) complete in place.

The residual asphalt content, based on % weight of dry aggregate, shall be 8% to 12%.

404.3.3.3.2. Micro-Surface Mixing Equipment. The material shall be mixed by a self-propelled microsurfacing mixing machine which shall be a continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler and water to a revolving multi-blade mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler and water to maintain an adequate supply to the proportioning controls. The machine shall be equipped with self-loading devices which provide for the loading of all materials while continuing to lay microsurfacing, thereby minimizing construction joints.

Individual volume or weight controls for proportioning each material to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked.

The mixing machine shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray immediately ahead of and outside the spreader box with 0.05- to 0.15-gallons-per-square-yard (0.22- to 0.68-L/m²).

The aggregate feed to the mixer shall be equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time. The mixing machine shall be equipped with an approved fines feeder that shall provide a uniform accurately metered, predetermined amount of the specified mineral filler. Application rate of aggregate, based on dry weight of aggregate, shall be 22- to 28-lbs-per-squareyard (11.9- to 15.2-kg/m²) complete in place.

The emulsion pump shall be a positive displacement type and shall be equipped with a revolution counter or similar device so that the amount of emulsion used may be determined at any time. The residual asphalt content, based on % weight of dry aggregate, shall be 6% to 11.5%.

404.3.3.4. Spreading Equipment.

404.3.3.4.1. Slurry Seal. The spreader box shall be equipped to prevent loss of slurry seal from all sides and with a flexible rear strike-off capable of being adjusted. It shall have suitable means for side tracking to compensate for deviations in pavement geometry. The box shall be kept free of built-up asphalt and aggregate. The strike-off drag shall be kept completely flexible at all times.

404.3.3.4.2. Micro-Surface. The surface mixture shall be spread uniformly by means of a mechanical type spreader box attached to the mixer, equipped with paddles to agitate and spread the materials throughout the box. A front seal shall be provided to insure no loss of the mixture at the road contact point. The rear seal shall act as final strike off and shall be adjustable. The mixture shall be spread to fill cracks and minor surface irregularities and leave a uniform skid resistant application of material on the pavement. The longitudinal joint where two passes join shall be neat appearing, uniform and lapped. All excess material shall be removed from the job site prior to opening the road. The spreader box shall have suitable means provided to side shift the box to compensate for variations in pavement geometry.

404.3.4. Preparation. Any breakdowns, base failures, or other defects shall be properly repaired by the CITY before application of the surface treatment. No work shall commence on any location until approval by the Engineer.

Immediately prior to applying the surface treatment, CONTRACTOR shall thoroughly clean the pavement of all loose materials, vegetation, soil and objectionable material. The CONTRACTOR shall cover manholes, valve boxes, raised pavement markers and other designated objects to insure their integrity. All pavement cleaning and covering of appurtenances shall be subject to the final approval and acceptance of the Engineer.

If required, the CONTRACTOR shall apply a tack coat or a second coverage of treatment on brick, concrete, or other highly absorbent or polished pavements. If a tack coat is required, a 1-part emulsion, 3-part water tack coat of the same asphalt emulsion type and grade as specified for the surface treatment is required. Rate of application of tack coat material shall be 0.05- to 0.10-gallons-per-square-yard (0.22- to 0.45-L/m²). All debris and unused material shall be removed.
404.3.5. Surface Treatment Application. Surface treatments shall be placed on the location and within the time limit as specified by the Engineer.

404.3.5.1. Fogging. If conditions require, the pavement shall be pre-wetted by fogging ahead of the slurry/spreader box. Water used in fogging the surface shall be applied so that the entire surface is damp with no flowing water in front of the box. Rate of spray shall be 0.05- to 0.15-gallons-per-square-yard (0.22- to 0.68-L/m²) or as directed by the Engineer. No streaks, lumps, balls or unmixed aggregated shall be permitted.

404.3.5.2. Mix Stability. The mix shall be sufficiently stable during the spreading period so that the emulsion does not break, there is no segregation of the fines from the coarser aggregate and the liquid of the mix does not float to the surface.

404.3.5.3. Lines and Joints. Straight lines along curb gutters and shoulder will be required. No runoff on these areas will be permitted. Lines at intersections must be kept straight to provide a good appearance. Surface treatment shall be placed at the lip of the gutter or at a distance from the face of the curb as directed by the Engineer.

No excessive buildup or unsightly appearance shall be permitted on longitudinal or transverse joint. An excessive overlap will not be permitted on longitudinal joints. The CONTRACTOR shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. Longitudinal joints shall be placed on lane lines when possible. If half passes are used, they shall not be the last passes on any paved area.

404.3.5.4. Rolling. If required, specified areas shall be rolled by a self-propelled 10-ton (9000- to 10,000-kg) pneumatic roller with tire pressure of 50-psi (3.5-kg/cm²) and equipped with a water spray system. The slurried pavement shall be subjected to a minimum of 5 full coverages by the roller. Rolling should not commence until the slurry has cured enough so that it will not pick up on the tires. In areas of high traffic volume and subject to slow turning, e.g. major intersections, rolling may be feasible.

404.3.5.5. Hand Work. In areas where the spreader box cannot be used, hand squeegees to provide complete and uniform coverage shall apply the surface treatment. Any joint cracks not filled by the mix shall be corrected by use of hand squeegees. Handwork shall be completed during the machine applying process. Due to the difficulty in hand working micro-surfacing material because of the quick-set nature of the emulsion, hand work for micro-surface treatment shall be kept to a minimum.

404.3.5.6. Curing and Finishing. All traffic shall be kept off the treated area until it has cured to a firm condition that will prevent damage to the surface treatment. Any uncured areas damaged will be repaired satisfactory to the Engineer at the CONTRACTOR’S expense.

After completion of surface treatment placement, the CONTRACTOR shall remove covered objects (manhole covers, valve covers, raised traffic markers, etc.) so the object protected will remain fully functional. All objects not to have been covered shall be restored to original integrity. Any objects damaged by the CONTRACTOR’S work activities shall be repaired or replaced at no cost to the CITY.

Any work directed by the Engineer to correct any appearance defect shall be subject to the final approval of the Engineer.

The CONTRACTOR shall remove all unused material and debris from the site prior to final acceptance.

404.4. BITUMINOUS SURFACE TREATMENT (CHIP SEAL)

404.4.1. Description. This item shall consist of a wearing surface composed of one, two or three applications of asphaltic materials, each covered with aggregate, constructed on the prepared base course or surface in accordance with the requirements as shown on the plans and these specifications.

404.4.2. Materials.

404.4.2.1. Asphaltic Materials. The asphaltic materials used shall be of the type and grade as specified by the CITY and shall meet the requirements of Item 302.3. Bituminous Materials.

WARNING TO CONTRACTOR: Attention is called to the fact that asphaltic materials are highly flammable. The utmost care shall be taken to prevent open flames from coming in contact with the asphaltic materials or the gases of same. The CONTRACTOR shall be responsible for any fires or accidents that may result from heating the asphaltic materials.
404.4.2.2. Aggregate. Aggregate shall be composed of dry, sound, durable particles of processed stone or steel slag having a percent of wear of not more than 35 when tested in accordance with ASTM C131 Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. Crushed gravel shall not be allowed. The aggregate shall be free from organic matter, clay, loam, or coated pebbles and shall contain not more than five-percent of slate, shale, schist, or soft particles.

The aggregate used shall be of the type and grade or types and grades selected from those prescribed in Item 301.5. Flexible Subbase or Base (Crushed Stone/Concrete). The particular type and grade or types and grades shall be as provided on the plans or as required by the CITY.

Aggregate when tested by standard laboratory methods shall meet the grading requirements in Table 404.4.2.2.(a) Chip Seal Aggregate Gradations. Prior to shipping aggregate to the project, the CONTRACTOR shall furnish the Engineer with samples of the proposed aggregate.

### Table 404.4.2.2.(a) Chip Seal Aggregate Gradations

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Retained, by weight</th>
<th>Sieve Size</th>
<th>% Retained, by weight</th>
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<tbody>
<tr>
<td><strong>FIRST APPLICATION</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Small Aggregate “SB”</td>
<td>Large Aggregate “LB”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8-in.</td>
<td>0%</td>
<td>1-in.</td>
<td>0%</td>
</tr>
<tr>
<td>1/2-in.</td>
<td>0 - 10%</td>
<td>3/4-in.</td>
<td>15 - 45%</td>
</tr>
<tr>
<td>1/4-in.</td>
<td>70 - 100%</td>
<td>1/2-in.</td>
<td>85 - 100%</td>
</tr>
<tr>
<td>No. 10</td>
<td>95 - 100%</td>
<td>1/4-in.</td>
<td>98 - 100%</td>
</tr>
<tr>
<td><strong>SECOND APPLICATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Aggregate “ST”</td>
<td>Large Aggregate “LT”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8-in.</td>
<td>0%</td>
<td>3/4-in.</td>
<td>0%</td>
</tr>
<tr>
<td>1/4-in.</td>
<td>2 - 20%</td>
<td>1/2-in.</td>
<td>0 - 10%</td>
</tr>
<tr>
<td>No. 10</td>
<td>70 - 100%</td>
<td>1/4-in.</td>
<td>65 - 85%</td>
</tr>
<tr>
<td>No. 20</td>
<td>95 - 100%</td>
<td>No. 10</td>
<td>90 - 100%</td>
</tr>
<tr>
<td></td>
<td>No. 20</td>
<td></td>
<td>98 - 100%</td>
</tr>
</tbody>
</table>

404.4.2.2.1. Precoated Aggregate. The grade of aggregate specified shall meet all other requirements of Item 404.4.2.2. Aggregate prior to the application of precoat or fluxing material. Materials that are not uniformly and/or properly coated, in the opinion of the Engineer, shall not be accepted for use.

Precoated aggregate shall be aggregate of the type and grade specified, coated with 0.5- to 1.5-percent (by weight) of residual bitumen from a precoating material. When limestone rock asphalt is used, it shall be fluxed with 0.5- to 1.5-percent (by weight) of fluxing material. The materials may be mixed on the job or at a central mixing plant and shipped ready for use. Mixes that do not maintain flow qualities such that the precoated aggregate may be satisfactorily spread by approved mechanical spreading devices will not be acceptable.

Precoated aggregate will show no stripping when tested in accordance with TxDOT test method Tex-530-C Effect of Water on Bituminous Paving Mixtures. If antistripping additives are required to meet this requirement, they shall meet the requirements of TxDOT Item 301 Asphalt Antistripping Agents.

404.4.3. Construction Methods.

404.4.3.1. Equipment and Preparation. All storage tanks, piping, retorts, booster tanks, and distributors used in storing or handling asphalt shall be kept clean and in good operating condition at all times. They shall be operated in such a manner that there shall be no contamination of the asphalt with foreign material.

The area to be treated shall be cleaned of dirt, dust or other deleterious matter by sweeping or other approved methods. If it is found necessary by the CITY, the surface shall be lightly sprinkled just prior to the application of the asphaltic material.

404.4.3.2. Application of Asphalt. The CITY shall select the temperature of application based on the temperature-viscosity relationship that shall permit application of the asphalt with the limits recommended in Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials. The CONTRACTOR shall apply the asphalt at a temperature within 15°F (8°C) of the temperature selected. It shall be the responsibility of the CONTRACTOR to provide and maintain in good working order a recording thermometer at the storage heating unit at all times.

Asphaltic material may be placed by preheating aggregate to 280°F (138°C) when the air temperature is 70°F (21 °C) and falling or when the air temperature is 50°F (10°C) and rising.
Asphaltic material of the type and grade shown on the plans shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the material in the quantity specified, evenly and smoothly, under a pressure necessary for proper distribution. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic materials in all of the heating equipment and in the distributor, for determining the rate at which they are applied, and for securing uniformity at the junction of two distributor loads. The distributor shall have been recently calibrated and the CITY shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the asphaltic materials appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the CITY before proceeding with the work.

Asphaltic materials for each course may be applied for the full width of the surface treatment in one application, unless the width exceeds 26-ft. (8m). No traffic or hauling shall be permitted over the freshly applied asphaltic materials. Asphaltic materials shall not be applied until immediate covering with aggregate is assured.

404.4.3.3. Application of Aggregate. Aggregate, of the type and grade shown on the plans for the first course, shall be immediately and uniformly applied and spread by approved calibrated mechanical spreaders, operated on the rear of the aggregate trucks or as a separate power-driving unit. These spreader units shall be approved by the CITY prior to the start of the work. The aggregate shall be applied at the approximate rates indicated on the plans, within the limits shown in Table 404.4.3.4.(a) Chip Seal Rates of Application, and as directed by the CITY. The entire surface shall then be broomed, bladed or raked as required by the CITY and shall be thoroughly rolled with both pneumatic tire and steel wheel (3- to 6-t ons) (2,700-kg to 5,400-kg) rollers to insure proper embedding into the bitumen. The rolling shall be continued until no more aggregate can be worked into the surface. Rolling shall meet the governing specifications for Item 301.1.2. Rolling of Embankment, Subgrade or Flexible Base.

404.4.3.4. Rates of Application. The asphalt and aggregates shall be applied at the approximate rates indicated on the plans within the following limits, as directed by the Engineer. The rates of application and the estimated quantities of aggregate are based on the usual or average gradation of known materials. Prior to shipping aggregate to the project, the CONTRACTOR shall furnish the Engineer with samples of the proposed aggregate so that the gradation may be determined and rate of application changed if necessary.

<table>
<thead>
<tr>
<th>Application</th>
<th>Asphalt gal/yd² (L/m²)</th>
<th>Aggregate yd³ per yd² (m³:m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>SMALLER AGGREGATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First, Aggregate “SB”</td>
<td>0.20(0.9)</td>
<td>0.30 (1.4)</td>
</tr>
<tr>
<td>Second, Aggregate “ST”</td>
<td>0.30(1.4)</td>
<td>0.40 (1.8)</td>
</tr>
<tr>
<td>LARGER AGGREGATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First, Aggregate “LB”</td>
<td>0.25(1.1)</td>
<td>0.35 (1.6)</td>
</tr>
<tr>
<td>Second, Aggregate “LT”</td>
<td>0.35(1.6)</td>
<td>0.45 (2.0)</td>
</tr>
</tbody>
</table>

404.4.3.5. Multiple Courses. Where double or triple surface courses are specified on the plans, each succeeding course shall be constructed by the procedures as prescribed for the first course. The rates of asphaltic material and aggregate for multiple-course construction shall be as shown on the plans within the limits shown in Table 404.4.3.4.(a) Chip Seal Rates of Application or as directed by the CITY.

404.4.3.6. Maintenance and Completion. The CONTRACTOR shall be responsible for the maintenance of the surface and distribution of the excess aggregate until final completion and acceptance of the entire project by the CITY. All holes or failures in the surface shall be repaired per each course by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material per each course in such a manner that the asphaltic material will not adhere to or be picked up by the wheels of vehicles.
ITEM 405. ULTRA THIN CONCRETE PAVING (WHITETOPPING)

405.1. DESCRIPTION
This Item shall govern for a 2-inch thick (5cm) to 4-inch thick (10cm) bonded concrete overlay placed on an asphaltic surface in accordance with the details shown on the plans and the requirements of this Item.

405.2. MATERIALS
Unless otherwise shown on the plans or required herein, all materials shall conform to the requirements of Item 303. Portland Cement Concrete Pavement, except for the following:

1. The concrete shall be designed to include seven (7) sacks of Type III cement.
2. The maximum water cement ratio shall not exceed 5.5-gallons (20.8L) per sack.
3. The fineness modulus of aggregate shall be 2.6 to 2.8 unless otherwise shown on the plans.
4. An ASTM Type A water-reducing admixture and an ASTM Type C nonchloride set-accelerating admixture shall be used to achieve the earliest possible concrete-setting times.
5. The use of a set-retarding admixture will not be permitted.
6. The concrete will be designed to achieve a minimum flexural strength of 425 psi (29.9-kg/cm²). Aggregate size shall conform to size number 467 as shown in Table 303.2.1.3.2.(a) Grading Requirements for Coarse Aggregates.

The entrained air content of the fresh concrete shall be 4% with a tolerance of +/-1 % when tested in accordance with TxDOT Test Method Tex-416-A.

Reinforcing fibers in accordance with Item 303.2.6. Fibrous Reinforcement shall be of the type and amount shown on the plans, and shall be added to the mix in accordance with the manufacturer's recommendations.

Curing materials shall conform to Item 303.2.13. Curing Materials or as specified on the plans.

Equipment and forms shall comply with requirements as stated in Item Item 303. Portland Cement Concrete Pavement.

405.3. CONSTRUCTION METHODS

405.3.1. General. Loads on the milled area shall be kept to a minimum so not to cause failure to the underlying material. This may require using small loads of concrete or other than normal concrete delivery methods. Once the milled area has been cleaned, no traffic other than construction equipment for the overlay shall be permitted on any portion of the milled area. The thickness of the concrete overlay shall be as specified on the plans. The screed shall be adjusted to provide an approved grade line and sufficient thickness. To identify insufficient depth areas prior to concrete placement, the following procedures shall be used, unless other methods are approved by the CITY. To identify areas of insufficient depth, a filler block having a thickness ¼-inch (6mm) less than the overlay thickness shall be attached to the bottom of the screed and the screed shall be passed over the area to be overlaid. Areas which have insufficient depths shall be corrected by adjustments of the screed and/or rail system, or by chipping or scarifying of the milled asphalt prior to the overlay as approved by the Engineer.

405.3.2. Preparation of Surface. Oil or other foreign material spilled or dripped onto the milled surface shall be removed by cleaning. Immediately before the concrete is placed, the asphalt surface shall be cleaned with a filtered air blast to remove windblown dust, dirt, debris, and standing water and then brought to a to a moist, approximately saturated surface dry condition. It is important that the milled surface be thoroughly clean so as to facilitate the bond between the asphaltic surface and the concrete.

405.3.3. Spreading and Finishing Concrete. The spreading and finishing of the concrete overlay shall be in accordance with Item 303. Portland Cement Concrete Pavement, including environmental constraints.

405.3.4. Transverse Construction Joints. When the placing of concrete is stopped, CONTRACTOR shall provide a bulkhead of sufficient cross sectional area to prevent deflection that is shaped accurately to the cross section of the pavement. The bulkhead shall be at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Intentional stoppage of the placing of the concrete shall be at either a construction joint or at a weakened plane joint. This joint shall be sawed and sealed using a joint sealant in accordance with Item 303. Portland Cement Concrete Pavement, type as indicated on the plans.

When an unintended stoppage occurs, the CONTRACTOR shall immediately install the above described bulkhead at a weakened plane joint. The available concrete should completely fill against the bulkhead and any concrete remaining on the subgrade ahead of the bulkhead shall be removed and disposed of as directed by the Engineer. This joint shall be sawed and sealed using a joint sealant in accordance with Item 303. Portland Cement Concrete Pavement, type as indicated on the plans.
All construction joints adjacent to existing concrete paving, curb, or curb and gutter shall be sawed and sealed using a joint sealant in accordance with Item 303. Portland Cement Concrete Pavement, type as indicated on the plans.

405.3.5. Initial Curing. Immediately after any section of pavement has been tined and the surface moisture has disappeared, the concrete surface shall be sprayed uniformly with a curing compound as specified in Item 303.5.7. Curing. Immediately after this curing compound has dried, the concrete surface shall be sprayed uniformly with a second application of curing compound in accordance with Item 303.5.7. Curing. Should the membrane be damaged from any cause, except for the sawing cutting, before the water cure is started, the damaged portions shall be repaired immediately with additional compound.

405.3.6. Saw Cutting Weakened Plane Joints. Unless otherwise shown on the plans, sawed joints shall be sawed to a minimum depth of one-third the thickness of the concrete overlay. The minimum saw cut depth for a dry, early saw cut shall be $\frac{3}{4}$-inch (2cm).

Saw cuts shall be perpendicular to the surface of the overlay. Unless otherwise shown on the plans, the saw cuts shall be in lines that are perpendicular and parallel to the centerline of the travel lanes and spaced at a maximum distance apart of 1-foot (30cm) for every inch (2.5cm) of design overlay depth. Saw joints for radii shall be as detailed in the plans. Chalk line, offset string line, sawing template or other approved methods shall be used to provide a true joint alignment. The saw cuts are not to be sealed, but shall be cleaned of all deleterious material after sawing.

Since the starting and ending times for sawing is the function of many variables within the mix, the weather, and the type and number of saws used, the CONTRACTOR is wholly responsible for the timing and order of the saw cutting. If excess spalling or raveling occurs at the top of the saw cuts or the intersection of saw cuts, or if uncontrolled full depth cracking occurs before traffic is allowed on that portion of the concrete, that portion of concrete which is bordered by existing saw cuts shall be entirely removed and replaced at the CONTRACTOR’s expense.

405.3.7. Deficient Thickness. The pavement shall be tested for depth by direct measurement in accordance with TxDOT Test Method Tex-423-A at locations selected by the Engineer. If the thickness of the pavement indicated by the direct measurement depth test is deficient by more than $\frac{1}{4}$-inch (6mm) from the plan thickness, the CONTRACTOR may verify the thickness by cores taken in accordance with TxDOT Test Method Tex-424-A at the locations selected by the Engineer.

Any area of pavement deficient in thickness by more than $\frac{1}{4}$-inch (6mm) of plan thickness shall be removed and replaced. The deficient area along with the concrete within the same border of the existing saw cuts shall be entirely removed, the asphalt surface chipped or scarified as described above, and the concrete replaced, all at the CONTRACTOR’s expense.

405.3.8. Opening to Traffic. Opening of the completed overlay to normal construction traffic and to the traveling public shall be after the concrete has obtained a flexural strength of 255-psi (18-kg/cm²) or a compressive strength of 1800-psi (127-kg/cm²).
## DIVISION 500

### UNDERGROUND CONDUIT CONSTRUCTION AND APPURTENANCES

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ITEM 501. UNDERGROUND CONDUIT MATERIALS

501.1. GENERAL

All pipe and fittings shall be new.

The CITY shall at all times have free access to the manufacturer’s plant while production in progress, and may at any time refuse to accept pipe made when the plant is failing to follow the stipulations of the specifications in regard to workmanship, or failing in provisions to insure a uniform product coming within the permissible variations of the specifications. The CITY may reject pipe if adequate means and methods are not provided so as to insure the manufacture of a product of uniform high quality.

Pipe shall be color coded according to the American Public Works Association Uniform Color Code (i.e. blue for water, green for wastewater or storm drain lines, violet for reclaimed water, etc.) or labeled with labeling tape identifying its specific use. Where feasible, permanent identification of the piping service shall be provided by co-extruding color stripes into the pipe outside surface. The striping shall be of the same material except for the color. For co-extruded markings, IPS sized pipe shall have four equally spaced, longitudinal color stripes and DIPS sized pipe shall have three equally spaced pairs of longitudinal color stripes. The color or marking shall be visible on top of buried pipe when pipe is excavated.

Pipe shall be acceptable by the Underwriters’ Laboratories, Inc. or Factory Mutual Research when specifically requested and shall be acceptable by the State Fire Insurance Commission for use in water distribution systems when used for fire protection without penalty. Potable water pipe shall also bear the seal of approval (or “NSF” mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

Installation shall be performed in accordance with relevant portions of Division 500 Underground Conduit Construction and Appurtenances.

501.1.1 Rejection. Pipe, joints, fittings, or coatings may be rejected for failure to meet any of the requirements of this specification or for any manufacturing, transportation and/or handling defects that may cause pipe, joints, fittings or coatings to be unsuitable for intended use(s). When approved by the CITY, materials may be retested to establish conformity. All rejected materials shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with materials which meets the requirements of these specifications. Such rejected materials shall be removed immediately from the site of the work.

501.2. CONCRETE PRESSURE PIPE AND FITTINGS

501.2.1. General. These specifications cover the manufacture of concrete pressure pipe designed for internal pressures from a minimum of 20-psi (1.4-kg/cm²) to a maximum of 350-psi (24.6-kg/cm²). Products shall conform to relevant standards as noted in Table 501.2.1. Standards for Concrete Pressure Pipe and Fittings.
Table 501.2.1. Standards for Concrete Pressure Pipe and Fittings

<table>
<thead>
<tr>
<th>Item Reference No.</th>
<th>AWWA Standard</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>501.4.5</td>
<td>C301</td>
<td>Prestressed Concrete Pressure Pipe, Steel-Cylinder Type</td>
</tr>
<tr>
<td></td>
<td>C304</td>
<td>Design of Prestressed Concrete Cylinder Pipe</td>
</tr>
<tr>
<td>501.4.6</td>
<td>C303</td>
<td>Bar-Wrapped Concrete Cylinder Pipe</td>
</tr>
</tbody>
</table>

Items 501.2.2. through 501.2.4., inclusive, shall apply to each type of pipe in Item 501.2 Concrete Pressure Pipe and Fittings.

The type of pipe to be supplied shall be as shown on the plan and/or in the special provisions for each project. The manufacturer shall submit a successful experience record in the design and construction of the type of concrete pressure pipe involved. Each type of pipe shall have the complete approval of the Underwriters’ Laboratories, Inc., for the manufacture of the pipe specified and diameters required. Pipe shall have NSF61 standard approval for potable water applications.

Upon award of the Contract, the CONTRACTOR shall furnish CITY with shop drawings showing the pipe and fittings to be furnished and shall include a tabulated layout schedule with reference to the stationing of the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the CITY and fabrication of pipe and fittings shall not be commenced until such drawings have been approved by the CITY. Such approval by the CITY shall not relieve the CONTRACTOR of any responsibility of providing pipe and/or fittings in accordance with the CITY’S plans and specifications.

No cracks will be permitted in the lining of the pipe, except for minor hairline cracks. Cracks in the vicinity of the spigot of prestressed pipe and those cracks in the vicinity of the circumferential wrappers and outlets shall not be allowed, unless after inspection it is determined that they do not interfere with the performance of the pipe and they are accepted by the manufacturer so as to not void the warranty.

501.2.2. Fittings and Specials. The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blowoffs and connections to mainline valves and other fittings shown on the contract drawings or as set out in the specifications conforming with AWWA C301, AWWA C303, or AWWA C304 as applicable. All openings in the pipe for fittings, manholes, taps, blowoffs, etc. shall have the interior and exterior surfaces of the steel lined and coated with mortar. The lining thickness shall be a minimum of 0.5-inches (12.5mm) for sizes 16-in. (400mm) and smaller, and 0.75-in. (19mm) minimum lining thickness for sizes larger than 1 6-in. (400mm). The minimum coating thickness shall be 1-in. (25mm). The type of fittings and details covering the design of fittings and specials shall be furnished by the manufacturer and subject to the approval of the CITY. The fittings and specials shall comply in all respects with the requirements of AWWA with modifications as herein set forth.

501.2.3. Flanged Outlets. Flanged outlets shall be insulated at all points where external valves, pipe, fittings, etc., are connected to the line. The CONTRACTOR shall furnish an insulating flange kit, flange gaskets, insulating sleeves, and two plastic washers for each bolt approved by the OWNER. Bolts, nuts, and washers for flanged outlet connections shall be carbon steel.

501.2.4. Tests. All pipe shall be tested in accordance with applicable specifications and AWWA Standards. In addition to certification of all applicable tests required by governing AWWA Standards, the following tests or certifications of tests may be required.

501.2.4.1. Steel Cylinder Pipe. The manufacturer shall submit for approval the specified details of materials and methods of welding it proposes to use before any welding is done.

The manufacturer shall furnish one specimen for tensile tests of welds from each 3,000-ft. (900m) of pipe. If tests indicate the welding is unsatisfactory, additional samples as required shall be furnished. Two test cylinders out of each day’s pour of the concrete used, or as required by the CITY, shall be furnished for testing by an independent laboratory. The cost of such a test shall be borne by the CITY. Certified test reports made by the manufacturer shall be acceptable in lieu of the test cylinders, provided such test certificates show that they cover pours from which the purchased pipe is made.

Mill test reports on each heat from which steel cylinders and reinforcing are rolled shall be furnished by the CITY, if required.

Test certificates showing the physical properties of the compound used in the gaskets shall be furnished by the CITY, if required.

501.2.4.2. Three-Edge Bearing Test. The manufacturer of concrete cylinder pipe supplied in accordance with the provisions of Item 501.2. Concrete Pressure Pipe and Fittings shall have demonstrated, or
shall demonstrate as may be required, that the pipe when tested in a three-edge bearing test as described in ASTM C497 (C497M) Concrete Pipe, Sections or Tile under a load equivalent to the design ditch load shall not deflect more than 0.1-percent. At the above specified load, there shall be no continuous cracks wider than 0.002-in. (0.7mm) for a length of 12-in. (30mm).

501.2.4.3. Concrete Cylinder Fittings. Hydrostatic testing of fittings is not required unless specifically called for in the Project Specifications.

501.2.5. Prestressed Concrete Cylinder Pipe, AWWA C301.

501.2.5.1. General. The pipe shall comply in all respects with the requirements of AWWA C301 Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids. The pipe may be of two types of prestressed concrete steel cylinder pipe as specified on the plans and/or specifications or special conditions:

1) the lined cylinder type with a core composed of a steel cylinder lined with concrete and subsequently wire-wrapped directly on the steel cylinder and coated with the mortar.

2) the embedded cylinder type with a core composed of a steel cylinder encased in concrete and subsequently wire-wrapped on the exterior concrete surface and coated with concrete or mortar.

501.2.5.2. Design Pressures and Stresses. Design pressure shall be that shown on plans and/or specifications. The size of the high-tensile wire and the spacing and tension under which it is wound shall be such that the conditions required by AWWA C304 Design of Prestressed Concrete Cylinder Pipe are met.

501.2.6. Bar-Wrapped Concrete Cylinder Pipe, AWWA C303.

501.2.6.1. General. The pipe shall consist of a welded sheet-steel or plate-steel cylinder, manufactured by the spiral or straight seam method with joint rings attached, inside of which a cement mortar lining is centrifugally spun; a mild steel bar spirally wrapped under measured tension on the steel cylinder and protective cement mortar coating applied to the outside of the cylinder and spirally-wrapped rod.

The manufacturer shall furnish pipe in uniform lengths except lengths ordered as specials.

The pipe shall comply in all respects with the requirements of AWWA C303, with the following addition.

501.2.6.2. Design Pressures and Stresses. Design pressure shall be that shown on the plans and/or specifications. Steel cylinder and bar reinforcement shall be designed in accordance with AWWA Manual M9, Concrete Pressure Pipe.

501.3. REINFORCED CONCRETE WASTEWATER PIPE WITH RUBBER GASKET JOINTS

Concrete pipe shall not be used in wastewater applications
501.4. REINFORCED CONCRETE CULVERT, STORM DRAIN, PIPE AND BOX SECTION

This item shall govern reinforced concrete culvert, storm drain, pipe and precast reinforced concrete box sections. Pipe shall be cured in accordance with the applicable ASTM Designations for each type of pipe as referred to below.

501.4.1. Reinforced Concrete Culvert, Storm Drain, and Pipe.

501.4.1.1. General. Except as applicable to Item 501.6.1.1.1. Alternate Concrete Pipe D-Load Design, circular reinforced concrete pipe shall conform to ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; arch pipe shall conform to ASTM C506 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe; elliptical pipe shall conform to ASTM C507 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe, of the class as designed on the plans subject to the following modifications:

1. All pipe shall be machine-made by a process which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product.

2. Sizes larger than 60-in. (1524mm) diameter shall be manufactured using two lines of circular reinforcement.

3. Where Class III pipe of sizes larger than 60-in. (1500mm) diameter are specified, the manufacturer may at its option furnish pipe manufactured with either Wall “B” or Wall “C” minimum thicknesses and the applicable minimum steel area as listed for circular cages in Table II of ASTM C76 (C76M), provided tests strength requirements for Class III pipe are satisfactorily met.

501.4.1.1.1. Alternate Concrete Pipe D-Load Design. When bedding is specified in accordance with Item 504.5.2.16. Alternate Embedment for Concrete Pipe, reinforced concrete pipe shall conform to ASTM C1417 (C1417M) Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design. This specification covers the manufacture and acceptance of precast concrete pipe designed to conform to the OWNER’s design requirements and to ASCE 15-93, ASTM C655 (C655M) Specification for Reinforced Concrete DLoad Culvert, Storm Drain, and Sewer Pipe, or an equivalent design specification. Conditions of 501.4.1.1. modifications (1) and (2) apply to pipe provided under this specification.

501.4.1.2. Sizes and Permissible Variations. Variations in diameter, size, shape, wall thickness, reinforcement, placement of reinforcement, laying length and the permissible underrun of length shall be in accordance with the applicable ASTM specification for each type of pipe as referred to previously.

Where rubber gasket pipe joints are to be used, the design of joints and permissible variations in dimensions shall be in accordance with ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, Sections 5 and 6.

501.4.1.3. Joints. Pipe to be placed along curves shall consist of whatever pipe joint lengths or beveled end joints of pipe or combination thereof that are required to place the pipe on the designated centerline curve with no more than one-half of the tongue length of the pipe exposed from its normal fully closed joint position. The amount of bevel, “drop” or shortening of the pipe joint length by the bevel shall not exceed the amount shown in Table 501.4.1.3.(a) Maximum Bevel or Drop for the pipe sizes indicated.
Table 501.4.1.3.(a) Maximum Bevel or Drop

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Maximum Amount of Bevel or Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 12-in. (305mm) to 27-in. (685mm), inclusive</td>
<td>3.1875-in. (80mm)</td>
</tr>
<tr>
<td>From 30-in. (760mm) to 51-in. (1295mm), inclusive</td>
<td>5-in. (125mm)</td>
</tr>
<tr>
<td>From 54-in. (1370mm) to 84-in. (2135mm), inclusive</td>
<td>6-in. (150mm)</td>
</tr>
<tr>
<td>From 90-in. (2285mm) to 96-in. (2440mm), inclusive</td>
<td>6.5-in. (165mm)</td>
</tr>
</tbody>
</table>

501.4.1.3.1. Gaskets. Unless otherwise specified on the plans or in the special provisions, pipe joints shall be sealed with either of the following types of gaskets; Cold-applied preformed plastic gaskets or Expanded Cellular Rubber Gaskets. Each joint shall require one continuous gasket conforming to the joint shape. Gasket cross-sectional diameters shall be in accordance with the manufacturer’s recommendations.

Cold-Applied Preformed Plastic Gaskets. Plastic gasket shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes, or obnoxious odors.

The gasket joint sealer shall not depend on oxidizing, evaporating nor chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope-form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer’s recommendations and sufficient to obtain the squeeze out as described under construction methods. The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application as noted below.

The chemical composition of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.4.1.3.1.(a) Sealing Compound Chemical Composition when tested in accordance with the test methods shown. The gasket joint sealing compound when immersed for 30-days at ambient room temperature separately in 5-percent solution of caustic potash, a mixture of 5-percent hydrochloric acid, a 5-percent solution of sulfuric acid and a saturated H2S Solution, shall show no visible deterioration.

Table 501.4.1.3.1.(a) Sealing Compound Chemical Composition

<table>
<thead>
<tr>
<th>Composition</th>
<th>Test Method</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen (petroleum plastic content)</td>
<td>ASTM D4 Bitumen Content</td>
<td>50-70</td>
</tr>
<tr>
<td>Ash-Inert Mineral Matter</td>
<td>AASHTO T-111</td>
<td>30-50</td>
</tr>
<tr>
<td>Volatile Matter at 325°F (163°C)</td>
<td>ASTM D6 Loss on Heating of Oil and Asphalitic Compounds</td>
<td>2.0 Max.</td>
</tr>
</tbody>
</table>

The physical properties of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.4.1.3.1.(b) Sealing Compound Physical Properties when tested in accordance with the test methods shown.

Table 501.4.1.3.1.(b) Sealing Compound Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Typical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity at 77°F</td>
<td>D71 Relative Density of Solid Pitch and Asphalt (Displacement Method)</td>
<td>1.20 to 1.35</td>
</tr>
<tr>
<td>Ductility at 77°F (cm)</td>
<td>D113 Ductility of Bituminous Materials</td>
<td>5.0 min.</td>
</tr>
<tr>
<td>Softening Point at 77°F</td>
<td>D36 Softening Point of Bitumen (Ring-and-Ball Apparatus)</td>
<td>320°F min.</td>
</tr>
<tr>
<td>Penetration: 32°F (300-gms) 60-sec.</td>
<td>D217 Cone Penetration of Lubricating Grease</td>
<td>75 min.</td>
</tr>
<tr>
<td>77°F (150-gms) 5-sec.</td>
<td></td>
<td>50 to 120</td>
</tr>
<tr>
<td>115°F (150-gms) 5-sec.</td>
<td></td>
<td>150 max.</td>
</tr>
<tr>
<td>Flash Point C.O.C.</td>
<td>D92 Flash and Fire Points by Cleveland Open Cup Tester</td>
<td>600°F</td>
</tr>
<tr>
<td>Fire Point C.O.C.</td>
<td></td>
<td>625°F</td>
</tr>
</tbody>
</table>

Expanded Cellular Rubber Gaskets. Expanded cellular rubber gaskets shall be produced from tubular cross-sections of a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056 Flexible Cellular Materials-Sponge or Expanded Rubber, Class 2C1.
501.4.1.4. Workmanship and Finish. Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The ends of the pipe shall be normal to the walls and centerline of the pipe within the limits of variations allowed as stated previously.

501.4.1.5. Pipe Marking. Markings shall be indented on the pipe section or painted thereon with waterproof paint. The following information shall be clearly marked on each section of pipe:

1. the class of pipe,
2. the date of manufacture,
3. the name or trademark of the manufacturer,
4. where elliptical reinforcement is used, one end of each section or joint of pipe shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the “top” or “bottom” of the pipe as it should be installed.
5. “Top” and “bottom” shall be required on pipe, unless pipe has such an external shape that the correct position of the top and bottom is obvious.

501.4.1.6. Tests. The acceptability of the pipe in all diameters, strengths and classes shall be determined by such material tests performed as required in ASTM C76 (C76M), C506 or C507; by the results of the three-edge bearing test for the load to produce a 0.01-in. (0.25mm) crack and ultimate load and by absorption tests on selected samples from the wall of the pipe in accordance with ASTM C497 (C497M) Concrete Pipe, Manhole Sections, or Tile; and by inspection of the finished pipe to determine its conformance with the design prescribed in these specifications and its freedom from defects.

Testing rates shall be as follows, except that in no case fewer than two specimens shall be furnished:

1. If subjected to three-edge-bearing tests for the 0.01-in. (0.25mm) crack only, testing shall be performed on 0.8-percent of the number of pipe sections of each size included in the order. Pipes that have been tested only to the formation of a 0.01-in. (0.25mm) crack and that meet the 0.01-in. (0.25mm) test load requirements shall be accepted for use.
2. If subjected to three-edge-bearing tests for both the 0.01-in. (0.25mm) crack and the ultimate load, testing shall be performed on 0.2-percent of the number of pipe sections of each size included in the order.

As an alternate to the three-edge-bearing test, concrete pipe 60-in. (150cm) in diameter and over may be accepted, at the option of the manufacturer, on the basis of material tests and inspection of the completed product. Acceptability of pipe on this basis shall be determined by the results of material tests as required in ASTM C76, C506 or C507; by crushing tests on cores taken from the barrel of the completed and cured pipe; by absorption tests on samples from the wall of the pipe; and by inspection of the finished pipe, including amount and placement of reinforcement, to determine its conformance with the design prescribed in these specifications and its freedom from defects.

The manufacturer shall furnish facilities and personnel for taking the cores from the pipe barrel and for determining the compressive strength of the samples. When the cores cut from a section of pipe successfully meet the strength requirement, the core-holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section shall meet all of the test requirements of ASTM C76, C506 or C507. Pipe sections, so sealed, shall be accepted for use.

Tested pipe accepted for use shall be marked “TEST” or otherwise appropriately identified. Should any of the test specimens fail to meet the test requirements, two consecutive joints in the same mix series shall be tested and results shall be a basis of accepting or rejecting the pipe of the series.

501.4.1.7. Rejection of Pipe. All rejected pipe shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with pipe that meets the requirements of these specifications. Such rejected pipe shall be removed immediately from the site of the work.

501.4.2. Precast Reinforced Concrete Box Sections. Precast reinforced concrete box sections shall conform to ASTM C789 (C789M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers, or ASTM C850 (C850M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subject to Highway Loadings. Two-piece box culverts, if approved by the CITY, must meet or exceed the load requirements of ASTM C789 and ASTM C850. Materials and construction methods, unless otherwise specified, shall conform to the requirements of Item 702.8. Precast and Cast-In-Place Concrete Units.

501.5. DUCTILE-IRON PRESSURE PIPE AND FITTINGS

501.5.1. General. Ductile-iron pressure pipe 4-in. through 64-in. shall conform to the American National Standard for Ductile-Iron Pipe Centrifugally Cast for Water or Other Liquids, AWWA C151. Polyethylene encasement for ductile iron pipe systems shall conform to Item 502.8. Polyethylene Wrap for Metal Pipe and Fittings.
501.5.2. Joints. All ductile-iron pressure pipe shall be furnished with one of the types of joints indicated in Table 501.5.2.(a) Ductile Iron Pressure Pipe Joint Types and as described in the proposal or bid request.

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion-resistant steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints, Type 3.

All threaded flanges shall be ductile iron.

<table>
<thead>
<tr>
<th>Type Joint</th>
<th>AWWA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-on</td>
<td>AWWA C111 Gasket Joints for Ductile-Iron Pressure Pipe and Fittings</td>
</tr>
<tr>
<td>Mechanical Joint</td>
<td>AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3 In.-48 In. (76 mm-1,219 mm), for Water, or AWWA C115 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges</td>
</tr>
<tr>
<td>Flanged Ends</td>
<td>AWWA C606 Grooved and Shouldered Joints</td>
</tr>
</tbody>
</table>

501.5.3. Coating and Lining. All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside with seal coat in accordance with AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Cement mortar lined ductile iron pipe can be used for water and certain wastewater applications, such as non-acid-producing gravity wastewater lines and wastewater force mains that unquestionably flow full. Contact pipe manufacture for linings suitable in other applications.

501.5.4. Fittings. Fittings shall be of ductile-iron and shall conform to AWWA C110 ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. Through 48-in. (76 mm Through 1,219 mm) for Water, or conform to AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service, 3-in. through 64-in. (76 mm through 1,600 mm), unless otherwise specified in the proposal, special specification or in the plans.

All fittings shall be rated for a minimum of 250-psi (2069-kPa) working pressure unless otherwise specified.

Special fittings using end condition combinations of bells, spigots, mechanical, integrally restrained or push-on joints, flanges, or special internally locked joints shall be dimensioned in accordance with AWWA C110 or C153.

Bolts and nuts for mechanical joints or flanged ends shall be of a high-strength, corrosion-resistant low-alloy steel and shall conform to ASTM A325 (Type 3) or shall be stainless steel in accordance with ASTM A304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements.

The CITY shall determine whether fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with AWWA C104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water or whether the interior and exterior surfaces shall be protected consistent with AWWA C116 Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.

501.5.5. Tests. All ductile-iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto.

501.5.6. Markings. Class, weight, and casting period shall be shown on each pipe.

501.6. DUCTILE-IRON PIPE FOR PIPE REHABILITATION

501.6.1. General. This standard establishes criteria for the specification of centrifugally cast, "bell-less", ductile iron pipe sizes 3" through 16" for pressure or gravity applications up to a maximum of 50-feet of head (43-psi) (296-kPa), including the conveyance of sewage, wastewater, storm water, treated water, and raw water, installed by trenchless methods. Ductile-iron pipe for pipe reconstruction, as described in Item 601.9. Pipe Bursting with Rigid Pipe, shall meet the minimum property and testing requirements as specified herein.

Pressure and gravity "bell less" pipe shall be manufactured in accordance with AWWA C151 Standard for Ductile-Iron Pipe, Centrifugally Cast for Water, except as modified herein.

The outside diameter of ductile iron "bell less" pipe shall be in accordance with AWWA C151.

Finished pipe lengths of Rubber gasket coupled "bell less" pipe shall have a standard nominal laying length and shall have a standard manufacturing tolerance for actual laying length equal to ±0.25-in (6mm). Laying length shall be specified per project conditions.
501.6.2. Joints. Pressure and gravity “bell less” ductile iron pipe joints shall be sealed with O-ring rubber gaskets installed in a machined tongue and groove type joint. The rubber gasketed joints of gravity service shall be field air pressure tested to 5-psi (35-kPa).

501.6.3. Coating and Lining. The candidate pipe for trenchless use may be uncoated or standard asphaltic coating in accordance with AWWA C151. Lining systems for ductile iron “bell less” pipe shall be specified by the CITY based on the corrosiveness of the liquid being conveyed and other service requirements.

501.6.4. Tests. All pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto.

501.6.5. Markings. Class, weight, and casting period shall be shown on each pipe.

501.7. STEEL PIPE AND FITTINGS

501.7.1. General. Steel pipe, fittings and specials shall conform to the details as shown on the plans or included in the specifications and as specified below.

501.7.2. Applicable Standard Specifications. Except as modified or supplemented herein, all steel pipe, fittings and specials shall conform to the applicable requirements of the standard specifications indicated in Table 501.7.2.(a) Standards for Steel Pipe and Fittings.

<table>
<thead>
<tr>
<th>Standard Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C200 Steel Water Pipe—6 In. (150 mm) and Larger</td>
</tr>
<tr>
<td>AWWA C203 Coal Tar Protective Coatings and Linings for Steel Water Pipeline — Enamel and Tape — Hot Applied</td>
</tr>
<tr>
<td>AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. (100 mm) and Larger — Shop Applied</td>
</tr>
<tr>
<td>AWWA C206 Field Welding of Steel Water Pipe</td>
</tr>
<tr>
<td>AWWA C207 Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)</td>
</tr>
<tr>
<td>AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings</td>
</tr>
<tr>
<td>AWWA C209 Cold -Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipe</td>
</tr>
<tr>
<td>AWWA C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>AWWA C214 Tape Coating Systems for the Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>AWWA C222 Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings</td>
</tr>
<tr>
<td>AWWA C602 Cement-Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger</td>
</tr>
<tr>
<td>AWWA C606 Grooved and Shouldered Joints</td>
</tr>
<tr>
<td>ASTM A283 Low and Intermediate Tensile Strength Carbon Steel Plates</td>
</tr>
<tr>
<td>ASTM A139 Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)</td>
</tr>
</tbody>
</table>

501.7.3. Pipe and Fittings Requirements. Fabricated pipe and fittings shall be made of steel plate conforming to ASTM A283, Grade D, or ASTM A139, Grade B, C, or D in accordance with AWWA C200. Milltype pipe and fittings shall be Grade B conforming to AWWA C200.

Nominal pipe diameter shall be as specified in the plans. Nominal diameters for steel pipe sizes under 24-in. (61cm) are outside diameters and for sizes 24-in. (61cm) and over are inside diameters per AWWA M11 Steel Pipe—A Guide for Design and Installation.

The pipe wall thickness shall be as specified in the plans.

Pipe sections shall be furnished in not less than 20 ft. (6.1 m) lengths except for specials and closures sections as may be required.

501.7.4. Joints. Steel pipe and fittings shall be joined with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on drawings. Welded joints shall conform to and be tested in accordance with AWWA C206.

Rubber gasketed joints may be used up to 72-in. (1.8m) in diameter and shall conform to, and be tested in accordance with AWWA C206.

Grooved and shouldered joints shall conform to, and be tested in accordance with AWWA C606.

Mechanically coupled joints shall consist of Dresser Couplings Style 38 or equal or as specified on the drawings.
Flanged joints shall conform to the AWWA C207, Class D. The thickness of flanges shall be as specified in Table 1 or 2 of AWWA C207, or as specified on the drawings.

501.7.5. Lining and Coating. Steel pipe and fittings shall be lined in accordance with any of the standards indicated in Table 501.7.5.(a) Lining and Coating for Steel Pipe and Fittings, unless a particular specification is shown on the plans.

The exterior surface of steel pipe and fittings to be installed underground shall be coated in accordance with AWWA C214. If coated in accordance with AWWA C214, then the fittings will be coated in accordance with AWWA C209. The exterior surface of steel pipe and fittings to be installed above ground shall be cleaned, primed and coated, all in accordance with either AWWA C222 or C210.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C205</td>
<td>Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied</td>
</tr>
<tr>
<td>AWWA C210</td>
<td>Liquid-Epoxy Coating Systems for Interior and Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>AWWA C222</td>
<td>Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings</td>
</tr>
<tr>
<td>AWWA C602</td>
<td>Cement-Mortar Lining of Water Pipeline — 4 In. and Larger — in Place</td>
</tr>
</tbody>
</table>

501.7.6. Testing. All steel pipe shall be hydrostatically tested to a pressure that will induce a stress of 75% of the minimum yield strength of the steel in accordance with AWWA C200. Fittings fabricated from hydrostatically tested pipe shall not require shop hydrostatic testing. Welds for fittings that were not previously hydrostatically tested shall require hydrostatic testing, air testing, or other ASTM nondestructive testing.

501.8. SEAMLESS COPPER TUBING

501.8.1. General. These specifications pertain only to Type K, annealed (soft) copper water tubing for use with solder, flared, or compression-type fittings. The copper tubing shall conform to ASTM B88 Seamless Copper Water Tube.

501.8.2. Quality. The vendor shall be responsible for submission of a laboratory analysis of the products supplied. The manufacturer’s own laboratory analysis is acceptable providing that these standards meet the requirements of ASTM B88 (seamless copper water tubing). The certificate of analysis shall state size and type of analysis and results obtained. A statement shall be made and validated that tests confirm compliance with the requirements of this specification.

The CITY reserves the right to conduct or cause to have conducted independent laboratory tests. Where the results of such tests prove the quality requirements have not been met: (1) the costs of tests shall be charged to the vendor’s account, and (2) the entire shipment may be rejected on the basis of such tests.

501.9. CORRUGATED METAL PIPE OR PIPE ARCH SHAPES

501.9.1. General. This item shall govern the furnishing of corrugated metal pipe for culverts and storm water conduit for the locations and designations as shown on the plans and contract specifications as herein outlined.

Pipe having a design hydraulic head exceeding 5-ft. (1.5m) of water will have helical corrugations and the lock seam shall be either continuously welded or caulked with a neoprene or mastic seal during fabrication. Caulked helical pipe shall be fabricated by applying a uniform bead of neoprene or mastic compound to the lock seam in such a manner that the inner surfaces of the lock seam are free of voids.

Shell Data shall specify diameter, classification (Type), material, gage and corrugation. This information shall be designated on the plans and/or contract specifications.

501.9.2. Pipe Manufacture. Corrugated metal pipe or pipe arch shapes shall meet the requirements of ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains, ASTM B745 (B745M) Corrugated Aluminum Pipe for Sewers and Drains, or ASTM A742 (742M) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe. All pipe shall be manufactured with a minimum of two re-rolled ends.

501.9.2.1. Steel Pipe. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO Designation M36, Type I, Type II or Type III as specified in the plans.

501.9.2.2. Aluminum Pipe. Aluminum pipe shall conform to the requirements of AASHTO Designation M196, Type I, Type II or Type III pipe arch as specified on the plans.

Aluminum pipe may be placed bare of any precoating, but any portions of aluminum pipe that are to be in contact with a metal other than aluminum or in contact with concrete containing chlorides, shall be insulated from...
this other metal or concrete by a coating of bituminous material or a plastic coating, such as asphalt mastic or polymeric coating. The coating applied to the aluminum pipe or pipe arch to provide an insulation between the aluminum and other metal shall extend a minimum distance of 1 ft. beyond the area of contact.

501.9.2.3. Precoated Galvanized or Aluminized Steel Pipe. Pipe shall be full circle or arch pipe conforming to AASHTO Designation M245, Type I, Type II or Type III as specified in the plans.

501.9.3. Classification (Type). Corrugated metal pipe shall be classified on the plans and/or specifications with the notations as set forth in ASTM A760 (A760M), ASTM B745 (B745M) and ASTM A742 (A742M) and indicated in Table 501.9.3.(a) Corrugated Metal Pipe Type.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Pipe with a full circular cross section with a singular thickness of corrugated sheet, fabricated with annular or helical corrugations.</td>
</tr>
<tr>
<td>Type IA</td>
<td>Pipe with a full circular cross section, with an outer shell of corrugated sheet fabricated with helical corrugations and an inner liner of smooth (uncorrugated) sheet attached to the shell at helical lock seams. Unless otherwise shown on the plans or contract specifications, the inner liner of smooth (uncorrugated) sheets shall be 18-gage, polymer coated per ASTM A762 (A762M) Grade 10/10 or 20-gage, polymer coated per ASTM A762 (A762M) Grade 10/10.</td>
</tr>
<tr>
<td>Type IR</td>
<td>Pipe with a full circular cross section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.</td>
</tr>
<tr>
<td>Type II</td>
<td>Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type IIA</td>
<td>Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type IIR</td>
<td>Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type III</td>
<td>Type I pipe which has been perforated to permit the inflow and outflow of water, intended for use as underdrains.</td>
</tr>
<tr>
<td>Type IIIA</td>
<td>Pipe shall consist of semi-circular cross section having a smooth bottom with a corrugated top shield which has been perforated, intended for use as deck drains.</td>
</tr>
</tbody>
</table>

501.9.4. Material. Corrugated metal pipe or pipe arch shapes shall be fabricated from corrugated sheets conforming to one of the styles indicated in Table 501.9.4.(a) Corrugated Sheets for Pipe or Pipe Arch Shapes.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>GALV</td>
<td>ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains</td>
</tr>
<tr>
<td>ALT2</td>
<td>ASTM A760 (A760M) (same as above)</td>
</tr>
<tr>
<td>POLY</td>
<td>ASTM A762 (A762M) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains (Grade 10/10)</td>
</tr>
<tr>
<td>ALUM</td>
<td>ASTM B744 (B744M) Aluminum Alloy Sheet for Corrugated Aluminum Pipe</td>
</tr>
</tbody>
</table>

501.9.5. Gage. Where reference is made to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets in ASTM A929 (A929M) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe. Unless otherwise shown on the plans or contract specifications, minimum gages shall be as required by TxDOT Standard Specifications for Construction of Highways, Streets and Bridges, Item 460.4. Selection of Gages.

501.9.6. Corrugation. Corrugated configurations shall be governed by dimensional tolerances set forth in ASTM A760 (A760M). The corrugations as shown in Table 501.9.6.(a) Corrugation Configurations shall only be valid with their respective classifications (type).
Table 501.9.6.(a) Corrugation Configurations

<table>
<thead>
<tr>
<th>Type</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>2½-in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in.</td>
</tr>
<tr>
<td></td>
<td>(68mm x 13mm; 75mm x 25mm; 125mm x 25mm)</td>
</tr>
<tr>
<td>Type IA</td>
<td>2½-in. x ½-in.; 3-in. x 1-in.</td>
</tr>
<tr>
<td></td>
<td>(68mm x 13mm; 75mm x 25mm)</td>
</tr>
<tr>
<td>Type IR</td>
<td>¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in.</td>
</tr>
<tr>
<td></td>
<td>(19mm x 19mm x 190mm; 19mm x 25mm x 292mm)</td>
</tr>
<tr>
<td>Type II</td>
<td>2½-in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in.</td>
</tr>
<tr>
<td></td>
<td>(68mm x 13mm; 75mm x 25mm; 125mm x 25mm)</td>
</tr>
<tr>
<td>Type IIA</td>
<td>2½-in. x ½-in.; 3-in. x 1-in.</td>
</tr>
<tr>
<td></td>
<td>(68mm x 13mm; 75mm x 25mm)</td>
</tr>
<tr>
<td>Type IIR</td>
<td>¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in.</td>
</tr>
<tr>
<td></td>
<td>(19mm x 19mm x 190mm; 19mm x 25mm x 292mm)</td>
</tr>
<tr>
<td>Type III</td>
<td>2½-in. x ½-in.; 3-in. x 1-in.</td>
</tr>
<tr>
<td></td>
<td>(68mm x 13mm; 75mm x 25mm)</td>
</tr>
</tbody>
</table>

501.9.7. Repairs. All damage incurred in fabrication will be repaired at the fabrication location. Damage incurred during handling and placement will be repaired, inspected and approved by the CITY prior to backfilling the pipe.

501.9.7.1. Galvanized Steel Pipe. Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld burned spelter coating. The cleaned area shall be painted with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-641.

501.9.7.2. Aluminized Steel Pipe. Damaged areas of aluminized coating, including saw cut ends and welds, shall be cleaned and repaired by brush coating of aluminized paint to the damaged, cut or welded area to a minimum thickness of 0.005-in. (0.13mm).

501.9.7.3. Precoated Pipe. Damaged or cut areas of polymeric coatings shall be repainted by the application of a polymeric coating similar and compatible with the polymeric coating on the pipe and to a minimum 10-mil (0.25mm) thickness.

Damaged areas of bituminous coated galvanized steel shall be repaired by repair of any damaged areas of spelter coatings in accordance with Item 501.9.7.1. Galvanized Steel Pipe before repairing the bituminous coating by applying asphalt mastic to the same thickness as the original coating.

501.9.8. Pipe Marking. The following information shall be clearly marked on each section of pipe:

1. Date of manufacture of the pipe.
2. The name or trademark of the manufacturer of the pipe.
3. Gage or thickness of metal.
4. Alloy number (aluminum pipe only).

501.9.9. Couplings.

501.9.9.1. Coupling Bands. Except as may be otherwise required, coupling bands shall be of the same base material(s) as the pipe. Coupling bands shall lap evenly on each of the pipes being connected and shall fit securely into a least one full circumferential corrugation to form a tightly closed joint. Pipe end circumferential corrugations shall be the corrugation width and depth as shown on the plans or as specified by the Engineer.

All pipe shall be field jointed with corrugated locking bands. Coupling bands shall not be more than three nominal sheet thicknesses lighter than the pipe to be connected and in no case thinner than 0.052-in. (1.32mm). The minimum width of the corrugated locking bands shall be as shown in Table 501.9.9.1.(a) Corrugated Locking Band Width for the corrugation which corresponds to the end circumferential corrugations on the pipe being joined.

Table 501.9.9.1.(a) Corrugated Locking Band Width

<table>
<thead>
<tr>
<th>Corrugation</th>
<th>Minimum Band Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½-in. x ½-in. (68mm x 13mm)</td>
<td>10½-in. (267mm)</td>
</tr>
<tr>
<td>3-in. x 1-in. (75mm x 25mm)</td>
<td>12-in. (305mm)</td>
</tr>
<tr>
<td>6-in. x 1-in. (152mm x 25mm)</td>
<td>18-in. (457mm)</td>
</tr>
</tbody>
</table>
When it is necessary to join a new pipe of helical corrugations to an existing pipe which was installed with no circumferential end corrugations, the two pipes shall be field jointed with helically corrugated bands. The width of helically corrugated bands shall conform to the minimum widths in Table 501.9.9.1.(b) Helically Corrugated Band Width.

**Table 501.9.9.1.(b) Helically Corrugated Band Width**

<table>
<thead>
<tr>
<th>Helical End Corrugation</th>
<th>Minimum Band Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>½-in. (13mm) deep</td>
<td>12-in. (305mm)</td>
</tr>
<tr>
<td>1-in. (25mm) deep</td>
<td>14-in. (356mm)</td>
</tr>
</tbody>
</table>

All coupling bands 12-in. (305mm) wide or less shall be drawn together by means of a minimum of two ½-in. (13mm) diameter bolts through angles or bar and strap device suitably welded; coupling bands greater than 12-in. (305mm) wide shall have a minimum of three ½-in. (13mm) diameter bolts.

**501.9.9.2. Bell-and-Spigot Coupling.** Except as may otherwise be required, bell-and-spiogt couplings shall be of the same base material as the pipe, and in no case thinner than 0.052-in. (1.32mm).

Couplings shall be bell and spigot type. The bell shall have a corrugation to engage the rerolled annular corrugation in the pipe, with a flare to receive the spigot end of the next section of pipe. The bell shall have factory-welded lap(s) applied after snugging the bell corrugation into the pipe rerolled annular corrugation.

Gaskets, if required, shall be polyisoprene (or similar) with a durometer of 45 ±5. The gasket on the spigot end shall be fluted with two flutes to prevent rolling when assembled in the field and to resist pull out from the bell.

**501.10. STRUCTURAL PLATE STRUCTURES**

**501.10.1. General.** Structural plate conduit, pipe arch, box culverts and special shapes shall meet the requirements of TxDOT Standard Specifications for Construction of Highways, Streets and Bridges Item 461 Structural Plate Structures and be in accordance with ASTM A761 Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Archs, and Arches for galvanized steel structures or ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, for aluminum alloy structures.

**501.10.2. Plates.** Steel plates shall consist of structural units of corrugated galvanized metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2-ft. (0.6m). Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 1-ft. (0.3m).

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans. Joints shall be staggered so that not more than 3 plates are joined at any one point. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be:

1. staggered in rows 2-inches (5cm) apart, with one row in the valley and one in the crest of the corrugations and not less than 4-bolts-per-foot for galvanized steel structures, or
2. in rows 1¾-in. (4.5cm) apart with 2 bolts in each valley and on each crest and not less than 16-bolts-per-3-feet for aluminum alloy structures.

Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12-in. (30cm). The minimum distance from center of hole to edge of the plate shall be not less than 1¾-times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than ¼-in. (6mm). Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a workmanlike finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

**501.10.3. Corrugations.** Permissible corrugations of metal plates to be furnished for each structure shall be shown on the plans. Corrugations for steel structures shall have a pitch of 6-in. (150mm) with a tolerance of ½-in. (6mm) and a depth of 2-in. (50mm) with a tolerance of ½-in. (3mm). The radius on the inside of the corrugations shall be at least 1½-in. (26mm) for steel structures. Corrugations for aluminum alloy structures shall have a pitch of 9-in. (229mm) with a tolerance of ½-in. (9.5mm) and a depth of 2½-in. (64mm) with a tolerance of ½-in. (3mm). The radius of the inside of the corrugation shall be at least 2-in. (50mm) for aluminum alloy structures.
501.10.4. **Gauge Determination and Tolerances.** The gage or minimum thickness of metal plates to be furnished for each structure shall be shown on the plans. The gauge and tolerances of aluminum plates shall conform to those in ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes. The thickness of galvanized steel plates shall conform to those in ASTM A929/A929M Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.

501.10.5. **Metal Headwalls.** The material for metal headwalls shall comply with requirements shown on plans. When required, aluminum alloy inverts, toewalls footings and closure plates shall conform to the material requirements herein. Extruded aluminum transverse stiffeners shall conform to ASTM B221 Aluminum and Aluminum- Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, Alloy 6061-T6.

501.10.6. **Fasteners.** Fasteners for steel structural plate shapes shall be high strength bolts ¾-in. (19mm) diameter, hot-dip galvanized, meeting ASTM A449 Quenched and Tempered Steel Bolts and Studs. Nuts shall conform to ASTM A563 Carbon and Alloy Steel Nuts, Grade C. Fasteners for aluminum structural plate shapes shall be ¾-in. (19mm) diameter, hot-dip galvanized steel, meeting ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. Nuts shall conform to ASTM A563, Grade A.

Bolt lengths shall be such as to result in at least “full nuts” when tightened in place.

501.10.7. **Anchor Bolts.** Anchor bolts for anchoring the ends of structural plate conduits into concrete headwall, footings or toewalls, as shown on the plans, shall be ¾-in. (19mm) diameter conforming to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. The length, shape and placement of these anchor bolts shall be as shown on the plans or approved by the Engineer.

501.10.8. **Identification.** No plates shall be accepted unless the metal is identified by a stamp on each plate in accordance with AASHTO M167 for Steel Structural Plate or AASHTO M219 for Aluminum Alloy Structural Plates.

501.10.9. **Inspections.** If the Engineer so elects, it may have the material inspected and sampled in the rolling mill or in the shop where fabricated. Engineer may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the directions of the Engineer. The Engineer or its representative shall have free access to the mill or shop for inspection and every facility shall be extended to the Engineer or representative for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

The CONTRACTOR shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating on steel plates. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

501.10.10. **Rejection.** In addition to the provisions of Item 501.1.1 Rejection, structures shall be rejected on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

1. elliptical shaping,
2. variation from a straight centerline,
3. ragged edges,
4. unevenly lined or spaced bolt holes,
5. illegible brands,
6. bruised, scaled or broken spelter coating,
7. dents or bends in the metal itself, or
8. uneven laps.

501.11. **TUNNEL LINER PLATES**

501.11.1. **General.** This specification covers the material, galvanizing, coating, shapes and gauge requirements of tunnel liner plates for use in tunneling under railroads, highways and streets.

501.11.2. **Plates.** The plates shall be fabricated from steel sheets conforming to the requirements of ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-
Alloy with Improved Formability. In addition, the flat plates before cold forming shall have mechanical properties indicated in Table 501.11.2.(a) Tunnel Liner Plate Requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>42,000-psi (2953-kg/cm²)</td>
</tr>
<tr>
<td>Yield Strength</td>
<td>28,000-psi (1967-kg/cm²)</td>
</tr>
<tr>
<td>Elongation, 2-in. (51 mm)</td>
<td>30-percent</td>
</tr>
</tbody>
</table>

501.11.3. Bolts and Nuts. Bolts used with lapped seam type (2 flange) liner plates shall be not less than 5/8-in. (15mm) diameter. Bolts shall conform to ASTM A449 Quenched and Tempered Steel Bolts and Studs for plate thickness equal to or greater than 0.209-in. (5mm) and to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength for plate thickness less than 0.209-in. (5mm). Nuts shall conform to ASTM A307.

Bolts and nuts used with the four-flanged type shall be not less than 1/2-in. (12mm) for 7-gauge plates and lighter and not less than 5/8-in. (15mm) diameter for plates heavier than 7-gauge. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A307, Grade A.

501.11.4. Fabrication. The plates shall be new and unused prior to fabrication. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from the inside of the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

501.11.5. Grout Holes. One-half of the total number of the top plates shall be equipped with 2-in. (50mm) diameter grout holes to facilitate grouting above and around the tunnel liner conduit. All grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes.

501.11.6. Galvanizing. After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter or equal shall be applied in accordance with ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots. All nuts shall be galvanized to conform to ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

501.11.7. Bituminous Coating. The plates shall be given a bituminous coating meeting the current American Railway Engineering & Maintenance of Way Association specification or ASTM A849 Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe. Bituminous protected corrugated metal pipe or plates may be spray-coated in the field with a minimum dry film thickness of 0.05-in. (1.3mm) prior to installation.

501.11.8. Section Properties. Section properties shall conform to those specified in AASHTO Standard Design Specifications for Highway Bridges, Section 16, Steel Tunnel Liner Plates.

501.11.9. Rejection. Structures on which the spelter coating has been bruised or broken either in the shop or in shipping or which shows defective workmanship shall be rejected. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual liner plate or in general in any shipment shall constitute sufficient cause for rejection:

   (1) uneven laps,
   (2) elliptical shaping,
   (3) variation from a straight centerline,
   (4) ragged edges,
   (5) unevenly lined or spaced bolt holes,
   (6) illegible brands,
   (7) bruised, scaled or broken spelter coating, or
   (8) dents or bends in the metal itself.

501.12. POLYVINYL CHLORIDE (PVC) WATER PIPE

501.12.1. General. Unplasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., For Water, AWWA C900 with cast-iron outside dimensions or AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 in. through 48 in., with cast-iron outside dimensions. Laying lengths shall be 20-ft ±1-in. (6m ±2.5cm).

501.12.2. Approvals. PVC water pipe shall be approved by the Underwriters’ Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of
Texas. PVC water pipe shall also bear the seal of approval (or “NSF” mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

**501.12.3. Dimension Ratio.** PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in AWWA C900 or C905. The pressure classification refers to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations. DR 21 is a non-standard product in pipe sizes 18-, 20- and 24-inch. 42- and 48-in pipe DRs of 41 and 51 shall not be used for water applications.

**501.12.4. Joints.** PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic, water soluble approved by AWWA & NSF rating and shall have no detrimental effect to either gasket or pipe.

**501.12.5. Fittings.** Fittings for PVC water pipe shall conform to one of the standards Table 501.12.5.(a) PVC Water Pipe Fittings unless otherwise specified. Fittings joints shall be push-on, integrally restrained, or mechanical. Bolts and nuts for mechanical and integrally restrained fittings joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints (Type 3) or shall be stainless steel in accordance with ASTM A304.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C110 (ANSI A21.10)</td>
<td>Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water</td>
</tr>
<tr>
<td>AWWA C153</td>
<td>ANSI Standard for Ductile-Iron Compact Fittings for Water Service</td>
</tr>
<tr>
<td>AWWA C907</td>
<td>Polyvinyl Chloride (PVC) Pressure Fittings for Water—4 In. Through 8 In. (100 mm Through 200 mm)</td>
</tr>
<tr>
<td>AWWA C900</td>
<td>Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm) for Water Distribution</td>
</tr>
<tr>
<td>AWWA C905</td>
<td>Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution</td>
</tr>
</tbody>
</table>

**501.13. POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES)**


**501.13.2. Material.** The pipe shall be made of PVC plastic having cell classifications of 12454, 12454 or 14333.

**501.13.3. Joints.** Joint tightness shall be tested in accordance with ASTM D3139, Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

**501.13.4. Testing.** All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

**501.14. MOLECULARLY ORIENTED POLYVINYL CHLORIDE (PVCO) WATER PIPE**

**501.14.1. General.** Unplasticized (PVCO) Water pipe shall meet the requirements of AWWA Standard C909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. – 12 In. (100 mm-300 mm), for Water Distribution. Laying length shall be 20ft ± 1 inch (6m ± 2.5cm).

**501.14.2. Material.** PVCO water pipe starting stock shall be made from ASTM D1784 cell class 12454 material, having an Hydrostatic Design Basis (HDB) of 4000-psi (281-kg/cm²). When orientation is achieved, PVCO pipe will have an HDB of 7100-psi (500-kg/cm²). The pressure classifications refer to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations.

**501.14.3. Dimensions.** Dimensions shall conform to the requirements in AWWA C909.

**501.14.4. Joints.** PVC water pipe shall be furnished with gasketed joints, meeting ASTM D3139 Joints for Plastic Pressure Pipes using Elastomeric Seals. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe. Solvent cement shall not be used with PVCO pipe.

**501.14.5. Fittings.** Fittings for PVCO water pipe shall conform to American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In., For Water and Other Liquids, AWWA Standard C110 (ANSI A21.10) or AWWA C907 for Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 In. through 8 In., or AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service unless otherwise specified. Fittings joints shall be push-on or mechanical joints. Bolts and nuts for mechanical joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM A325 (Type 3) or stainless steel in accordance with ASTM A304.
501.15. POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE & FITTINGS WITH DIMENSION CONTROL

501.15.1. General. PVC Wastewater Pipe and Fittings shall conform to ASTM D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings for 4 in. through 15 in. diameter and ASTM F679 Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings for greater than 15 in. diameter.

501.15.2. Material. The pipe shall be made of PVC plastic having cell classification of 12454, 12454 or 12364, and fittings shall be made of PVC plastic having cell classifications of 12454, 12454 or 13343 as defined in ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. Pipe type shall be determined by size as shown in Table 501.15.2.(a) PVC Wastewater Pipe Type.

<table>
<thead>
<tr>
<th>Pipe Size (diameter)</th>
<th>Type</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-in. through 15-in. (10cm - 38cm), inclusive</td>
<td>PSM SDR-35 or SDR-26</td>
<td>ASTM D3034</td>
</tr>
<tr>
<td>greater than 15-in. (38cm)</td>
<td>T-1 A or T-2 B</td>
<td>ASTM F679</td>
</tr>
</tbody>
</table>

501.15.3. Dimensions. Dimensions shall conform to requirements of ASTM D3034 or F679.

501.15.4. Testing. All pipe shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM D3034 or F679.

501.16. POLYVINYL CHLORIDE (PVC) PROFILE GRAVITY WASTEWATER PIPE AND FITTINGS – FOR DIRECT BURY AND SLIPLINING APPLICATIONS

501.16.1. General. This specification designates requirements for PVC plastic gravity wastewater pipe for the conveyance of domestic wastewater with various modified wall profiles and performance requirements.

501.16.2. Stiffness. Minimum pipe stiffness at five percent deflection shall be 46-psi (3.2-kg/cm²) for wastewater conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.16.3. Pipe Classification. Pipe as indicated on the plans shall conform to one of the standards in Table 501.16.3. PVC Profile Gravity Pipe Standards.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F789</td>
<td>Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings, size 4 in. to 18 in.</td>
<td>Pipe conforming to ASTM F789 shall be joint compatible to ASTM D3034 pipe joint dimensions</td>
</tr>
<tr>
<td>ASTM F794</td>
<td>PVC Ribbed Gravity Sewer Pipe and Fitting Based on Controlled Inside Diameter, sizes 4 in. through 48 in.</td>
<td>--</td>
</tr>
<tr>
<td>ASTM F949</td>
<td>PVC Corrugated Sewer Pipe with Smooth Interior and Fittings, sizes 4 in. through 36 in. (46 psi pipe stiffness) or sizes 8 in. through 15 in. (115 psi pipe stiffness)</td>
<td>--</td>
</tr>
<tr>
<td>ASTM F1803</td>
<td>PVC Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter, sizes 18 in. through 60 in.</td>
<td>--</td>
</tr>
</tbody>
</table>


501.16.5. Testing. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.17. PVC COMPOSITE PIPE FOR WASTEWATER CONDUITS

501.17.1. General. PVC composite pipe shall conform to ASTM D2680 Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping for 8 in. through 15 in. diameter. Acrylonitrile-Butadiene-Styrene (ABS) shall not be allowed.

501.17.2. Joints, Couplings and Fittings. Wyes or tees with saddle shall be provided as indicated on the plans. Adapters to other types of pipe shall be supplied as indicated on the plans.

501.17.2.1. Chemically Welded Joints. If the pipe is plane ended with couplings, the pipe shall be delivered prebelled. Sufficient primer and solvent cement shall be provided. The solvent cement shall conform to ASTM D2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
501.17.2.2. **O-Ring Joints.** If the pipe is prebelled with an enlarged coupling, an O-Ring shall be provided for each joint. The physical properties of the gasket shall be at least equal to the requirements of ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

501.17.3. **Tests.** The pipe stiffness at five-percent vertical deflection shall be at best equal to or exceed 200-lb./in. (3612-g/cm) of deflection for each diameter as determined by ASTM D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. The physical test may be the 3-Edge Bearing Method under applicable ASTM Designation if preferred.

501.18. **POLYVINYL CHLORIDE (PVC) CORRUGATED STORM WATER PIPE WITH A SMOOTH INTERIOR AND FITTINGS**

501.18.1. **General.** PVC Corrugated storm water pipe and PVC Perforated Corrugated drainpipe shall conform to ASTM F949 Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings (4”-36”).

501.18.2. **Material.** The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

501.18.3. **Stiffness.** Constant minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm²) for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.18.4. **Joints.** Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2-psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8-psi test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

501.18.5. **Testing.** Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.19. **SOLID WALL POLYETHYLENE PLASTIC PIPE FOR WATER, WASTEWATER, AND PIPE REHABILITATION**

501.19.1. **General.** Pipe and fittings shall conform to the material and physical properties as described in ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, unless otherwise specified herein or in the special specifications. Standard Lengths shall be 40-ft (12m) or 50-ft (15m) for straight pipe. Coiled pipe may be obtained in reels of 500-ft (152m), 1000-ft (305m) or 1500-ft (457m) depending on outside diameter and Dimension Ratio (DR) requested.

Solid wall high density polyethylene pipe (HDPE) for pressure water pipe shall meet the requirements of AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ in. (13 mm) Through 3 In. (76 mm), for Water Service or AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,575 mm), for Water Distribution.

501.19.2. **Material.** Pipe and fittings shall be made of high density, high molecular weight polyethylene pipe PE3408 material, polyethylene resin which conforms to Polyethylene Plastics Molding and Extrusion Materials, meeting the requirements of Type III, Grade P33, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials. The polyethylene plastic shall meet the Cell Classification requirements of 345464C or 345464E as defined in ASTM D3350. Pipe for non-pressure applications shall have a light colored interior, unless otherwise specified in the plans, contract documents or purchase request.

501.19.3. **Dimensions.** The polyethylene (PE) pipe shall meet the dimension ratios and outside diameter, wall thickness and tolerances as provided in the reference specifications of manufacture as listed in Table 501.19.3.(a) Solid Wall PE Pipe Dimension Standards. Diameters and wall thickness other than those shown in the standards may be used if specifically called for in the plans, contract documents or purchase request, and if they are mutually agreed upon by the manufacturer and CITY.
Table 501.19.3.(a) Solid Wall PE Pipe Dimension Standards.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C901</td>
<td>Polyethylene (PE) Pressure Pipe and Tubing, ½ in Through 3 in for Water Service</td>
</tr>
<tr>
<td>AWWA C906</td>
<td>Polyethylene (PE) Pressure Pipe and Fittings, 4in through 63in for Water Distribution and Transmission</td>
</tr>
<tr>
<td>ASTM D2239</td>
<td>Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter</td>
</tr>
<tr>
<td>ASTM D2737</td>
<td>Polyethylene (PE) Plastic Tubing</td>
</tr>
<tr>
<td>ASTM D3035</td>
<td>Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter</td>
</tr>
<tr>
<td>ASTM F714</td>
<td>Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter</td>
</tr>
</tbody>
</table>

501.19.4. Joints. Dependent upon installation requirements, site location, and weather conditions, joining shall be performed within or outside the excavation.

Sections of polyethylene pipe and fittings shall be joined by the butt fusion process, unless one of the alternate methods is approved by the CITY. The butt (heat) fusion method shall be performed in accordance with the pipe manufacturer's recommendations. Electrofusion fittings may be used. Mechanical joint adapters, flanges, unions, grooved-couplers, transition fittings, and some mechanical couplings may be used to mechanically connect PE pipe/tubing and fittings. Extrusion welding or hot gas welding of PE shall not be used for pressure pipe application or fabrications where shear or structural strength is important.

501.19.4.1. Alternate Methods. When approved by the CITY, pipe may be joined to one another and to polyethylene fittings by electrofusion or socket thermal fusion joints in accordance with ASTM D2657 Heat Joining of Polyolefin Pipe and Fittings, ASTM F1290 Electrofusion Joining of Polyolefin Pipe and Fittings, and as recommended by the pipe manufacturer.

501.19.5. Tests and Requirements. Tests for compliance with this specification shall be made as specified herein and according to the applicable ASTM or AWWA Standard(s). All polyethylene pipe shall be tested for brittleness, joint separation, quality and ring stiffness as specified in the applicable ASTM or AWWA Standard(s). A certification of compliance with this specification shall be furnished by the manufacturer for all material furnished under this specification. In addition, the CITY may, at its own expense, witness inspection and test of the materials.

501.19.5.1. Tensile Properties. The tensile strength, yield strength, elongation and elastic modulus of the material shall be determined in accordance with Tensile Properties for Plastics, ASTM D638 (D 638M).

501.19.5.2. Hydrostatic Properties. The long term hydrostatic strength rating shall be listed in the name of the pipe and fittings manufacturer in PPI (Plastic Pipe Institute) TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings compounds, with a standard grade HDB rating of 1600-psi (112-kg/cm²) at 73°F (23°C).

501.19.5.3. Melt Index. The melt index of the polyethylene plastic, as determined in accordance with ASTM D1238 Flow Rates of Thermoplastics by Extrusion Plastometer, shall meet the requirements as specified in ASTM D3350 Cell Classification of 4.

501.19.5.4. Density. The density of the polyethylene plastic, as determined in accordance with ASTM D1505 Density of Plastics by the Density - Gradient Technique shall have specific base resin densities meeting the requirements as specified in ASTM D3350 Cell Classification 3.

501.19.5.5. Environmental Stress Cracking Resistance. The environmental stress cracking resistance (ESCR) of the material shall meet the requirements as specified in ASTM D3350 Cell Classification of 6 using ASTM F1473 (PENT) or meet a Cell Classification of 4 according to ASTM D1693.

501.19.5.6. Wastewater Pipe Stiffness. Minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm²) for all sizes of gravity and pressure wastewater conduits as specified in Section XI "Deflection Control In Unpressurized Polyethylene Piping Systems," Table X1.1 “Pipe Stiffness Ranges for Specified Materials” and DR's of ASTM F714.

501.20. POLYETHYLENE (PE) LARGE DIAMETER WASTEWATER PIPE WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS

501.20.1. General. High Density Polyethylene gravity wastewater pipe and fittings in nominal sizes 18-in. through 120-in. (46cm – 305cm) with integral bell joints shall conform to current ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.
501.20.2. Materials. The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials with a minimum cell classification of 345444C.

501.20.3. Stiffness. Minimum pipe stiffness at five-percent deflection shall be 10-psi (0.7-kg/cm²) for wastewater as specified for all sizes when calculated according to Appendix XI, “Relation of RSC To Pipe Properties and Pipe Stiffness” of ASTM F894.


501.20.5. Testing. Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designations.

501.21. POLYETHYLENE (PE) CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS

501.21.1. General. High Density Corrugated and Corrugated Smooth Lined Polyethylene storm water tube/pipe and fittings shall conform to current AASHTO Designations as follows: AASHTO M-252, Corrugated Polyethylene Drainage Tubing (3’-10’ (75 mm – 250 mm)) or AASHTO M-294, Corrugated Polyethylene Pipe (12”- 48” (300 mm-1200 mm)). Profile wall HDPE pipe shall conform to ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

501.21.2. Materials. The tube/pipe and fittings shall be made of virgin polyethylene which conforms with the requirements of cell class 335400C as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials.

501.21.3. Stiffness. Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi (3.5-kg/cm²) for 3-in. through 10-in. (76mm – 254mm) diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters. Profile wall HDPE pipe shall have minimum RSC Class equal to 40.

501.21.4. Joints. Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24” or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.21.5. Testing. All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F894, as applicable.

501.22. FIBERGLASS (GLASS-FIBER-REINFORCED THERMOSETTING-RESIN) WASTEWATER PIPE

501.22.1. General. This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) sizes from 8-in. to 144-in. (20cm – 366cm) for the conveyance of wastewater. Pipe for gravity application shall conform to ASTM D3262 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. Pipe for force main applications shall conform to or ASTM D3754 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. If ASTM D3754 pipe is selected, its actual outside diameter shall be in accordance with AWWA C950 Fiberglass Pressure Pipe.

501.22.2. Stiffness. Minimum pipe stiffness at 5-percent deflection shall be 46-psi (3.2-kg/cm²) for gravity and pressure wastewater conduit and 36-psi (2.5-kg/cm²) for gravity slippining applications as specified for all sizes when calculated in accordance with ASTM D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.22.3. Joints. Joint tightness shall be tested in accordance with ASTM D4161 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.


ITEM 502. APPURTEANCES

502.1. MANHOLES

502.1.1. Manhole Materials. Manholes shall be fabricated in different configurations to meet the specific needs required in the water or wastewater or storm water system.

502.1.1.1. Precast Reinforced Concrete Manhole Sections. These specifications cover precast reinforced concrete manhole sections, which shall conform to ASTM C478 (C478M) Precast Reinforced Concrete Manhole Sections, with the following additions:

1. All pipe shall be machine made by a process that shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product, except that reducer cones may be wet-cast.

2. Aggregates for the concrete shall comply with requirements of ASTM C33 Concrete Aggregates, with the additional requirement that the aggregate shall have a minimum of 50-percent of calcium carbonate equivalent.

3. Minimum wall thickness for the manhole risers shall be as listed under Wall “B” in the “Class Tables” of ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. Unless otherwise noted, manhole steps shall not be furnished. If required, the steps shall be of the noncorrosive plastic or rubber coated steel type, with a clear cleat space of 10 in. (25.4 cm) minimum that shall support a concentrated load of 300 pounds (136.2 kg), and be in accordance with applicable OSHA specifications.

5. Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals or ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.

502.1.1.1.1. Joints. Joints shall conform to the joint specification ASTM C478 Precast Reinforced Concrete Manhole Sections (C478M). All joints shall have rubber gaskets. Rubber gaskets shall meet the requirements of Item 501.5.4.1. Rubber Gaskets.

502.1.1.1.2. Coatings and Linings. At the discretion of the CITY coatings and linings called for in specifications or as shown on the plans shall meet the requirements as specified and shall be installed or applied by a certified applicator with minimum three years experience. All warranties shall be provided by the product manufacturer.

Manholes shall be tested in accordance to CITY standards prior to surface preparation to produce the required level of cleanliness, which must be achieved either by high pressure water blasting rated at minimum of 5,000 psi at 4 gpm or dry abrasive using slag grit. All specified surface preparation shall be performed in accordance with the latest version of the SSPC, NACE and ICRI. Concrete surfaces shall be abraded to produce a minimum surface profile. All interior surfaces must be thoroughly cleaned before application of coating. It is the responsibility of the contractor and job inspector to inspect and report unacceptable concrete substrate surface conditions to the CITY prior to the commencement of surface preparation activities. Unacceptable surface conditions are defined as the presence of cracked surfaces or concrete deteriorated to a depth of greater than 1-inch or otherwise unable to withstand surface preparation as specified herein.

All surfaces that show exposed structural steel, spalling greater than 3/4-inches deep or cracks greater than 3/8-inches wide, shall be patched using a quick setting, high strength cement mortar. The epoxy coating shall be sprayed on uniformly in two separate layers of achieve a total minimum thickness of 125 mils. Two distinct separate colors shall be used to differentiate the first and second coat and allowing, in accordance with manufacturers specifications, curing time between coating application.

502.1.1.1.3. Rejection. Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or having defects as follows:

1. Variations in any dimensions exceeding the permissible variation prescribed.

2. A piece broken out of the bell, spigot, tongue or groove in such size that the watertightness of the joint should be impaired.

3. Any shattering or flaking of concrete or other conditions indicating an improper concrete mix.

4. Lack of uniformity in placement steel which might preclude all joints being typical of those tested.

5. Cracks sufficient to impair the strength, durability, or serviceability of the pipe.

6. Joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.

502.1.1.2. Fiberglass Manholes. Allowable when proposed by design engineer and accepted by the City of Temple.

502.1
502.1.2. Grade Adjustment Risers. Casting may be raised or final grade adjustment of access covers and frame assemblies made using Grade Adjustment Risers. Grade Adjustment Risers shall be concrete with wire reinforcement.

Installed grade adjustment risers and riser assemblies shall fit within the existing casting without interference, cause no binding to the manhole lid and shall be immobile and watertight. Manhole lids shall have bearing on all of the surface of inner ring(s).

502.1.2.1. Precast Concrete Grade Adjustment Riser. Precast Concrete adjustment risers shall be precast, reinforced concrete meeting requirements of ASTM C478 Precast Reinforced Concrete Manhole Sections.

502.1.2.2. Cover Adjustment Riser. Cover riser rings shall only be used for resurfacing, rehabilitation or reconstruction activities on existing facilities.

502.1.2.2.1. Steel. Inner cover riser ring shall be of domestic steel meeting the requirements of ASTM A36 carbon structural steel. It shall be ¾” X riser height. Intermediate and outer rings shall be one of the combinations indicated in Table 502.1.2.3.1.(a) Cover Adjustment Risers, as specified by the CITY.

<table>
<thead>
<tr>
<th>Intermediate ring</th>
<th>Outer ring</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>ASTM A36 steel ½” thick</td>
<td>solid</td>
</tr>
<tr>
<td>ASTM A36 12-gauge steel</td>
<td>½” x ½” surrounding intermediate ring at finished elevation</td>
<td>solid</td>
</tr>
<tr>
<td>None</td>
<td>ASTM A36 steel ½” thick</td>
<td>Adjustable</td>
</tr>
<tr>
<td>ASTM A36 12-gauge steel</td>
<td>½” x ½” surrounding intermediate ring at finished elevation</td>
<td>Adjustable</td>
</tr>
</tbody>
</table>

1. Adjustment devices for adjustable steel risers shall be fabricated from stainless steel, have a positive lock, and be in line with the lower bearing bar. It shall be capable of adjustment 3/8” from nominal.

Rings shall be fabricated to ±1/16” concentricity. The outer riser ring shall have an inside diameter no greater than 3/16” larger than the outside diameter of the manhole lid. All materials shall be bituminous asphalt coated.

Certified welders shall securely weld rings in accordance with American Welding Society D1.5 Bridge Code to prevent differential movement between rings under traffic loads.

502.1.2.2.2. Iron. Gray iron adjustment cover risers shall be manufactured from iron conforming to ASTM A48 Gray Iron Castings, Class 35B, in accordance with AASHTO M306. Ductile iron adjustment risers shall be manufactured from iron conforming to ASTM A536 Ductile Iron Castings, Grade 70-50-05.

502.1.3. Manhole Frame and Cover. Manhole Frame (Ring) and cover shall meet the requirements as shown on detail drawings.

502.1.4. Manhole Construction. TCEQ/EPA regulations shall take precedence in the case of conflict between these specifications and TCEQ regulations. Construction shall be in accordance with City of Temple standard details.

The CONTRACTOR shall furnish all appropriate equipment and access required for inspection.

502.2. WASTEWATER MAIN CLEANOUTS

Cleanouts shall be constructed in accordance with the City of Temple specifications.

502.2.1. Typical Cleanout. Typical cleanout requirements are in the City of Temple standard details.
502.3. FIRE HYDRANTS

502.3.1. Materials. Fire hydrants which are to be installed as shown on the plans or to be furnished for general installation shall be dry-barrel traffic model that conform to AWWA C502 Standard for Dry-Barrel Fire Hydrants, except for changes and/or additions specified as follows or as shown on the plans or in the contract specifications. All hydrant components covered by NSF-61 must comply with NSF-61 requirements.

502.3.1.1. Supplementary Details Specified.

The type of shut-off shall be compression type with the flow.

The valve action shall provide positive shut-off at minimum closing torque. Wedge action closing gates shall not be permitted, and the scissors type main valves shall not be permitted.

Inlet connection shall be mechanical joint and shall be for a 6-in. pipe with minimum main valve opening of 5¼-in.

Delivery classification: number and size of pumper and hose nozzles shall be as shown on the plans and contract specifications.

Bury length: ground to bottom of connecting pipe shall be 4-feet (1.2m) or as specified by the CITY.

Diameter outlet connections: hose and pumper nozzle threads shall be of the size and type shown on the plans.

Gaskets shall be furnished on all nozzle caps and shall be long life, black rubber meeting ASTM D2000, Classification System for Rubber Products in Automotive Applications, or equal.

Unless otherwise specified in the special provisions or in the plans, the operating and nozzle cap nuts shall be tapered pentagon nuts with faces not less than 1-in. (2.5cm) high.

Drain valve and outlet: hydrants shall be equipped with a minimum of two drainholes and provided with an automatic and positively operating noncorrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut.

Direction to open is to be specified in the plans and contract specifications. Number of turns to open shall be in accordance with AWWA Standard C502.

The outside of the hydrant above the finished ground line shall be factory painted with one coat of red primer. After shop priming, a finish coat of Flynt Aluminum paint shall be applied to the barrel only leaving the top bonnet primer colored.

502.3.1.2. Breakable Type Hydrants. Breakable or Sleeve Type Couplings. The barrel of the hydrant between the base and the nozzle section must be made in two parts connected by a swivel flange or breakable flange which shall permit facing of the nozzles in any desired direction in increments of 45° or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the base of the hydrant.

The materials used for gaskets between the upper and lower barrels and the base and nozzle section shall be compounded to conform to ASTM D2000 or an equal material that shall have CITY approval prior to substitution unless otherwise specified in the plans.

Provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into the hydrant barrel, and the break shall not occur through the pins or bolts holding the coupling to the stem.

502.4. FITTINGS


502.4.1.1. General. Stops, cocks and other fittings furnished under these specifications shall be in accordance with AWWA C800 (ASTM B-62 and ASTM B-584 and UNS C83600-85-5-5) “Standards for Underground Service Line Valves and Fittings” of the sizes and type specified. Cast solder fittings shall conform to alloy 83-4-6-7, ASTM B-584 “Practice for Copper Alloy Sand Castings”. All stops, cocks and fittings shall be full port throughout the sizes specified.
502.4.1.2. **Physicals.** Any pipe, fitting, solder or flux used in the installation or repair of any public water system shall be lead-free. For purposes of this section, "lead-free" means solders and flux containing not more than 0.2-percent lead; and pipes and pipe fittings containing not more than 8.0-percent lead.

Brass used shall have a tensile strength (as determined from test bars) of not less than 30,000-psi (206,820-kPa) when tested as prescribed by ASTM B208 Practice for Preparing Tension Test Specimens for Copper-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings (Fig. 5).

Stops, cocks and fittings shall be tested and designed for working pressures as per the requirements of AWWA C800

**502.4.1.3. Design Features of Stops and Cocks.** Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasives to insure accurate fit. The large end to the tapered surface of the key shall be reduced in diameter for a distance that shall bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body, and the taper seat in the body shall be relieved on the small end, so that the small end of the key may extend through to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut and washer shall be so designed that if the key nut is tightened to failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three-times the necessary effort to properly seat the key without failure in any manner.

The ball stop shall have a full-size round-way opening with straight-through flow, teflon coated bronze ball with a minimum of 0.5-mil (0.0005-in.) (0.01 mm) thickness coating. The stop must be so constructed that it may be disassembled and the ball removed without special tools.

Plug type stop shall have full size round way opening with straight-through flow. Seating surfaces shall be brass (or teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. The stop must be so constructed that the plug may be removed without special tools. Rubber O-rings should conform to requirements of ASTM D2000 Classification System for Rubber Products in Automotive Applications and test method shall conform to ASTM D1414 for Test Methods for Rubber O-Rings.

Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA Standard C300 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, and inlet threads shall be protected in shipment by a plastic coating or other equally satisfactory means. If used, coupling nuts shall have a bearing skirt machined to fit the outside diameter of the pipe for a length at least equal to the outside of the pipe.

Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size. The inlet threads shall be male AWWA tapered threads and the outlet shall be female pipe threads, male iron pipe threads or copper tube size (CTS) compression nut with a stainless steel set screw.

Brass Meter Stops 1-in. in size shall have a 1-in. swivel meter nut connection on the outlet end with an AWWA meter thread reducing bushing reduced to ½-in. meter thread unless otherwise noted on the plans or specified by the CITY. The inlet side shall be 1-in Copper Tube Size (CTS) compression with stainless steel set screw. The outlet side of 1 ½ -in. and 2-in. brass meter stops shall be female iron pipe or AWWA meter flange. The inlet side of 1 ½ -in. and 2-in. brass meter stops shall be female iron pipe threads, male iron pipe threads or CTS compression nut with stainless steel set screw. All brass meter stops shall be full port ball style meter stops and shall be straight pattern (no angle stops will be accepted).

Brass Curb Stops 1-in., 1 ½ -in. and 2-in. shall be full port ball style with female iron pipe threads on the outlet and CTS compression nut with stainless steel set screw on the inlet or any combination thereof.

502.4.1.4. **Design Features of Fittings.** All castings shall be smooth, free from burrs, scales, sand holes and defects of every nature which would make them unfit for the use for which they are intended. Nuts shall be smooth cast and shall have symmetrical hexagonal wrench flats.

Solder-joint fittings shall be smooth cast. Inside surfaces of solder-joint ends shall be machined smooth to proper inside diameter.

All thread fittings, of all types, shall be protected in shipment by a plastic coating or other equally satisfactory means.

Compression fittings shall have a Buna-N or equivalent beveled gasket and an anti-friction ring. Compression nut shall have:

1. for PE tubing or copper tubing, a stainless steel set screw to bite into and lock on the tubing.
2. for iron pipe, a stainless steel set screw to bite in and lock on the pipe.
502.4.1.5. Tests. All brass stops, cocks and fittings included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

502.4.1.6. Rejection. Brass stops, cocks, and fittings may be rejected for failure to meet any of the requirements of this specification.

502.4.2. All Other Fittings. All other fittings shall conform to respective provisions of Item 501. Underground Conduit Materials, listed according to conduit type. In water pipe, Ductile Iron or Ductile Iron Compact fittings shall consist of standard crosses, tees, bends, reducers, sleeves, plugs, blind flanges, etc. Fittings for reinforced concrete pressure pipe, steel cylinder type, shall consist of special crosses, tees, bends, reducers, dished plugs, closure sections, flanged outlets, blind flanges, bored flanges, etc.

502.5. VALVES

502.5.1. Metal Seated Gate Valves for Ordinary Waterworks Service

502.5.1.1. General Description. All gate valves 3-in. (7.6cm) through 48-in. (122cm) shall conform to AWWA Standards C500 Metal-Seated Gate Valves for Water Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard 61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 48-in. (122cm) shall be a special consideration. The CITY shall hydrostatically test all gate valves larger than 48-in. (122cm) for a reasonable period after receipt of a specified test pressure.

All gate valves shall be iron body, bronze mounted, double disc, parallel seat, nonrising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and tracks for gates.

502.5.1.2. Bonnet Bolting. Body bolts, studs and nuts shall be 304 stainless steel. Drilled and tapped bodies for use with headless bolts will not be acceptable.

502.5.1.3. Ends. Valves shall have flanged or mechanical -joint ends, or any combination of these as may be specified.


502.5.1.4. Gates and Rings. Gates and rings shall conform to AWWA Standards C500 except as follows: All gates above 4-in. (10cm) shall be cast iron with bronze-gate rings, and 4-in. (10cm) gates may be solid bronze. Gates 3-in. (7.6cm) and smaller shall be solid bronze.

502.5.1.5. Wedging Device. Wedging devices shall conform to the requirements of AWWA C500, except as follows: Gate valves 4-in. (10cm) and smaller shall have solid bronze wedges. Wedges for valves above 4-in. (10cm) may be solid bronze or cast-iron with an integral bronze nut. Wedging surfaces may be bronze, monel, or stainless steel cast integral with the wedge. Stem nuts or wedging surfaces that are attached with fasteners are not acceptable. Wedging surfaces on valves up to 16-in. (41cm) shall be bronze-, monel-, or stainless-steel- to iron. Wedging surfaces on valves 16-in. (41cm) and larger shall be bronze-to-bronze, monel-to-monel, or stainless-to-stainless. Other moving surfaces integral to the wedging action shall be bronze to iron.

502.5.1.6. Rollers and Tracks and Scrapers for Horizontal Valves. Rollers and tracks and scrapers for horizontal valves shall conform to AWWA Standards C500, with the following exception: Babbit tracks shall not be acceptable.

502.5.1.7. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C500, except as follows: Stem shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as
specified. Upset stems on valves larger than 16-in. (41cm) shall not be permitted under these specifications. Upset stems shall conform to the requirements of AWWA C500.

502.5.1.8. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C500 with the following exceptions: All valves 2-in. (5cm) through 16-in. (41cm) shall be equipped with double O-rings, provided arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double O-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards. Stuffing box bolts and nuts shall be 304 stainless steel.

502.5.1.9. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C500 with the following exceptions: Gland flanges or followers that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (31cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.5.1.10. Hand Wheels and Operating Nuts. All valves 2-in. (5cm) in diameter and above shall be nut operated unless otherwise ordered. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise.

502.5.1.11. Gearing. Gearing shall be in accordance with AWWA C500. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

502.5.1.12. Gear Cases. Gear cases shall be furnished on all geared valves. All geared valves shall be equipped with extended type gear cases, with cast iron side plates. Stuffing boxes shall be located on top of the bonnet and shall be outside the gear case. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be cast iron.

502.5.1.13. By-Pass Valves. By-pass valves shall conform to the requirements of AWWA C500 with the following exceptions: By-pass valves are required on all 18-in. (46cm) valves and larger AWWA C500 valves.

502.5.1.14. Cast Iron. All gray cast iron shall conform to the requirements of ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B or ductile iron shall conform to ASTM A536 Ductile Iron Castings.

502.5.1.15. Horizontal Valves. All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.5.1.16. Valves for Installation in Vertical Pipeline. Valves 14-in. (36cm) and larger AWWA C500 valves ordered for installation in vertical pipeline shall be equipped with disc face tracks and wedge springs to prevent pre-wedging. Valves 4 in. (10.2 cm) through 12 in. (30.5 cm) shall be double disc, square-bottom valves.

502.5.1.17. Tapping Valves. Tapping valves shall conform to the requirements of AWWA C500, and the other requirements of this section with the following exceptions: Tapping valves shall have oversize seat rings to prevent pre-wedging. Valves 4 in. (10.2 cm) through 12 in. (30.5 cm) shall be double disc, square-bottom valves.

502.5.1.18. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

502.5.2. Resilient-Seated Gate Valves for Ordinary Waterworks Service.

502.5.2.1. General Description. All gate valves 2-in. (5.08cm) through 36-in. (91cm) shall conform to AWWA Standards C515 for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service, or C509 for Resilient-Seated Gate Valves for Water-Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard
61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 36-in. (91cm) shall be a special consideration. The CITY shall hydrostatically test all gate valves larger than 36-in. (91cm) for a reasonable period after receipt.

All gate valves shall be iron body, resilient seated, nonrising bronze stem and bronze stem nut. Valves must have the resilient seat bonded and vulcanized to the wedge and employ the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and guide tracks for the gate.

502.5.2.2. Bonnet Bolting. Bonnet Bolting shall conform to Item 502.6.1.2. Bonnet Bolting.

502.5.2.3. Ends. Ends shall conform to Item 502.6.1.3. Ends.

502.5.2.4. Gate. Gate shall be encapsulated with an elastomer that meets all requirements of AWWA C515 or C509. The bonding of the rubber to the gate shall meet the requirements of ASTM D429, Test Method A or Method B. Gates 3-in. (7.6cm) and smaller shall be rubber encapsulated bronze.

502.5.2.5. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C515 or C509 except as follows: Stem nuts shall be of a non-galling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as specified. Upset stems on valves larger than 1 6-in. (41 cm) shall not be permitted under these specifications.

502.5.2.6. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double o-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards.

502.5.2.7. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Gland flanges or followers, if used, that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (30cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.5.2.8. Hand Wheels and Operating Nuts. Hand wheels and operating nuts shall conform to Item 502.6.1.10.

502.5.2.9. Gearing. Gearing shall be in accordance with AWWA Standards C515 or C509. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

502.5.2.10. Gear Cases. Gear cases shall be furnished on all geared valves. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be gray iron or ductile iron.

502.5.2.11. By-Pass Valves. By-pass valves are not required on resilient seated gate valves.


502.5.2.13. Horizontal Valves. Valves for horizontal installation shall be equipped with wedge guide caps or inserts to guide and support the wedge during travel. All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.5.2.14. Valves for Installation in Vertical Pipeline. All resilient seated gate valves shall be suitable for horizontal mounting in a vertical pipeline without special modifications.

502.5.2.15. Tapping Valves. Tapping valves shall conform to the requirements of AWWA Standards C515 or C509 and the other requirements of this section with the following exceptions: Tapping valves shall have a port opening to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gate. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

502.5.2.16. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA Standards C515 or C509. Any leaking at the test pressure through any casting shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.
502.5.3. Air Valves.

502.5.3.1. General. Unless otherwise indicated in the plans or contract specifications, air valves shall meet the requirements of AWWA C512 Air Release, Air/Vacuum and Combination Air Valves for Water Works Service with exceptions specified herein. Only wastewater air valves shall be used for wastewater applications.

502.5.3.2. Description. Air valves shall be of two types as follows:

1. An air valve called for on the plans shall mean an air and vacuum valve of the ball type designed to permit the escape of air from a pipeline when the line is being filled and to permit air to enter the pipeline when the line is being emptied.
2. A combination air valve called for on the plans shall mean a combination air and vacuum and air release valve designed to fulfill the functions of air and vacuum valve and also designed to permit the escape of air accumulated in the line at the high point when the line is under pressure while in operation. Air valves 3-in. (7.6cm) and smaller shall be self-contained in one unit. Air valves larger than 3-in. (7.6cm) may be a combination of two valves.

502.5.3.3. Material. The valves shall be stainless steel or iron body, stainless steel, brass or bronze fulcrum levers and links, stainless steel ball floats and pins, steel flange bolts and nuts, Buna-N synthetic rubber seats or equal against bronze or stainless steel, and brass for other parts.

502.5.3.4. Inlets and Outlets. Inlets shall be threaded for 2-in. (5cm) and smaller and flanged for 3-in. (7.6cm) and larger. Outlets shall be threaded through 4-in. (10cm).

502.5.3.5. Operating Pressure and Testing. The valves shall be designed to operate under an operating pressure of 200-psi (1380-kPa) and shall be tested to 1½ times that pressure.

502.5.4. Brass Wheel Valves.

502.5.4.1. General. Valves furnished under this specification shall be wedge disc, non-rising stem gate valves with screwed ends. They shall be equipped with bronze hand wheels and nuts and shall have bronze packing gland followers. They shall be of all brass and/or bronze construction.

502.5.4.2. Pressure Rating. Valves shall be rated for 125-psi (862-kPa) saturated steam working pressure and 200-psi (1,380-kPa) for liquids and gases up to 150°F (65.6°C).

502.5.4.3. Tests. Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250-psi (1,724-kPa) with the valve open. Under this test the valve shall not show any indication of leakage at the packing or anywhere on the body. Each valve shall also be tested at hydrostatic pressure of 250-psi (1,724-kPa) applied to one end only with the valve closed. There shall be no indication of leakage by the gate or through the packing under this test.

502.5.4.4. Direction to Open. Valve shall open by turning the handwheel counterclockwise.

502.5.4.5. Material Specifications. The materials used in the manufacture of these valves shall equal or exceed the specifications shown in Table 502.6.4.5.(a) Brass Wheel Valve Materials.

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
<th>Designation/Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing</td>
<td>Teflon impregnated asbestos or approved equal</td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>Bronze</td>
<td>ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings</td>
</tr>
<tr>
<td>Bonnet</td>
<td>Bronze</td>
<td>ASTM B62</td>
</tr>
<tr>
<td>Gates</td>
<td>Bronze</td>
<td>ASTM B62</td>
</tr>
<tr>
<td>Handwheel</td>
<td>Bronze</td>
<td>ASTM B62</td>
</tr>
<tr>
<td>Handwheel Nut</td>
<td>Bronze</td>
<td>ASTM B62</td>
</tr>
<tr>
<td>Stem</td>
<td>Bronze</td>
<td>ASTM B62, 50,000-psi (344,700-kPa) minimum tensile strength</td>
</tr>
</tbody>
</table>

502.5.4.6. Stem. Stem shall be completely free of visible flaw, and matching shall be smooth and free of defect. A back seating surface shall be provided on the wedge or on the lifting nut to seat tightly against the bonnet when the valve is open to seal the packing gland against line pressure so that the valve may be repacked against line pressure.
502.5.4.7. Screwed Ends. Valve ends shall be threaded internally with American National Taper pipe threads. Thread shall be clean, true to form and concentric with the axis of the valve. Variations in alignment of thread shall not exceed $\frac{1}{32}$-in. -per-foot (0.5-cm-per-m). Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve at an angle approximately 45° with the axis of the thread for the purpose of easy entrance in making a joint and for protection of the thread.

502.5.4.8. Valve Body. The body of the valve shall offer sufficient support to the gate while it is moving to keep the gate wedge in place and to accurately align the gate on the body seat. The waterway opening shall be equal to or greater than the nominal pipe size.

502.5.4.9. Gate. The gate shall be of wedge design and may be furnished either solid or two-piece. Two-piece or “split” disc gates shall be equipped with lifting nut. Gate faces shall be accurately machined and fitted into the valve body in such a manner that the center of the gate circle is very slightly above the center of the seat circle when the valve is tightly closed.

502.5.4.10. Workmanship. All valve parts shall be true to form, free from injurious defects and shall be seated and finished in a workmanlike manner. Casting shall be free from blow holes, porosity, hard spots, excessive shrinkage, cracks or other injurious defects. They shall be smooth and well cleaned both inside and outside, and all fins and similar roughness shall be removed. Castings shall not be repaired, plugged, brazed or burned in.

502.5.4.11. Packaging. Valve shall be closed for shipment and wrapped or packaged in accordance with best commercial practice as necessary for mechanical protection and ease in handling.

502.5.5. Butterfly Valves.

502.5.5.1. General. Butterfly valves and actuators shall conform to AWWA C504 Rubber-Seated Butterfly Valves and to these specifications:

1. Type of body shall be short body, flanged.
2. Body material shall be cast iron or ductile iron.
3. Class shall be as specified on the plans or contract specifications.
4. Shafts shall be Type 304 or 316 stainless steel.
5. Flange holes shall be drilled full size.
6. Valve seats shall be natural rubber or Buna-N and polished stainless steel, Type 304 or 316, 90° seating angle only, with a 360° uninterrupted seating surface.
7. Shaft seals shall be standard split-V packing or double O-ring seal cartridges.
8. Discs shall be ductile iron, cast iron, or fabricated steel.
9. Operating nuts shall be ductile iron.

502.5.5.2. Submittals. The following shall be furnished to the CITY/ENGINEER. Incomplete data shall be cause for rejection of bid.

1. Weights and drawings in accordance with AWWA C504.
2. Guaranteed delivery time after receipt of purchase order.
3. Number of turns of handwheel required to close valve.
4. The required actuator torque (To) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
5. Seating-unseating torque (To) in foot-pounds required for each butterfly valve.
6. Rated torque capability of each butterfly valve actuator.

The following data shall be furnished if not previously available to the CITY/ENGINEER:

7. Experience: evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
8. Torque tests in accordance with rubber seated butterfly valves AWWA C504.
9. Proof of design tests in accordance with AWWA C504.

502.5.5.3. Ends. Valves shall have flanged ends. Flanged ends shall conform to AWWA C110 (ANSI A 21.10), Class 250-lb. (112.5-kg).

502.5.5.4. Actuators.

502.5.5.4.1. Manual Actuators:

Location. All actuators shall be located at the right end of a horizontal shaft with the input shaft vertical and upward looking in the direction of flow, unless otherwise noted.

Closure. The valve shall close by turning the input shaft clockwise. All handwheels shall turn clockwise to close the valve. All operators shall be equipped with a disc position indicator with each valve. The indicator shall be highly visible, clearly showing the legends “Open” and “Closed” at the ends of a 90° arc, with a pointer to show the disc position (Closed — 0° and Open —90°). The arc shall be graduated in degrees.
Type. All manual actuators shall be totally enclosed worm gear type and traveling-nut type. All manual worm gear type actuators shall be Limitorque, Type HBC or approved equal.

Sizing. Each valve actuator shall be sized for the maximum valve torque requirements based on the operating pressures and flow rates as specified.

502.5.5.4.2. Electric Motor Actuator. Each electric actuator shall conform to AWWA C504 and shall be of sufficient size to open and close the valve against maximum differential pressure and maximum required torque conditions when voltage at motor terminals is 90-percent of nominal voltage and shall have totally enclosed worm gear reducer with spur gear attached. Limit switches shall be of the four traingear with switches adjustable to operate at any point in the opening or closing cycle of the valve.

Limit switches and torque switches shall be located in a special compartment that is an integral part of the actuator and shall be readily accessible. Each limit switch shall have two normal closed contacts. Limit switch gearing shall be in step at all times whether in power or manual operation. Limit switch gearing shall be stainless steel or high-grade bronze. Two torque switches shall be furnished, one for opening direction and one for closing direction. The torque switches shall be connected in series so that they will operate regardless of the phasing of the power.

Torque and thrust loads in both closing and opening directions shall be limited by torque switches. Each torque switch shall be provided with a micrometer adjustment and reference setting indicator. The adjustment shall permit a variation of approximately 40-percent in torque setting. Switches shall have a rating of not less than 6-amperes at 120-volts-a.c. and 2.2-amperes at 115-d.c. The torque switches shall be in series with the opening and closing coils of the starter.

The torque switches shall be factory adjusted by the manufacturer for this application. A handwheel for manual operation shall be provided. Motor shall not rotate when handwheel is in use. A fused motor shall not interfere with manual operation. For valve control, furnish for each valve a reversing starter in watertight enclosure that is integral with the actuator housing. Furnish a push-button station NEMA-4 with red and green indicating lights separate from the valve actuator. Space heaters shall be provided to protect the motor, reversing starter and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be furnished with submittal data.

Valve actuators shall conform to latest revision of AWWA C504 and shall be designed to hold the valve in any intermediate position between fully opened and fully closed without creeping and fluttering.

502.5.5.4.3. Other Actuators. Other types of actuators shall conform to AWWA C504.

502.5.5.5. Shipment and Storage Requirements. Electric motor actuated valves shall be shipped to bonded covered warehouse storage to be designated by the CITY. Valves shall be stored indoors and shall have space heaters energized. Full face flange protectors of waterproof plywood shall be at least one-inch (2.5cm) thick.

502.5.5.6. Tests. All butterfly valves shall be tested by the manufacturer in accordance with AWWA C504. Test results shall be furnished to the CITY.

502.5.6. Line Valve Installation. At locations shown on the plans, CONTRACTOR shall furnish and install valves of the type and size indicated. Valve vaults shall be furnished as provided in the special contract documents and constructed in accordance with Item 702.4.9.8. Vaults and applicable Division 4000 Standard Drawings.

502.5.6.1. Gate Valves. Valves shall be carefully handled and lowered into position in such a manner as to prevent damage to any part of the valve. The valve shall be placed in the proper position and held securely until all connections have been made. Where valves are to be placed in a concrete structure, the floor shall be completed before installing the valve. The valve shall be securely blocked so that its weight is carried by the floor rather than being supported by connected piping. See also Standard Drawing 4050.

502.5.6.2. Air Release Valves. The term “air release valve” as used in this section shall apply to the installation of both air release valve and combination air and vacuum release valves. Vaults shall be furnished as an integral part of either air release valve or combination air and vacuum release valve installation.

Air valves shall be installed in the manner shown in Standard Drawings 4090 – 4100B and on the appurtenance sheet unless otherwise indicated on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the schedule in Table 502.6.6.2.(a) Air Release Valve Sizing unless otherwise specified.
Table 502.5.6.2.(a) Air Release Valve Sizing

<table>
<thead>
<tr>
<th>Inches</th>
<th>I.D. of Main</th>
<th>Size of Valve and Fitting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centimeter equivalent</td>
<td>Inches</td>
</tr>
<tr>
<td>16 and smaller</td>
<td>41 and smaller</td>
<td>1</td>
</tr>
<tr>
<td>18 through 36</td>
<td>46 through 91</td>
<td>2</td>
</tr>
<tr>
<td>42 and larger</td>
<td>107 and larger</td>
<td>3</td>
</tr>
</tbody>
</table>

Matching taps shall be provided for and made in accordance with Item 502.10. Connections to Conduit for Service. Fittings required for mounting air valves shall be as specified in Item 502.5. Fittings. All fittings shall be tight, leak free and plumbed true to the required position.

502.5.7. Rejection. Any valve may be rejected for failure to meet its respective requirements of this specification or referenced specifications.

502.6. PREFORMED FLEXIBLE CONDUIT JOINT SEALANT

502.6.1. General. This specification covers a cold-applied preformed flexible butyl rubber or plastic sealing compound for sealing interior and/or exterior space on concrete sewer pipe and manhole sections, where infiltration or exfiltration is a factor in the design.

502.6.2. Applicable Standards. Except as modified or supplemented herein, all preformed flexible joint sealants shall conform to the applicable requirements of the standard specifications listed in Table 502.6.2.(a) Conduit Joint Sealant Standards.

Table 502.6.2.(a) Conduit Joint Sealant Standards

<table>
<thead>
<tr>
<th>Publisher</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Specification</td>
<td>SS - S - 210A(1) Sealing Compound, Preformed Plastic, For Expansion Joints</td>
</tr>
<tr>
<td>American Association for State Highway and Transportation Officials (AASHTO)</td>
<td>M198</td>
</tr>
</tbody>
</table>

502.6.3. Basis of Acceptance. The acceptability of the preformed flexible joint sealant shall be determined by the results of physical tests, by inspection and by approval of its experience record.

502.6.4. Material. The joint sealer shall be supplied in either extruded rope form of suitable cross-sectional area or flat tape form and shall be sized as recommended by the manufacturer and approved by the Engineer. The joint sealer shall be protected by a suitable removable wrapper. The joint sealer shall not in any way depend on oxidation, evaporation, or any other chemical action for either its adhesive properties or cohesive strength. The joint sealer shall remain totally flexible without shrinking, hardening, or oxidizing regardless of the length of time it is exposed to the elements.

The manufacturer shall furnish an affidavit attesting to the successful use of the product as a preformed flexible joint sealant on concrete pipe and manhole sections for a period of at least 5-years.

If requested by the CITY, the CONTRACTOR shall provide results of above specified tests to insure product compliance with these specifications or shall supply an affidavit of compliance from the manufacturer insuring compliance with these specifications.

502.6.5. Installation of Joint Sealant. All surfaces to be in contact with the joint sealant shall be thoroughly cleaned of dirt, sand, mud or other foreign matter. The protective paper wrapper shall remain on the joint sealant until immediately prior to placement of the pipe in the trench. After removal of the protective paper wrapper, the joint sealant shall be kept clean.
Backfilling of pipe laid with this joint sealer may proceed after the joint has been inspected by the CITY.

502.6.7. Rejection. The preformed flexible joint sealant may be rejected for failure to meet any of the requirements of this specification.

502.7. POLYETHYLENE WRAP FOR METAL PIPE AND FITTINGS

These specifications cover 8 mil black polyethylene film used as a wrap to protect cast iron, ductile iron and other metals in a corrosive soil environment.

502.7.1. Material. Unless otherwise specified, encasement material, sizing, and marking shall conform to ANSI/AWWA C105/A21.5-99 or latest revision Polyethylene Encasement for Ductile-Iron Pipe Systems.

502.7.2. Installation. Unless otherwise specified, encasement installation shall conform to AWWA C105/A21.5-99. Polyethylene wrapping of pipe, fittings or hydrants shall precede blocking or restraint.

Fittings such as bends and reducers shall be wrapped similarly to pipe. Specials such as but not limited to hydrants and crosses shall be wrapped by splitting, tucking and overlapping the polyethylene tube, then closing the field-made splices with the required tape. All seams shall be folded twice prior to taping in accordance with AWWA C105/A21.5-99.

Hydrants shall be encased with the polyethylene tubing slipped over the hydrant and extended to a point 2-in. to 3-in. (5cm – 7.5cm) above the ground line. The wrap shall be excluded from the drain region to allow normal drain function of the hydrant.

502.7.3. Rejection. Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

502.8. CORROSION-RESISTANT COATINGS AND LINERS FOR WASTEWATER CONDUIT AND APPURTENANCES

502.8.1. General. Coatings and liners are used as a protective barrier attached to the interior walls of concrete, ductile iron, or steel pipe or manhole sections, special concrete appurtenances for protection against the corrosive chemical elements which may occur in certain domestic wastewater environments and for protection against certain corrosive wastes from industry.

All work for and in connection with the installation of the coatings and linings, including interlocking liner plates and epoxy lining in concrete pipe and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the manufacturer.

502.8.2. Basis of Acceptance. The acceptability of the protective material and its attachment to the pipe or appurtenance shall be determined by the results of tests, by inspection and by approval of its experience record. The tests are designed to prove, demonstrate and insure:

1. whether or not the protective material is the same as used in the tests,
2. surface continuity and lack of holidays,
3. adhesion,
4. resistance to temperature changes,
5. resistance to abrasion,
6. resistance to fire, and
7. chemical resistance.

The inspection at the manufacturing plant or in the field is to determine:

8. whether or not the protective material is the same as used in the tests,
9. that it is attached in the same manner, and as uniformly, as it is attached to the concrete in the tests,
10. that the joint areas are adequately protected.

The experience record of the protective material attached to the pipe or appurtenances must be acceptable.

To qualify the material and the attachment of the material to the pipe or appurtenances for acceptance, all tests must be met or certified for the specific protection intended, all conditions to be evaluated by inspection must be met, and the experience record must be submitted and approved.

502.8.3. Testing Requirements. Unless otherwise specified, the manufacturer of the protective material is responsible for meeting the testing, inspection standards and experience records as described herein, except in
the case of a pipe manufacturer electing to procure the protective material and applying the material as the pipe is manufactured. In such a case the pipe manufacturer would be responsible.

The test results shall be certified by a recognized testing laboratory acceptable to the CITY and do not necessarily have to be made on each project.

The inspection results shall be attested to in writing by a licensed Professional Engineer or witnessed by the Engineer representing the CITY. The experience record shall be documented with dates, locations, actual number of feet (m) of protected conduit in the ground, length of time in the ground, the nature of the environment against which the conduit is being protected and the names and addresses of responsible references who shall verify the facts in the experience record.

502.8.4. Physical Requirements.

502.8.4.1. Chemical Resistance. The CITY may designate which of the solutions mentioned may be used or may designate others.

The chemical resistance test shall be made as follows:

(1) The specimens, approximately 5-in. long, 2¼-in. wide and 1-in. thick (125 mm x 56 mm x 25 mm), shall be cut from the pipe. The protective material shall be attached to these test specimens in the same manner as it would be attached to the pipe. The protective material shall be to manufacturer’s specified minimum thickness. If curing is required, the protective material shall be cured to the manufacturer’s recommendations.

(2) The protective material on the prepared test specimens shall be tested for indentation hardness in accordance with the requirements of ASTM D2240 Test Method for Rubber Property—Durometer Hardness and the hardness recorded.

(3) The prepared test specimens shall then be placed in wide mouth glass containers half submerged in the following solutions:

- 5% sulphuric acid
- 5% hydrochloric acid
- 3% salt (NaCl) water
- 1 % phenol
- 5% alum
- 5% phosphoric acid
- 10% biodegradable detergent
- 100% motor oil

(4) The containers shall be closed and held at 100°F (37.7°C) for six-months.

(5) After six months the specimens shall be taken from the containers and tested again for indentation hardness in accordance with the requirements of ASTM D2240. The test durometer hardness shall be made in both the area exposed to the liquid and in the area exposed to the vapor above the liquid. There shall be no loss of indentation hardness either in the area below the liquid or in the area above the liquid.

502.8.4.2. Surface Continuity and Holidays. Voids or holidays shall be cause for rejection. The surface continuity and holiday test shall be made as follows:

(1) An electrical holiday detector, capable of producing and maintaining a voltage equal to 800 times the square root of the specified minimum protective thickness expressed in mils, shall be used to determine the complete continuity of the protective surface.

(2) The electrical holiday detector shall be used on a full size piece the protective material taken from a production run.

502.8.4.3. Adhesion to the Pipe or Appurtenances.

502.8.4.3.1. Adhesion to Concrete. Where the protective material adheres directly to the concrete, adhesion test shall be made as follows:

(1) Make a test specimen by drilling a core hole through the protective material and the pile to produce a core sample 1-in. (2.5cm) in diameter by ¾-in. (1.9cm) or more in depth. (This hole may be repaired and the pipe from which the sample was taken may be used.)

(2) Check the protective material for thickness.

(3) Cement the test specimens onto a solid wooden block at least 2-in. x 2-in. x 1-in. (5cm x 5cm x 2.5cm) in thickness so that the protective material is cemented onto the wooden block.

(4) Allow sufficient time for the cement to set.

(5) Support the wooden block so that the test specimen is on its underside and hang a 40-pound (18-kg) weight on the test specimen. This can be done using an ordinary wooden clamp.

(6) This test should be made at an ambient temperature of between 60°F and 90°F (15°C - 32°C).
(7) The protective material shall adhere to the material for a minimum of two-hours.

502.8.4.3.2. Anchored to Concrete. Where the protective material is anchored to the concrete by fins embedded or dovetailed into the concrete adhesion test shall be made as follows:

1. Using a large enough square footage (m²) of the protective material to be a representative sample, the fins shall not be capable of being pulled out of the material, usually concrete, nor the protective material torn away from the embedded fins using less than a pull equal to 50-psi (3.6-kg/m²).

2. For the adhesion test, either Item 502.9.4.3. Adhesion to the Pipe or Appurtenances or paragraph (1) above shall be used, but not both.

502.8.4.4. Resistance to Temperature Changes. The test for resistance to temperature changes for those materials that adhere directly to the concrete shall be made in accordance with the latest ASTM Method when required by the CITY.

502.8.4.5. Resistance to Abrasion. The test for resistance to abrasion shall be made as follows:

1. A 1-foot (30cm) length of pipe which has been lined with the protective material shall be suitably capped and arranged on rollers so that it can be revolved at high speeds. A door shall be left in one end so that access can be had to the interiors of the test section.

2. A slurry shall be made composed of six-pounds (2700-grams) of gravel and three-pounds (1360-grams) of water, and it shall be placed inside the test section and the test section shall be rotated so that the protective material has peripheral speed of four-feet-per-second (122-cm-per-second). After 1,500,000 revolutions, the protective material shall not show visible signs of wear or abrasion.

502.8.4.6. Resistance to Fire. The protective material, if plastic, shall be tested for resistance to fire by meeting the requirements of ASTM D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position. The material shall be self-extinguishing or nonburning according to ASTM D635.

502.8.5. Appurtenance Protection. Adequate protection shall be provided at the ends of joints. All special shapes such as tees and wyes, branches, slants and curves shall be protected with the protective material, and they shall be given the same degree of protection provided to the production run of pipe. Lift holes, if called for on the plans or in the specifications, shall be sealed with epoxy or sealant recommended by the coating or liner manufacturer that shall pass the tests as set out in this Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

502.8.6. Inspection. The tests required under the physical test requirements section of this specification need only be made once on any one project. Each length of pipe or special may be subject to visual inspection during manufacture, transportation or laying by the OWNER in order to cull and reject pipe as specified in Item 502.9.8. Rejection.

502.8.7. Repair of Coatings and Liners. Where the protective material is damaged or where the adhesion of the protective material to the concrete is damaged, repairs may be made at the discretion of the CITY.

502.8.8. Rejection. The protective material shall be rejected if:

1. Any tests described under physical test requirements are not met,

2. The manufacturing method of applying, adhering and curing the protective material differs from that used on the test samples,

3. The protective material thickness as used on the test samples exceeds the minimum specified in the manufacturer’s specification by more than five-percent, or

4. It cannot be adequately repaired in the field.

502.9. CONNECTIONS TO WATER CONDUITS FOR SERVICE

502.9.1. Definitions. “Service” shall be defined as a service line to an individual customer. “Bullheads” shall be defined as an individual service line with branches at the end to serve two or more customers.


502.9.2.1. Water Service Saddles-General. All Water Service Saddles shall be designed for tapping water conduit piping under normal operating pressures and shall be designed for 150-psi working pressure. All Service Saddles shall be sealed against the pipe with a Buna-N or EPDM Chloramine resistant gasket and shall have a heavy style hub tapped with CC (AWWA) corporation stop threads. Service Saddles shall be shaped so as to provide approximately 180 degree coverage around the pipe.
502.9.2.1. Saddle/Straps. Single band saddles for conduit piping under 4 inches shall be of material confirming to ASTM B62 Bronze or, shall be constructed of a Ductile Iron body meeting ASTM A536 with fusion bonded Epoxy or Plastic coating and a 14 gauge 18-8 type 304 stainless steel strap with antiseize coated stainless steel nuts. Double band saddles for conduit piping 4 inches or larger shall be of material conforming to ASTM B62 Bronze with two Bronze straps, or Ductile Iron body meeting ASTM A536 with fusion bonded Epoxy or Plastic coating with two 14 gauge 18-8 type 304 stainless steel straps with anti-seize coated stainless steel nuts. Straps shall be flat on one side to fit uniformly against the wall of the pipe. No hinged type saddles shall be allowed on any size main.

502.9.2.1.2. Markings. Saddles shall be distinctly and permanently marked showing manufacturers name and minimum/maximum O.D. ranges.

502.9.2.1.3. Rejection. All Water Service Saddles furnished under these specifications shall be subject to the inspection and approval of the City of Temple. If any products are found not to conform to the specifications, the lot or any portion thereof may be rejected.

502.9.2.2. Tapping Valves. Tapping valves shall conform to the requirements of Item 502.6.1.15.

502.9.2.3. Tapping Sleeves. The material for tapping sleeve bodies shall be cast iron or ductile iron in accordance with AWWA C110 (ANSI 21.10) or ASTM A285 Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength, Grade C carbon steel, in two sections or halves to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts conforming to AWWA C111 (ANSI A21.11). Branch outlet of tapping sleeves shall be flanged with a machined projection or recess to mate with tapping valve inlet flange to assure correct alignment.

Cast-iron and ductile-iron tapping sleeves shall be mechanical joint, or as specified, with dimensions to secure proper fit on the type and class of pipe on which they are to be used. Bolts, nuts and glands for mechanical joint ends shall conform to the requirements of Item 502.6.1.3. Ends.

Steel sleeves shall be restricted to use on pipe sizes 12-in. (31cm) and larger and subject to the following additional specifications:

1. Flange shall conform to AWWA Standard C207 for Steel Pipe Flanges for Waterworks Service — Sizes 4 in. through 144 in. Class D, ANSI 150 lb. (68.0 kg) drilling. Gasket shall be affixed around the recess of the tap opening in such a manner as to preclude rolling or binding during installation.
2. All steel sleeves shall be fusion bonded epoxy coated to an average of 12-mil (0.012-in.) (0.3mm) thickness. Finished epoxy coat shall be free of laminations and blisters, shall not peel and shall remain pliable and resistant to impact.
3. Steel sleeves shall be provided with a ¾-in. (19mm) NPT test opening so that test can be made prior to tapping. Opening shall be provided with a ¾-in. (19mm) bronze plug.

502.9.2.4. Residential Meter Boxes. The meter box shall be constructed for impact strength and corrosion resistance. The meter box shall not be constructed of a material known to degrade in wet, acidic or alkaline soil. Materials specified by the City includes, precast polymer concrete and HDPE plastic boxes with cast or ductile iron hinged lid.

Cast iron shall meet ASTM A48 Gray Iron Castings, Class 30B. Ductile iron shall meet ASTM A536 Ductile Iron Castings. Plastic boxes shall be black on the exterior, white on the interior for better illumination and shall be UV stabilized.

All meter box covers shall be solid, made of gray cast iron conforming to ASTM A48 Class 30B or ductile iron conforming to ASTM A536 and shall bear the manufacturer’s ID and product number.

The City will furnish and install meter boxes at the time the meter is set for an additional fee to the permittees set by City.
502.9.3. Water Conduit Connections. This section and Item 506.6. Connections to Existing Water Conduits shall govern for the construction of connections to water conduits.

502.9.3.1. Taps and Tap Assemblies in Water Conduit. Taps and/or tap assemblies of the specified size shall be installed in locations as detailed and indicated on the plans or as specified.

502.9.3.1.1. Taps. Taps for transmission of water or air from the main into system service accessories can be either of two types as follows:

1. Standard internal pipe threaded holes in wall of water mains. These taps may be either manufactured into the pipe or installed in the field.
2. Tap installations that are made by clamping a service saddle equipped with a sealed threaded port on the periphery of the main and then drilling through the pipe wall to complete each service port. Taps may be made either on an uncharged system or into a main under pressure.

502.9.3.1.2. Tap Assemblies. The tap assembly shall consist of a corporation stop and an iron to copper connection attached to a hard copper (Type K) tubing terminating approximately 1-ft. (30cm) below ground surface with a brass gate valve as shown and detailed on the plans to serve as additional air release.

When tap assemblies are an integral part of an air valve installation, measurement and payment shall be in accordance with Item 502.6. Valves.

Tap assemblies may be required by the project plans and specifications adjacent to gate valve installations. Tap assemblies so required shall be installed in the water main on either side of the valve. Payment for the tap assemblies shall be included in the unit price bid for furnishing and installing the gate valve complete in place.

When taps are required for flushing, chlorination and/or testing, the CONTRACTOR shall locate the taps in accordance with Standard Drawing 4110 or other detail drawings, plans or in locations directed by the CITY. No separate payment shall be made for taps required for testing, flushing, and/or chlorination.

Upon completion of the testing and purification, the CONTRACTOR shall return to the job site, remove the blow-off down to the corporation stop, backfill leaving the corporation stop in place, and replace all pavement. The CONTRACTOR’S removal of the blow-off shall include all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, backfill and disposal of surplus materials without additional compensation.

502.9.3.1.3. Tapping Sleeves. Steel sleeves shall not be used for taps greater than 75-percent of the pipe diameter. Use of steel sleeves for “size-on-size” taps is prohibited.

Care shall be taken to protect all coatings, gaskets and flange surfaces of all tapping sleeves during transport and storage.

502.9.3.1.4. Tapping Ductile Iron Pipe. No direct taps. Taps shall only be done by using an approved tapping sleeve or saddle. See Section 502.10.2.1 Water Service Saddles.

502.9.3.1.5. Tapping Concrete Pipe. Tap location shall be provided to the pipe manufacturer, when available, and taps shall be made by the manufacturer during the fabrication phase of the pipe when locations are so furnished. Taps fabricated during manufacture with a diameter less than or equal to 2-in. (5cm) shall be provided with brass or bronze insert bushings. Taps greater than 2-in. (5cm) shall be provided as flanged outlets with flange to thread insulator adapter kits. When taps are required to be made in the field, the taps shall be made in accordance with the pipe manufacturer’s recommended procedures and to the satisfaction of the CITY.

502.9.3.1.6. Tapping Asbestos or Asbestos Cement Pipe. If asbestos pipe is found contact City Utility Department.

502.9.3.1.7. Tapping PVC Pipe. Service taps in AWWA C900 PVC pressure pipe shall be made with a shell cutter assembly and the coupon removed for tap sizes relative to pipe class and diameter.

No direct taps. Taps shall only be done by using an approved tapping sleeve or saddle.
502.9.3.2. Procedures for Transferring Service. The CONTRACTOR will inform the customer that the service is being transferred.

502.9.3.2.1. Short Service. A water service shall be classified as a “Short Service” if the existing service line to the water meter is on the same side of the street as the new main and requires the existing service line to be replaced to complete the installation as indicated on the plans and specified herein. A curb stop will be installed on the end of the service line.

502.9.3.2.2. Long Service. A water service shall be classified as a “Long Service” if the existing service line to the meter is on the opposite side of the street as the new main and requires a new service line to be installed under the street to complete the installation as indicated on the plans and specified herein. Splices in service lines shall not be permitted.

All new services will be flushed according to TCEQ Standards. The main will then be hydrostatically tested and disinfected. After a good sample is received, the CONTRACTOR will then begin transferring the services.

502.9.4. Wastewater Conduit Connections. This section shall govern for new construction of connections to wastewater conduits and for connections of wastewater pipe to existing wastewater conduits or wastewater appurtenances as shown on the plans or as directed by the Engineer. Details of standard construction shall be shown on the plans.

The end of each new wastewater service connection shall be marked with a 2” x 2” x 3’ stake painted green and heavy gauge foil backed polyethylene tape, 6-inches (15cm) in width with a minimum thickness of 0.004-inches. The tape should be green in color on which has been printed “Caution Buried Wastewater Line Below” in continuous print. The tape should have a minimum tensile strength of 1700-psi (120-kg/cm²) lengthwise and 1200-psi (85-kg/cm²) crosswise. The tape shall extend from the end of the capped service pipe and shall be wrapped around the green painted stake to the top of the stake.

502.9.4.1. Service Connection Piping. Service pipe shall be of the same material as the main wastewater conduit unless otherwise specified on the plans or in the contract or approved by the CITY. Connections shall be made to prevent the occurrence of bi-metallic corrosion or any other corrosion that can result by joining incompatible materials.

Wastewater service connections shall be defined as a service line connecting the customer’s wastewater system at the property line or utility easement to the main wastewater conduit and shall consist of the service wye and fittings as shown on the plans, the necessary Class B or Class PB (as specified by the CITY) concrete cradle or crushed stone for the service wye, the service pipe necessary to extend the line from the main wastewater conduit to the customer’s property line and a cap placed in the end of the service line.

Services for single-family residences shall normally be one 4-inch lateral for single services and one 6 inch lateral branching off to two 4 inch laterals for double services. Standard laterals shall consist of a standard wye bend(s) and fittings along with the necessary pipe as shown on the plans or directed by the CITY. Larger laterals shall consist of a manhole and the necessary minimum 6-inch (15cm) pipe as shown on the plans or directed by the CITY. If the CONTRACTOR is required to connect or reconnect the service line to the customer’s wastewater system, the connection shall be as shown on the plans. If the CONTRACTOR is not required to connect to the customer’s wastewater system, the service line shall be plugged and sealed.

Extra depth service connections shall be installed when the wastewater main is at a depth greater than that necessary to serve the abutting property. The service is identical to a standard connection except that pipe risers will be installed at a maximum 45-degree angle into the trench walls to connect the combination tee wye and 45-degree bend to the service pipe. Where possible, a minimum slope of ¼-in.-per-foot (equivalent to a 2% slope) will be maintained. Where the wastewater main is located in the street and the abutting property slopes to the street, the wastewater service shall normally have a minimum depth of 5-feet below the top of the curb at the point where it passes beneath the curb. Where abutting property slopes away from the wastewater main, service connections shall be placed at a depth adequate to serve the normally expected use of the property.

Where water and wastewater service connections cross, they shall be treated in accordance with TCEQ regulations.

502.9.4.2. Cleanouts. Service line cleanouts shall conform to Standard City of Temple details and specifications. If service line cleanouts are required, they shall be installed at the property line. When specified in the special provisions or in the plans, a test tee shall be installed at the end of the service line (located in the parkway), with the branch in a vertical position.
502.10. STRUCTURES

502.10.1. Description. This section shall govern for the construction of all miscellaneous structures such as junctions, transitions, and utility supports, and for the construction of appurtenances such as deep-cut connections, wyes, stoppers and bulkheads, and such other miscellaneous structures or appurtenances which may be shown on the plans. Construction shall conform with any applicable provisions of Division 700. Structures.

Unless otherwise specified on the plans, all storm sewer structures such as junctions, transitions, manholes, cleanouts, wyes, elbows, tees, stoppers and such other miscellaneous structures or appurtenances which may be shown on the plans shall be made of the same base metal and coating (metallic or otherwise) as the pipe on which it is connected. All such structures or appurtenances field fabricated or otherwise will be repaired in accordance with Item 502.9.7. Repair of Coatings and Liners or Item 804.3.5. Repair of Damaged Zinc Coating, as applicable.

In general there shall not be a pay item for pipe support when a temporary part of conduit installation, but the contract prices for the new or re-laid pipe, shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work including excavation, installation and removal of the temporary piping, construction of piers, stripping of forms, disposal of surplus materials, in accordance with the plans and specifications. Where a pay item is included, the contract price shall be the additional compensation for all excavation, labor, tools, and materials over and above the bid price for furnishing and installing the conduit.

502.10.2. Permanent Concrete Structures. The construction of reinforced concrete structures, including junctions, transitions, vaults, piers and beam supports, and such other similar structures as may be covered by this specification, shall be performed in accordance with the requirements of Item 702. Concrete Structures, applicable Division 1000-5000 Standard Drawings, and the following additional requirements. Unless otherwise specified, all concrete shall have an average compressive strength at 28-days equal or greater than 3000-psi (210-kg/cm²). Excavation shall be made to the required depth and of sufficient width to construct the work to grade, form and dimensions. All soft and yielding materials shall be removed and replaced with acceptable materials. The subgrade shall be moistened to a minimum depth of 2-in. (5cm) before placing concrete. All formed surfaces of the concrete exposed to public view shall be given a textured finish as shown on the plans. All other formed surfaces shall be given the “Type 1 Finish,” as described in Item 702.4.14. Finishing Exposed Surfaces. Corrosion protection shall be applied as may be called for on the plans or the proposal and shall be measured for payment and paid for at the contract price as detailed in Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

502.10.3. Miscellaneous Pipe Structures. Riprap and miscellaneous pipe structures that may be necessary shall be designed in detail on the plans.

502.10.4. Connections to Existing Structures. The bottom of the existing structure shall be mortared or concreted, if necessary, to eliminate any drainage pockets by the new connection in general accord with details for the new structure as shown on the plans. Where conduit is connected into old structures that are to remain in service, any damage to the structure resulting from the work of making the connection shall be restored by the CONTRACTOR to the satisfaction of the Engineer.
ITEM 503. TRENCHLESS INSTALLATION

RESERVED
ITEM 504. OPEN CUT – BACKFILL

5.04 Open Cut - Backfill

Trench backfill must be in compliance with the following:

504.1 Backfill Material

504.1.1 Trench excavation material may be used as backfill material subject to the following:

1. Backfill requirements, established by the project engineer, are noted on the construction plans.
2. Excavated rock exceeding 2” in diameter may not be used. Such material must be sufficiently graded to fill all voids & bind together.
3. Groundwater, encountered in any excavation, must be reported to the project engineer for establishing backfill criteria.

504.2 Compaction Equipment

504.2.1 Authorized compaction equipment and related maximum loose lift:

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<td>Vibratory Rammer</td>
<td>6”</td>
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<tr>
<td>Compaction Wheel for Rubber-Tired Backhoe</td>
<td>18” – 24”</td>
</tr>
<tr>
<td>Compaction Wheel for Excavator</td>
<td>24” – 30”</td>
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<tr>
<td>(Wheel type must be appropriate for specific site conditions)</td>
<td></td>
</tr>
<tr>
<td>Motorized Sheep’s Foot Vibratory Roller (22 – 25hp)</td>
<td>18” – 24”</td>
</tr>
<tr>
<td>Pneumatic or Hydraulic “Pogo Stick” Tamper</td>
<td>4”</td>
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504.2.2 Use of any alternative compaction equipment and related maximum loose lift must receive prior approval of the Project Engineer or the City Engineer.

504.3 Onsite Construction Representative

The Onsite Construction Representative is the authorized person responsible for project quality control.

504.4 Density Testing

1. Random testing will be made and scheduled at the discretion of the Onsite Representative.
2. Contractors will not be required to suspend construction, pending testing or test results.
3. Failed Tests: Additional testing, at contractor’s expense, may be made. Any portion of work, that does not meet Project Specifications, must be removed; reworked and retested (to the point of the last acceptable test) at contractor’s expense.
4. The contractor must provide adequate trench protection for testing.

DSAB Approved: February 21, 2008
ITEM 505. OPEN CUT - GENERAL CONDUIT INSTALLATION

RESERVED
ITEM 506. OPEN CUT – WATER CONDUIT INSTALLATION

RESERVED
ITEM 507. OPEN CUT – WASTEWATER CONDUIT INSTALLATION

RESERVED
ITEM 508. OPEN CUT – STORM WATER CONDUIT INSTALLATION

RESERVED
ITEM 509. CROSSINGS

RESERVED
# DIVISION 600

**CONDUIT AND APPURtenANCE REHABILITATION**

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ITEM 601. REHABILITATION OF MANHOLES OR UNDERGROUND VAULTS

PER ENGINEER DESIGN
ITEM 602. ABATEMENT OF COATINGS CONTAINING CERTAIN HEAVY METALS

PER ENGINEER DESIGN
DIVISION 700

STRUCTURES

SUBJECT
General Structures
Concrete Structures
Steel Structures
Piling

This infrastructure should be designed and constructed in accordance with the latest edition of the TxDOT Manual on Standards Specifications for Construction and Maintenance of Highways, Streets and Bridges. Copies of the manual can be purchased from TxDOT.
DIVISION 800

MISCELLANEOUS CONSTRUCTION AND MATERIALS

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Standard Details
Pavement Sections and Dimensions of Arrows and Words

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Right-Of-Way Management
INTERSECTION DRAINAGE GUTTER

N.T.S.

WIDTH AS REQUIRED (MIN. 6'-0"

SLOPE 1/4" / .1 FT.

MIN. 5/8"

VALLEY GUTTER SECTION A-A

N.T.S.

8" MAX.

#3 REBAR ON 8" O.C.E.W.

6-5/8" MIN

(REFER TO GENERAL NOTES FOR DETAILS)
**Drive Approach Detail**

1. **Option 1:** #3 Rebar at 12" O.C.E.W.
2. **Option 2:** 6 x 6 #10 Wire Mesh
   - Only when approved by City Engineer

- 9' MIN Residential
- 1.5' TYP
- 1/2" Expansion Joint
- Joint material in all expansion joints
- 1/2" X 24" Smooth Dowel Bars
- 1/2" X 24" O.C.E.W.
- 13' MIN Residential
- Non-Residential, per engineering design
- 2' MIN Residential

**Drive Approach Section**

- Taper curb to flat at sidewalk
- Add 2" select fill under driveway (PI less than 20)
- Stable sub-grade

**Notes:**
- Refer to general notes for details.
3 - #3 REBAR
OR 2 - #4 REBAR ON THE BOTTOM

END AREA
1.56 SQ. FT.

STANDARD 24" CURB & GUTTER
N.T.S.

REFER TO GENERAL NOTES FOR DETAILS
INDIRECT FLOW (SPILL) CURB & GUTTER

N.T.S.

3 - #3 REBAR
OR 2 - #4 REBAR ON THE BOTTOM

FLOW

REFER TO GENERAL NOTES FOR DETAILS
3 - #3 Rebar or 2 - #4 Rebar on the bottom

24" Mountable Curb
N.T.S.

(REFER TO GENERAL NOTES FOR DETAILS)
CONCRETE DRIVE APPROACH TO CONTINUE TO R.O.W./P.L.

1/2" EXPANSION JOINT MATERIAL

6" 3"

SLOPE DRIVEWAY TO MATCH

3"=R 4"=R

6-5/8"

VARIES TO FIT FIELD CONDITIONS

SEE NOTE #10

6" 12" 6"

24"

DRIVE APPROACH TRANSITION
N.T.S.

(REFER TO GENERAL NOTES FOR DETAILS)

(REFER TO GENERAL NOTES FOR DETAILS)
PLAN OF EXPANSION JOINT

N.T.S.

(SELECT TO GENERAL NOTES FOR DETAILS)

(SELECT TO GENERAL NOTES FOR DETAILS)
SIDEWALK & STREET DETAIL

SIDEWALK & STREET DETAIL

SIDEWALK SECTION

A = 4' MIN. COLLECTOR / 6' MIN ARTERIAL

1/2" X 24" SMOOTH DOWEL BARS WITH LUBRICATED CAPS 2'-0" LONG

20' MAX EXPANSION JOINT SPACING

CONTRACTION JOINT

#3 REBAR ON 16" O.C.C.W. OR 6"X8"X10" WIRE MESH

SIDEWALK PLAN

48" MINIMUM WIDTH

SLOPE TOWARD CURB
MIN. 1/4"
MAX. 1"

1 1/2"

ADD 2" SELECT fill UNDER SIDEWALK (F.I. LESS THAN 20) STABLE SUBGRADE

1/4"R

1/4" R

3" TYP

4" MIN.

SIDEWALK PLAN

MUNICIPAL BUILDING 2 NORTH MAIN TEMPLE, TX 76501

CONCRETE SIDEWALK

(CREFER TO GENERAL NOTES FOR DETAILS)
1/4” RADIUS ON CORNERS OF CONTROL JOINTS

CONTROL JOINTS MAY BE CONSTRUCTED USING METAL KEYWAY, TOOLED OR SAW CUT AT CONTRACTOR OPTION.

TYPICAL CONTROL JOINT

N.T.S.

(REFER TO GENERAL NOTES FOR DETAILS)
TYPICAL HANDICAPPED RAMP

N.T.S.

FINAL DESIGN SHALL BE IN CONFORMANCE WITH THE CURRENT TDLR REQUIREMENTS.

SECTION A-A

SECTION B-B

(REREF TO GENERAL NOTES FOR DETAILS)
1. HEIGHT OF WATER ALLOWED IN A 10–25 YEAR STORM FOR VARIOUS STREET SECTION.
   - 31’ BACK TO BACK 5.63” STREET JUST COVERED – 10 YR STORM
   - 36’ BACK TO BACK 4.96” ONE LANE OPEN – 10 YR STORM
   - 49’ BACK TO BACK 4.22” TWO LANES OPEN – 25 YR STORM
   - 60’ BACK TO BACK 4.22” TWO LANES OPEN – 25 YR STORM

2. CONCRETE FOR ALL ITEMS ON THIS SHEET SHALL BE CLASS “A”,
   3000 P.S.I. CONCRETE AT 28 DAYS MINIMUM. A 1/2” 9 SACK CEMENT GROUT TOPPING IS ALLOWED ON CURB & GUTTER SECTION.
   ALL CONCRETE SHALL BE GIVEN A BROOM FINISH UNLESS OTHERWISE SPECIFIED. ALL REINFORCING SHALL HAVE 2” MIN. COVER,
   3” MIN. IF PLACED AGAINST EARTH FORM.

3. ALL SEWER AND WATER SERVICES SHALL BE CLEARLY MARKED BY
   IMPRINTING A “W” FOR WATER AND “S” FOR SEWER INTO THE
   FACE OF CURB WHERE SERVICES ARE LOCATED.

4. 4” SIDEWALK, 6” X 6” #10 WIRE MESH MAY BE USED IN LIEU OF
   #3 BARS AT 16” O.C.E.W., FOR REINFORCING.
   EXPANSION JOINTS SHALL BE INSTALLED A MAX. OF 20’ FOR
   CONCRETE SIDEWALK DETAILS.

5. 6” DRIVEWAY APPROACH, 6” X 6” #10 WIRE MESH MAY BE USED
   IN LIEU OF #3 BARS ON 12” O.C.E.W., FOR REINFORCING.
   IF AND WHEN APPROVED BY THE CITY ENGINEER.

6. ALL EXPOSED CORNERS TO BE TOELED TO A 1/4” RADIUS.

7. SLOPE DRIVEWAY TO SUIT LOCAL CONDITIONS – SHOULD NOT
   EXCEED 1:10.

8. EXPANSION JOINTS SHALL BE INSTALLED A MAX. OF EVERY 40’
   FOR CONCRETE CURB DETAILS.

9. BASE MATERIAL REQUIRED UNDER ALL CURB & GUTTER, BEGINNING 1’ FROM
   BACK OF CURB, A MIN. OF 4” THICK.

10. IN AREAS WHERE NEW OR EXISTING CURB & GUTTER TIES INTO
     NEW OR EXISTING DRIVEWAYS AND SIDEWALKS, 24” SMOOTH DOWEL BARS
     WILL BE USED AT 24” O–C UNLESS OTHERWISE SPECIFIED.

11. ALL STEEL SHALL BE A MINIMUM OF 60 KSI.

12. THESE DETAILS SHALL BE IN CONJUNCTION WITH GEOTECHNICAL
    REPORT RECOMMENDATION.

13. MOUNTABLE CURB FOR LOCAL RESIDENTIAL ROADS OF SPEEDS NO GREATER
    THAN 30MPH.

14. MOUNTABLE CURB SHALL TRAVERSE TO STANDARD CURB AND GUTTER WITH
    IN 5’ FOOT OF BOTH SIDES OF ALL STRAIGHT INLINE INLET BOXES.

15. (MOUNTABLE CURB AND RECESSED INLET) CURB AND GUTTER THROAT
    SHALL HAVE A MINIMUM OF 10’ TRANSITION TO INLETBOX UP STREAM
    AND 5’ ON THE DOWN STREAM SIDE.
GENERAL NOTES FOR WATER

1. ALL WATER MAINS TO BE ONE OR A COMBINATION OF THE FOLLOWING MATERIALS HAVING DUCTILE IRON OUTSIDE DIAMETERS:
   A. DUCTILE IRON MUST:
      1. MEET OR EXCEED AWWA SPECIFICATIONS C150 AND C151;
      2. MECHANICAL JOINT BELL AND SPIGOT JOINTS WITH A SINGLE RUBBER GASKET, MEETING AWWA SPECIFICATIONS C111;
      3. HAVE A THICKNESS OF CLASS 50 OR BETTER
   B. POLYVINYL CHLORIDE (P.V.C.)
      1. 4 INCH AND LARGER AWWA C900 CL150 WITH RING-TITE SEAL, SDR 18;
      2. 3 INCH OR LESS CL200 SDR21 (MINIMUM) WITH RING-TITE SEAL.

2. TAPPING SLEEVE AND VALVE:
   A. TAPPING SLEEVE TO MEET AWWA SPECIFICATIONS WITH A MINIMUM WORKING PRESSURE OF 150 P.S.I.
   B. TAPPING VALVE SHALL MEET AWWA SPECIFICATIONS WITH A MINIMUM WORKING PRESSURE OF 175 P.S.I.
   C. ALL SIZE ON SIZE TAPS SHALL BE MADE USING A DUCTILE IRON FULL BODY TAPPING SLEEVE. ALL REDUCED SIZE TAPS MAY BE MADE USING AN EPOXY COATED FABRICATED STEEL TAPPING SLEEVE WITH STAINLESS STEEL BOLTS, OR A STAINLESS STEEL FULL CIRCLE TAPPING SLEEVE WITH DUCTILE IRON FLANGE.

3. BENDS AND FITTINGS:
4. TIED JOINT RESTRAINT SYSTEMS (ALL-THREAD ROD CONNECTIONS)
   A. DIRECT CONNECTION OF THE ALL-THREAD ROD TO THE FLANGE OF THE FITTING WILL NOT BE PERMITTED. THE APPROPRIATE "TIEBOLT", NUT AND WASHER IS THE ONLY ACCEPTABLE MEANS OF MAKING THIS CONNECTION. TIEBOLT SHOULD BE EQUAL TO OR EXCEED STAR "SUPER TIE-BOLT".
   B. ALL-THREAD ROD WILL BE OF THE FOLLOWING DIMENSION:
      1. 3 INCH OR SMALLER WATERLINE -- $\frac{5}{8}''$ DIAMETER ROD
      2. 4 INCH OR LARGER WATERLINE -- $\frac{3}{4}''$ DIAMETER ROD
   C. ALL THREAD RODS, NUTS, AND WASHERS SHALL BE STAINLESS STEEL. SPECIFICATIONS FOR TIEBOLT SHALL MEET OR EXCEED THOSE OF THE STAR "SUPERSTAR TIEBOLT".

5. FLUSHING OF WATER MAINS:
   THE FLUSHING OF ALL WATER MAINS SHALL BE ACCOMPLISHED THROUGH AN ACCEPTABLE FLUSHING (BLOWOFF) ARRANGEMENT COMPRISING OF A GATE VALVE AND REQUIRED LENGTH OF PIPE. THOROUGH FLUSHING AT A MINIMUM VELOCITY OF 2.5 FEET PER SECOND SHALL BE ACHIEVED USING THE OUTLET SIZE OPENINGS LISTED BELOW. (40 P.S.I. RESIDUAL PRESSURE MUST BE MAINTAINED IN THE WATER MAIN)
5. flushing of water mains: (continued)

<table>
<thead>
<tr>
<th>pipe size (in)</th>
<th>required gpm at 2.5 fps</th>
<th>flush valve and pipe size (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>220</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>400</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>660</td>
<td>6</td>
</tr>
</tbody>
</table>

for all other pipe sizes, engineer to specify flush valve and pipe size per awwa c651

all dead end water mains shall have an adequately sized flush assembly to facilitate flushing of the water lines. contractor shall study the plans and make provisions to comply with this requirement. any additional cost to the contractor for complying with this requirement shall be borne by the contractor.

6. joint restraints or adapter flanges: when restrainer flanges are specified on plans, or where the contractor elects to use them, the flanges will meet or exceed the requirements/specifications of uni-flange series 1300 or 1500 for pvc pipe or series 200 for ductile iron pipe. installation of these items will be in accordance with manufacturer's specifications for the type of material used. (the contractor will supply the inspector with copies of the manufacturer's installation specifications prior to installation of these items.)
7. **ALL WATER LINES MUST BE CONSTRUCTED IN ACCORDANCE WITH CURRENT TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) REGULATIONS, CHAPTER 290.**

8. **ALL WATER MAINS SHALL BE PRESSURE TESTED FOR A PERIOD NOT LESS THAN 4 HOURS AND AT A PRESSURE NOT LESS THAN 150 PSI (REFER TO TABLE 506.5(a) OF STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION -- NORTH CENTRAL TEXAS), THOROUGHLY DISINFECTED (AWWA C651), AND PASS MICROBIOLOGICAL ANALYSIS BEFORE BEING PLACED IN SERVICE.**

9. **MINIMUM DEPTH FOR ALL WATER MAIN LINES SHALL BE 42 INCHES FROM FINAL GRADE TO TOP OF PIPE.**

10. **ALL DUCTILE IRON PIPE AND FITTINGS SHALL BE WRAPPED IN 8 MIL POLYETHYLENE IN ACCORDANCE WITH ANSI/AWWA C105/A21.5-99 (POLYETHYLENE ENCASEMENT) FOR CORROSION PROTECTION.**

11. **PIPE CLEANLINESS: EVERY EFFORT SHALL BE MADE TO KEEP PIPE LINES CLEAN DURING INSTALLATION. FOREIGN MATERIAL SHALL BE PREVENTED FROM ENTERING THE PIPE WHILE IT IS BEING PLACED IN THE TRENCH.**

12. **METER BOXES: METER BOXES TO BE FURNISHED AND INSTALLED BY CITY OF TEMPLE AND PAID FOR BY PERMITTEE AT TIME OF METER INSTALLATION.**
STANDARD FIRE HYDRANT

NOT TO SCALE

1. TYPE OF FIRE HYDRANT: ALL REQUIRED FIRE HYDRANTS SHALL BE OF THE NATIONAL SCALE STANDARD THREE (3) WAY BREAKAWAY TYPE WITH NO LESS THAN A (5-1/4") MAIN VALVE OPENING (M.V.O.) AND SHALL CONFORM TO PROVISIONS OF THE LATEST A.W.W.A. SPECIFICATIONS C-602 AND SHALL BE PLACED UPON APPROVED WATER MAINS NOT LESS THAN SIX (6) INCHES IN DIAMETER. ONLY MUELLER A-423 CENTURION AND CLOW MEDALLION F-2540B ARE ACCEPTABLE UNLESS OTHERWISE ACCEPTED BY THE DIRECTOR OF UTILITIES.

2. VALVES SHALL BE PLACED WITHIN 3 FEET OF AND RESTRAINED TO WATER MAIN ON ALL FIRE HYDRANT LEADS.

3. REQUIRED FIRE HYDRANTS SHALL BE INSTALLED SO THAT THE BURY LINE WILL BE NO LESS THAN THREE (3) INCHES, AND NO GREATER THAN SIX (6) INCHES ABOVE THE GRADE SURFACE.

4. FIRE HYDRANTS WHEN LOCATED ON PUBLIC PROPERTY SHALL BE LOCATED A MINIMUM OF TWO (2) FEET AND A MAXIMUM OF EIGHT (8) FEET BEHIND THE CURB LINE.

5. ALL REQUIRED FIRE HYDRANTS SHALL BE INSTALLED SO THAT THE STEAMER CONNECTIONS WILL FACE THE FIRE LANE OR STREET.

6. ALL FIRE HYDRANTS SHALL BE RIGHT HAND THREAD, OPEN – COUNTER CLOCKWISE, CLOSE – CLOCKWISE.

7. PAINT COLOR SCHEME SHALL BE FACTORY PAINTED FLINT ALUMINUM FOR THE NOZZLE SECTION AND RUST PRIMER FOR THE BONNET.

8. HYDRANT SHOE INTERIOR AND EXTERIOR SHALL HAVE 8 TO 10 MILS OF FUSION BONDED EPOXY.

9. CONCRETE STRENGTH SHALL BE MINIMUM 3000 PSI

10. REFER TO TABLE FOR THRUST BLOCK REQUIREMENTS

PARALLEL FIRE HYDRANT ASSEMBLY

12"X12"X4" CONCRETE SLAB OR SOILD PRE-CAST BLOCK

HYDRANT

10"X10"X12" WOOD BARRIER BELOW THIS FLANGE CONNECTION

1/4" THICK WOOD BARRIER

WASHED GRAVEL 1.25 TO 1.5 INCH DIAMETER AROUND WEEP HOLES (MIN. OF 7 CUBIC FEET)

3/4" STAINLESS STEEL ALL-THREAD RODS, NUTS, AND WASHERS

MECHANICAL JOINT FITTINGS

* WHERE ALL-THREAD ROD CONNECTIONS ARE REQUIRED ON MECHANICAL JOINT FITTINGS, THEY WILL BE ANCHORED TO A RIGID FITTING THAT IS RESTRAINED TO THE WATER MAIN

STANDARD FIRE HYDRANT ASSEMBLY

12"X12"X4" CONCRETE SLAB OR SOILD PRE-CAST BLOCK

HYDRANT

6" GATE VALVE

WATER MAIN

THrust BLOCKING

*CONTRACTOR MAY SUBSTITUTE THE APPROPRIATE SIZED PARALLEL SWIVEL TEE FOR PARALLEL SWIVEL FITTING AND TEE

SECTION

3"-6" BETWEEN BURY LINE AND FINISHED Grade

SEE VALVE DETAIL

6" GATE VALVE

THrust BLOCKING

SWIVEL FITTING

2" MINIMUM-5" MAXIMUM

3" MAX

12" X 12" X 4" CONCRETE SLAB OR PRE-CAST BLOCK

BARRED EXTENSION
STANDARD GATE VALVE

NOT TO SCALE

24" X 24" X 6"
CONCRETE SLAB TO FINISHED GRADE PER ENGINEER

STEM EXTENSION
REQUIRED WHENEVER VALVE NUTS ARE ANTICIPATED TO BE GREATER THAN 4 FEET BELOW GRADE.

ADJUSTABLE SCREW TYPE 461S, 462S, OR 562S VALVE BOX
USE VALVE STAND WITH C-900 PVC PIPE FOR THE REMAINDER BETWEEN VALVE AND VALVE STAND
RIGHT HAND THREAD

AWWA C509 ALL DUCTILE IRON OR AWWA C515 RESILIENT WEDGE SEATED VERTICAL GATE VALVE OPEN LEFT

APPROVED BEDDING MATERIAL

VALVE BOX LID IN CENTER OF PAD

#3 BARS TYP. 2" BELOW TOP OF PAD

24"

3"

TOP VIEW – CONCRETE PAD
CONCRETE PAD NOT REQUIRED WHEN VALVE IS LOCATED IN PAVED AREAS
BLOCKING DETAIL

NOT TO SCALE

NOTE:
WRAP PLUG & ALL SURFACES IN CONTACT W/CONCRETE THRUST BLOCK IN 8 MIL POLYETHYLENE.
THRUST BLOCKING IS THE RESPONSIBILITY OF ENGINEER TO MEET EXISTING SOIL CONDITIONS.

HORIZONTAL BLOCKING TABLE

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>&quot;X&quot; DIM.</th>
<th>PLUGS &amp; TEES</th>
<th>90° BENDS</th>
<th>5° BENDS</th>
<th>22° 30° BENDS</th>
<th>11° 15° BENDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&quot;A&quot;</td>
<td>MIN. AREA</td>
<td>+MAX. VOL.</td>
<td>&quot;B&quot;</td>
<td>MIN. AREA</td>
</tr>
<tr>
<td>4&quot;</td>
<td>1'-0&quot;</td>
<td>.83</td>
<td>.05</td>
<td>1'-0&quot;</td>
<td>.83</td>
<td>.05</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-0&quot;</td>
<td>1.06</td>
<td>.06</td>
<td>1'-2&quot;</td>
<td>1.50</td>
</tr>
<tr>
<td>8&quot;</td>
<td>1'-6&quot;</td>
<td>1'-3&quot;</td>
<td>1.89</td>
<td>.11</td>
<td>1'-6&quot;</td>
<td>2.66</td>
</tr>
<tr>
<td>10&quot;</td>
<td>1'-6&quot;</td>
<td>1'-9&quot;</td>
<td>2.95</td>
<td>.17</td>
<td>2'-0&quot;</td>
<td>4.17</td>
</tr>
<tr>
<td>12&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>4.25</td>
<td>.24</td>
<td>2'-3&quot;</td>
<td>6.00</td>
</tr>
<tr>
<td>16&quot;</td>
<td>2'-0&quot;</td>
<td>2'-7&quot;</td>
<td>7.54</td>
<td>.56</td>
<td>3'-0&quot;</td>
<td>10.65</td>
</tr>
<tr>
<td>18&quot;</td>
<td>2'-0&quot;</td>
<td>2'-11&quot;</td>
<td>7.70</td>
<td>.57</td>
<td>3'-5&quot;</td>
<td>10.89</td>
</tr>
<tr>
<td>20&quot;</td>
<td>2'-0&quot;</td>
<td>3'-3&quot;</td>
<td>7.86</td>
<td>.59</td>
<td>3'-9&quot;</td>
<td>11.12</td>
</tr>
<tr>
<td>24&quot;</td>
<td>6'-0&quot;</td>
<td>3'-8&quot;</td>
<td>11.33</td>
<td>.84</td>
<td>4'-3&quot;</td>
<td>16.00</td>
</tr>
</tbody>
</table>

* CALCULATIONS IN MIN. AREA COLUMN ARE IN SQ. FT.
+ CALCULATIONS IN MAX. VOLUME COLUMN ARE IN CUBIC YARDS.

CALCULATIONS ARE MINIMUM, LOCAL SOIL CONDITIONS REQUIRE ADDITIONAL DESIGN CONSIDERATION BY ENGINEER.
FLUSH ASSEMBLY DETAIL

NOT TO SCALE

VALVE BOX

NATURAL GROUND

GATE VALVE

PVC CL 150

METER BOX
CAST IRON CAP

REDUCER TO BE INSTALLED
AFTER 45 DEGREE BEND

DIMJ 45° BEND
W/BLOCKING

VARIES
MIN 20’

RESTRAIN VALVE ASSEMBLY
WITH LOCKING RESTRAINT (MEGA-LUG OR
APPROVED EQUIVALENT)

<table>
<thead>
<tr>
<th>PIPE SIZE (IN)</th>
<th>REQUIRED GPM AT 2.5 FPS</th>
<th>FLUSH VALVE AND PIPE SIZE (IN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>220</td>
<td>4”</td>
</tr>
<tr>
<td>8”</td>
<td>400</td>
<td>4”</td>
</tr>
<tr>
<td>10”</td>
<td>600</td>
<td>6”</td>
</tr>
</tbody>
</table>

FOR ALL OTHER PIPE SIZES, ENGINEER TO SPECIFY FLUSH VALVE AND PIPE SIZE PER AWWA C-651
IN SAND 3” ABOVE AND 3” BELOW PIPE
MATERIAL. STEELED IN SCH 40 PVC. AND BEDDED
HERE SERVICES SHALL BE GRADE „A” VIRGIN
** OR APPROVED EQUIVALENT MANUFACTURER

<table>
<thead>
<tr>
<th>6100-22</th>
<th>4701-22</th>
<th>--</th>
</tr>
</thead>
<tbody>
<tr>
<td>P24350</td>
<td>P15008</td>
<td>DR2S</td>
</tr>
<tr>
<td>843444W</td>
<td>F1000-4</td>
<td>FC-202</td>
</tr>
</tbody>
</table>

** SERVICE THREE STOP, CURB STOP, CORROSION SADDLE

** SINGLE SERVICE CONNECTION FITTINGS

(Coupling) (Ford A34 or Approved
Meter Bushing
Curb Stop with 1” x 3/4”

Type “K” Soft Copper

CTC HDPPE (P.E. SDR-9 3408)

On Compression Fitting

Pack Joint with Set Screw

1” Approved “CC” X 1” CTS

Corrosion Stop

Limits of New Construction

LD No. EIW 3213010 (BY CM)

Meter Box EIW No. 32413701

** SINGLE SERVICE (TP)

WATER SERVICE

RESIDENTIAL
GENERAL NOTES FOR WASTEWATER

1. ALL GRAVITY WASTEWATER COLLECTION SYSTEM MAINS, LATERALS AND SERVICE LINES MUST BE:
   A. P.V.C WASTEWATER PIPE MINIMUM OF SDR 35 FOR 0’-10’ IN DEPTH AND A MINIMUM OF SDR 26 FOR
      10’ AND GREATER DEPTHS, MEETING A.S.T.M. D3034.
   B. ALL WASTEWATER LINES SHALL BE
      CONSTRUCTED OF SAME MATERIAL AND TYPE OF
      PIPE BETWEEN MANHOLES, UNLESS AN EXCEPTION
      IS SPECIFICALLY REQUESTED AND APPROVED BY
      DIRECTOR OF UTILITIES.
   C. DUCTILE IRON PIPE (MIN. C.L. 50) SHALL BE
      PROTECTIVE COATED (PROTECTO 401 EPOXY LINED
      OR APPROVED 40 MIL EQUIVALENT) ON THE INSIDE
      FOR WASTEWATER SERVICE.

2. ALL FORCE MAINS SHALL BE C.L. 160 PSI, SDR-26 PVC
   PIPE OR AS INDICATED BY DESIGN ENGINEER ON
   PLANS. (PURPLE PIPE)

3. A. PVC PIPE JOINTS FOR FORCE MAINS AND
   GRAVITY SEWER MAINS SHALL
   HAVE PERMANENTLY INSTALLED REINforced
   RUBBER RING GASKETS IN AN INTEGRAL BELL
   JOINT. GASKETS SHALL MEET ASTM F-477
   SPECIFICATIONS FOR ELASTOMERIC SEALS.
   B. DUCTILE IRON PIPE JOINTS SHALL BE TYTON JOINT
      OR APPROVED EQUIVALENT.

4. WASTEWATER PIPE LINES SHALL BE LAID IN
   STRAIGHT ALIGNMENT WITH UNIFORM GRADE BETWEEN
   MANHOLES AND WITH MINIMUM CURVE RADIi FOR PVC
   PIPE AND SHALL BE BASED ON THE FORMULA;
R = 300D WHERE
R = MINIMUM ALLOWABLE RADIUS OF CURVATURE FROM BENDING.
D = OUTSIDE PIPE DIAMETER (WHERE R AND D ARE IN THE SAME UNITS).

5. ALL WASTEWATER PIPE LINES MUST BE CONSTRUCTED IN ACCORDANCE WITH CURRENT OR AS AMENDED TEXAS COMMISSION ON ENVIRONMENTAL QUALITY REGULATIONS, CHAPTER 317 - DESIGN CRITERIA FOR SEWERAGE SYSTEMS.

6. WHEN THE EFFLUENT PIPE IS FOUR TIMES OR GREATER THAN THE OUTSIDE DIAMETER OF THE INFLUENT PIPE; THE TOPS OF ALL OF THE PIPES SHALL BE PLACED AT THE SAME ELEVATION IN THE MANHOLE AND THE FLOW CHANNELS IN THE INVERT BE SLOPED ON AN EVEN SLOPE FROM PIPE TO PIPE.

7. ALL STANDARD MANHOLES SHALL BE INSTALLED:
   A. WITH ECCENTRIC CONE SECTIONS.
   B. WITH APPROVED TYPE 32" DIAMETER FRAME AND COVER.
   C. WITH DROP PIPING WHEN THE WASTEWATER INFLUENT PIPE FLOWLINE IS 30" OR GREATER ABOVE MAIN WASTEWATER PIPE FLOWLINES.

8. FOR SEPARATION DISTANCES BETWEEN POTABLE WATER LINES AND WASTEWATER LINES; REFER TO TCEQ REGULATIONS SUBSECTION 317.13 APPENDIX E OR AS MAY BE AMENDED.

9. ALL TRENCH SAFETY AND TRENCH SHORING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND COMPLY WITH THE UNITED STATES OCCUPATIONAL SAFETY AND
HEALTH ADMINISTRATION (OSHA) REQUIREMENTS. ALL CONSTRUCTION OPERATIONS SHALL BE ACCOMPLISHED IN ACCORDANCE WITH APPLICABLE REGULATIONS OF OSHA. WHERE CONDITIONS WARRANT, THE CONTRACTOR SHALL PROVIDE A TRENCH SAFETY PLAN TO THE CITY OF TEMPLE AS REQUIRED BY THE LAWS OF THE STATE OF TEXAS.

10. TESTING OF WASTEWATER LINES AND MANHOLES:
   A. AIR TESTS SHALL BE MADE BY THE PRESSURE DROP VERSUS TIME METHOD; TIME RECORDED FOR PRESSURE TO DROP FROM 3.5 TO 2.5 PSIG. PER ATTACHED TABLE.
   B. DEFLECTION TESTING SHALL BE DONE ON THE INSTALLATION AT LEAST 30 DAYS AFTER ALL BACKFILL HAS BEEN COMPLETED. A MANDREL WILL BE PULLED THROUGH THE PIPE TO TEST FOR MAXIMUM FIVE PERCENT (5%) DEFLECTION. MANDREL SHALL BE CONSTRUCTED AS LISTED:

<table>
<thead>
<tr>
<th>NOMINAL PIPE SIZE (INCHES) (NEAREST 1/16&quot;)</th>
<th>MANDREL O.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5-7/16</td>
</tr>
<tr>
<td>8</td>
<td>7-4/16</td>
</tr>
<tr>
<td>10</td>
<td>9-1/16</td>
</tr>
<tr>
<td>12</td>
<td>10-13/16</td>
</tr>
</tbody>
</table>

FOR LARGER PIPE SIZES, DESIGN ENGINEER TO SPECIFY.
TABLE -- DURATION REQUIREMENTS FOR AIR TESTING

SPECIFICATION TIME REQUIRED FOR LOSS OF PRESSURE FROM 3.5 PSIG TO 2.5 PSIG FOR SIZE AND LENGTH OF PIPE INDICATION FOR Q=0.0015

<table>
<thead>
<tr>
<th>PIPE DIAMETER (IN)</th>
<th>MINIMUM TIME (MIN:SEC)</th>
<th>LENGTH FOR MINIMUM TIME (FT)</th>
<th>SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7:33</td>
<td>298.33</td>
<td>7:33 7:33 7:33 7:33 7:33 7:33 8:52 7:33</td>
</tr>
<tr>
<td>15</td>
<td>14:10</td>
<td>159.11</td>
<td>14:10 14:10 14:10 14:10 14:10</td>
</tr>
<tr>
<td>18</td>
<td>17:00</td>
<td>132.59</td>
<td>17:00 19:14 19:14 19:14</td>
</tr>
<tr>
<td>21</td>
<td>19:50</td>
<td>113.65</td>
<td>19:50 26:11</td>
</tr>
<tr>
<td>24</td>
<td>22:40</td>
<td>99.44</td>
<td>22:48</td>
</tr>
<tr>
<td>27</td>
<td>25:30</td>
<td>88.39</td>
<td>28:51</td>
</tr>
<tr>
<td>30</td>
<td>28:20</td>
<td>79.55</td>
<td>35:37</td>
</tr>
<tr>
<td>33</td>
<td>31:10</td>
<td>72.32</td>
<td>43:06 43:06</td>
</tr>
</tbody>
</table>

*THIS TABLE IS BASED ON T=DK/Q
WHERE: T = time, seconds
K = 0.0000419 DL, but not less than 1.0
Q = rate of loss, 0.0015 cu. ft/min/sq. ft. internal surface
D = pipe diameter, in.
L = length of pipe being tested, ft.

**TAKEN FROM APRIL, 1972 JOURNAL OF WATER POLLUTION CONTROL FEDERATION ARTICLE ENTITLED "TESTING NEW SEWER PIPE INSTALLATION" BY ROY E. RAMSEIER.

C. TESTING OF 48 INCH DIAMETER MANHOLE (ASTM C1244-93). TESTS TO BE CONDUCTED WITHOUT RING AND COVER (AT TOP OF CONE).

<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>0-8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMES (SEC)</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
</tbody>
</table>

11. SEWER CLEAN-OUT CAP
A CAST IRON SEWER CLEAN-OUT CAP SHALL BE FURNISHED AND INSTALLED BY PLUMBER AT THE PROPERTY LINE AND PAID FOR BY OWNER/BUILDER AT TIME OF WATER METER INSTALLATION.
REHAB SEWER SERVICE CONNECTION

NOTE:

1. STANDARD CLEANOUT AND CAST IRON BOXES TO BE INSTALLED AT PROPERTY LINE ON SEWER SERVICES

2. CAST IRON CLEANOUT BOX MUST BE SET FIRM IN CONCRETE AND AT A MINIMUM OF SIX INCHES ABOVE FINAL GRADE

3. CAST IRON SEWER CLEANOUT BOX WITH "SEWER" ON THE LID, WESTERN IRON WORKS MODEL #70, ACCUCAST LIDS # 115901 OR PRE-APPROVED EQUAL AND INSTALLED USING CONCRETE AND PVC PIPE SLEEVE

4. MUSHROOM CAP TO BE INSTALLED AT PROPERTY LINE
NEW 4" SINGLE RESIDENTIAL SEWER SERVICE LINE DETAILS

NOTE:

1. A 2" x 2" LATH (STAKE) 36" IN LENGTH WITH 24" ABOVE GRADE, PAINTED GREEN MUST BE INSTALLED AT ALL SANITARY SEWER LOCATIONS.

2. FOR LINES 0' - 10' DEEP, USE SDR 35, FOR LINES GREATER THAN 10' IN DEPTH, USE SDR 26 (TYPICAL).

3. SEWER TAPS SHALL BE LOCATED AT THE CENTER OF THE LOT UNLESS SPECIFIED BY DESIGN ENGINEER.
DROP MANHOLE

FOR 6" TO 10" DIA. INFLUENT PIPE

NOTE:

1. USE PVC CROSS FOR DROP CONNECTION

2. IF A PRE-CAST SECTION IS INSTALLED TO FORM THE BOTTOM BASE, INSTALL WATER TIGHT SEALS AT ALL PIPE PENETRATIONS THROUGH MANHOLE STRUCTURE

3. ALL SEALS BETWEEN SEWER LINES AND MANHOLES SHALL BE WATERTIGHT, SIZE-ON-SIZE RESILIENT CONNECTIONS ALLOWING FOR DIFFERENTIAL SETTLEMENT AND MEETING ASTM C923

4. TRIM PVC CROSS FOR EASE OF MAINTENANCE

5. A DROP MANHOLE IS REQUIRED WHEN THE INFLUENT FLOWLINE IS 30" OR HIGHER THAN THE FLOWLINE OUT

6. ALL FITTINGS INSIDE MANHOLE SHALL BE SDR 35 SOLVENT WELD

7. ALL PIPE INSIDE MANHOLE FOR DROP CONNECTION SHALL BE SDR 26 MINIMUM

8. 12 INCH DIAMETER AND LARGER TO BE DESIGNED BY ENGINEER
NOTE: ALL MANHOLES WILL HAVE ECCENTRIC CONES WITH 32" DIA. LIDS

(TYPE 3 - PRECAST CONCRETE CONE)
TONGUE & GROOVE JOINTS ASTM C478
OR MONOLITHIC PRECAST

NOTE:

1. IF A PRE-CAST SECTION IS INSTALLED TO FORM THE BOTTOM BASE; INSTALL WATER TIGHT SEALS AT ALL PIPE PENETRATIONS THROUGH MANHOLE STRUCTURE.

2. ALL SEALS BETWEEN SEWER LINES AND MANHOLES SHALL BE WATERTIGHT, SIZE-ON-SIZE RESILIENT CONNECTIONS ALLOWING FOR DIFFERENTIAL SETTLEMENT AND MEETING ASTM C923.

3. USE CONCRETE BONDING AGENT WHEN POURING BASE ON PRE-CAST "DOG HOUSE" MANHOLE.
MANHOLE BOTTOM

1) MANHOLE BOTTOM SHALL BE SHAPED WITH CONCRETE GROUT TO DRAIN TO CENTER, 1" PER FOOT MIN.

2) MIN. SLOPE OF 0.2 FT ACROSS MANHOLE INVERT

NOTE:

1. INSTALL WATER TIGHT SEALS AT ALL PIPE PENETRATION THROUGH MANHOLE STRUCTURE

2. ALL SEALS BETWEEN WASTEWATER LINES AND MANHOLES SHALL BE WATERTIGHT, SIZE-ON-SIZE RESILIENT CONNECTIONS ALLOWING FOR DIFFERENTIAL SETTLEMENT AND MEETING ASTM C923
1. ECCENTRIC CONE

2. USE CONCENTRIC CONES ONLY AT CITY APPROVED LOCATIONS

3. REINFORCEMENT MEETS OR EXCEEDS ASTM C478-95 REQUIREMENTS

4. REQUIRED 28 DAY CONCRETE STRENGTH RANGE IS 4,000 - 4,500 PSI (WET CONCRETE)

5. MONOLITHIC MANHOLE TO BE DESIGNED BY REGISTERED PROFESSIONAL ENGINEER
4' - 0" I.D. MANHOLE - REGULAR BASE

4' I.D. MANHOLE - REGULAR BASE
FLATTOP ILLUSTRATION
FOR SHALLOW MANHOLE

NOTE:
1. REINFORCEMENT MEETS OR EXCEEDS ASTM C478-95 REQUIREMENTS
2. REQUIRED 28 DAY CONCRETE STRENGTH RANGE IS 4,000 - 4,500 PSI (WET POURED CONCRETE)
3. ALL SEALS BETWEEN WASTEWATER LINES AND MANHOLES SHALL BE WATERTIGHT, SIZE-ON-SIZE RESILIENT CONNECTIONS ALLOWING FOR DIFFERENTIAL SETTLEMENT AND MEETING ASTM C923
4. ALL MANHOLE INVERTS SHALL:
   A. BE PROVIDED WITH A "U" SHAPED CHANNEL WITH A MINIMUM OF 0.1 FT FALL ACROSS THE MANHOLE. PROVIDE AS MUCH AS POSSIBLE FALL FOR A SMOOTH CONTINUATION OF THE INLET AND OUTLET PIPES
   B. ENSURE ALL BENCH PROVIDED ABOVE THE CHANNEL SHALL BE SLOPED AT A MINIMUM OF 1° PER FT TOWARDS THE FLOW LINE
5. WHEN EXISTING CONDITIONS REQUIRE AN EXTENDED CONCRETE BASE, REFER TO DESIGN ENGINEER
NOTES FOR SPACERS:

1. No. of Spacers needed shall be in accordance with City of Temple Approved Manufacturer’s recommendations.

2. All Spacers installed will comply with appropriate ASTM Standards for physical characteristics for plastic and polyethylene spacers.

3. The packing and spacing of spacers in the casing shall be according to the minimum number of spacer assemblies recommended by the approved casing spacer manufacturer.

4. Approved Manufacturer are Phoenix (Cascade Mfg. Co.), and Advance Products & Systems, Inc.

PLAN VIEW

CITY OF TEMPLE
INSTALLATION OF DIAM AND PVC PIPE THROUGH CASING
DEPARTMENT

NOTES FOR STEEL CASING:

1. Ends of the enclosure pipe will be permanently sealed with concrete.

2. All steel pipe casing must be cleaned on the inside and made free of rust and scale build up.

3. Steel casing with wall thickness less than 0.250 inches will not be accepted.

PLAN VIEW
TYPICAL COLLAR DETAIL FOR CONCRETE MANHOLE

NOTES:

1. USE REINFORCED CONCRETE GRADE RINGS WITH GROUT TO ACHIEVE SPECIFIED ELEVATION AS REQUIRED.
NOTE:

1. INVERT CHANNEL SHALL BE "U" SHAPED. MINIMUM DEPTH 75% OF PIPE DIAMETER AND SLOPED MINIMUM OF 0.1' ACROSS MANHOLE

2. MANHOLE SHALL BE MINIMUM DEPTH UNLESS OTHERWISE SPECIFIED BY A REGISTERED PROFESSIONAL ENGINEER

3. CONCRETE SHALL HAVE MINIMUM 4,000 PSI COMPRESSIVE STRENGTH AT 28 DAYS

4. WASTEWATER LINES LESS THAN OR EQUAL TO 24" DIAMETER - USE 4' I.D. MANHOLE
   WASTEWATER LINES GREATER THAN 24" - REFER TO DESIGN ENGINEER
END-OF-LINE CLEANOUT ON WASTE WATER MAIN LINE

NOTE:

1. CLEANOUT COVER - NO. 339 OR APPROVED EQUIVALENT

2. CLEANOUTS WITH WATERTIGHT PLUGS MAY BE INSTALLED IN LIEU OF MANHOLES AT THE END OF SEWER LINES WHICH ARE ANTICIPATED TO BE EXTENDED
Class 3
Installation Out of Road

Class 2
Proposed Future Roadway

Class 1
Existing Roadway

**NOTES:**

1. Lay out to breaker asphalt or concrete pavement and pour to 3" from road edge.
2. The embankment consists of washed gravel.
3. The minimum side slope is 1:2.50 on washed gravel fill for proposed and existing.

**WATER & WASTEWATER PVC PIPE EMBEYMENT AND BACKFILL DETAILS**

1. Install pipe with a minimum of 12" above the road base.
2. The installation of any water line or other works or excavation on the proposed or existing roadways will be the responsibility of the contractor.
3. All excavation must be returned to the original condition.
4. The embankment consists of washed gravel fill for proposed and existing.
5. The minimum side slope is 1:2.50 on washed gravel fill for proposed and existing.
6. The installation of any water line or other works or excavation on the proposed or existing roadways will be the responsibility of the contractor.
HEAVY DUTY

LOAD RATING

AS A TOP FLANGE UNIT
AND CAN BE INSTALLED
FRAME IS REVERSIBLE

MACHINED SURFACE

FRAME - GRAY IRON

MATERIAL SPEC.

FRAME: 150 LBS. BEG.

EST. WT.

00202211

PRODUCT NO.

280-24R FRAME

FXF 231-536-4458
1-800-874-1400
EAST JORDAN, RH 49
P.O. BOX 49
IRON WORKS INC.

EAST JORDAN
STORM SEWER RING AND COVER

CITY OF TEMPLE

ENGINEERING DEPARTMENT

HEAVY DUTY

LOAD RATING

ASME A14.4 CL 35

COVER - GRAY IRON

MATERIAL SPEC.

N/A

OPEN AREA

20320

REF. PRODUCT DRAWING

20320A

CATALOG NO.

20351

PRODUCT NO.

COVER

FAK: 231-236-4486

1-800-874-4100

EAST JORDAN, MI 49777

P.O. BOX 439

EAST JORDAN IRON WORKS, INC.

H.R.S. Rod

1" Dia.

2 5/16" 3/4"

2 3/4" 2"

Cover Section

Bottom View

(2) Pick Bars

1/16" 3/4"

23 3/4" 2"
JUNCTION BOX DETAILS

HEAVY DUTY MH RING & COVER 24" DIA # 280-244.
OR APPROVED EQUIVALENT, EJW IRON WORKS.

#5 BARS
ON 12" C-C
VERT. & HORIZ.

SHAPE INVERT
W/2000 psi
CONCRETE

ADD 4" SELECT FILL MATERIAL
UNDER JUNCTION BOX &
STORM DRAIN PIPE
(PI LESS THAN 20)
STABLE SUB-GRADE

SECTION A-A

IN Inside WWidth OVER 4' TOP MUST BE MIN. THICKNESS OF 8".

SECTION B-B

JUNCTION BOX DECK
STEEL TO BE #5 BARS ON
12" CENTERS

PLAN

N.T.S.
TYPICAL SLOPED END TREATMENT (SET) DETAIL

TYPICAL DOUBLE (SET)
NOT TO SCALE

TYPICAL SINGLE (SET)
NOT TO SCALE

SECTION A- A
NOT TO SCALE

3000 PSI CONCRETE

6:1 SLOPED PIPE END
VARIIES

STORM WATER PIPE

6 X 6 #6 WIRE MESH MINIMUM

APPROVED BY:
APPROVED DATE:
REVISION DATE:

CITY OF TEMPLE
ENGINEERING DEPARTMENT
MUNICIPAL BUILDING 2 NORTH MAIN TEMPLE, TX 76502
DETAIL NO.
STORM DRAIN
1874 Heavy Duty Frame & Cover
375 pounds. (Cast in Place)
CONCRETE HEADWALL - TYPE A
NOT TO SCALE

FRONT ELEVATION

SIDE SECTION

PLAN VIEW

NOTE:
DIMENSIONS AND MATERIAL REQUIREMENTS VARY FROM ONE APPLICATION TO ANOTHER. FOR COMPLETE DETAILS, MEASUREMENTS, MATERIALS LIST, AND OTHER APPROPRIATE FACTORS REFER TO THE CURRENT TXDOT CHART ON CONCRETE HEADWALLS FOR PIPE CULVERTS.
CONCRETE HEADWALL - TYPE B

NOT TO SCALE

FRONT ELEVATION

SIDE SECTION

NOTE:
DIMENSIONS AND MATERIAL REQUIREMENTS VARY FROM ONE APPLICATION TO ANOTHER. FOR COMPLETE DETAILS, MEASUREMENTS, MATERIALS LIST, AND OTHER APPROPRIATE FACTORS REFER TO THE CURRENT TXDOT CHART ON CONCRETE HEADWALLS FOR PIPE CULVERTS. CAST IN PLACE OR PRE-CAST IS ALLOWABLE.

PLAN VIEW
Curb Inlet

Heavy Duty Manhole Ring & Cover 24" Dia.
East Jordan Iron Works L202351
F202211 or Approved Equal
(See Section A-A Details)

Profile

Use same layout as shown for 10" Inlets

Section A-A

Inlet Notes

1. Reinforcement and all other construction details for inlets are as specified on City Standards may be modified with approval of the engineer as necessary to construct inlet as shown (See curb inlet details No.)

2. All variable height curb & gutter are included in the unit price for inlet.

3. Inlet size as called for in construction plans refers to the total length of openings - the total length of the structure is as per details this sheet.

4. The inside dimension of an inlet or junction box shall be no less than the outside dimension of the pipe entering the wall.
1. Reinforcement and all other construction details for inlets are as specified on city standards may be modified with approval of the engineer as necessary to construct inlet as shown (see curb inlet details no.).

2. All variable height curb & gutter are included in the unit price for inlet.

3. Inlet size as called for in construction plans refers to the total length of openings – the total length of the structure is as per details this sheet.

4. The inside dimension of an inlet or junction box shall be no less than the outside dimension of the pipe entering the wall.
NOTES:
1. ALL CONCRETE SHALL BE CLASS "A" CONCRETE.
2. MANHOLE SHALL BE HEAVY DUTY, 350 LBS., EAST JORDON IRON WORKS
   24" V - 1874 OR APPROVED EQUIVALENT.
TWO-SIDED DRAIN INLET - (Cast in Place)

NOT TO SCALE

NOTES:
1. SHOULD THE CURB INLET BE LOCATED IN A SAG, CONTRACTOR SHALL TRANSITION 9'-6" ON BOTH SIDES OF CURB INLET.
2. THE MAXIMUM LENGTH OF CURB INLET, WITH EXTENSIONS, SHALL BE 20'.
3. EXTENSIONS OF 5' OF OPEN CURB SHALL BE ACCOMPANIED BY 6" WIDE POST SUPPORTS, EXCEPT ON PRE-CAST.

PLAN

BACK SIDE ELEVATION
ENERGY DISSIPATOR DETAIL

NOT TO SCALE

PLAN VIEW

SECTION "A-A"

NOTES:
1. USE CLASS "A" CONCRETE, FC = 3000 PSI AT 28 DAYS, UNLESS NOTED.
2. REINFORCING STEEL – ASTM A615, GRADE 40, UNLESS NOTED.
3. LAP REINFORCING 30 BAR DIAMETERS MIN. AT SPLICES, UNLESS NOTED.
4. CHAMFER EXPOSED EDGES OF CONCRETE 3/4", UNLESS NOTED.
5. PLACE REINFORCING WITH THE CENTER OF THE OUTSIDE BARS 2 INCHES FROM THE SURFACE OF THE CONCRETE.

TABLE OF DIMENSIONS FOR ENERGY DISSIPATOR DETAIL

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ERGYDIS.DWG
FLOW PATTERNS FOR INVERT CHANNELS

NOT TO SCALE

NOTES:
1. INVERT CHANNELS TO BE CONSTRUCTED FOR SMOOTH FLOW WITH NO OBSTRUCTIONS.
2. SPILLWAYS SHALL BE CONSTRUCTED BETWEEN PIPES WITH DIFFERENT INVERT ELEVATIONS PROVIDING FOR SMOOTH FLOW.
3. CHANNELS FOR FUTURE CONSTRUCTIONS (STUBS) SHALL BE CONSTRUCTED, FILLED WITH SAND, AND COVERED WITH 1" OF MORTAR.
4. SLOPE MANHOLE ITSELF WITH A 1:2 SLOPE FROM MANHOLE WALL TO CHANNEL.
5. INVERT SHALL BE A MINIMUM OF 1/2 THE DIAMETER OF THE LARGEST PIPE OR 4" DEEP.
NOT TO SCALE

RIGHT-OF-WAY MANAGEMENT DETAILS
CITY OF TEMPLE - TYPICAL RESIDENTIAL STREET

NOTES:
1. SPECIFIC LONGITUDINAL EASEMENTS TO BE NEGOTIATED AMONG CITY OF TEMPLE, DEVELOPER AND UTILITY PROVIDERS DURING PLAT PROCESS.
2. THESE HORIZONTAL ASSIGNMENTS SHALL BE OBSERVED UNLESS ADDITIONAL SPECIFIC EASEMENTS ARE NEGOTIATED / DEDICATED.
3. THESE VERTICAL ASSIGNMENTS ARE IDEAL BUT MAY VARY DEPENDING ON EXISTING AND / OR PROPOSED CONSTRAINTS FOR INFRASTRUCTURE PLACEMENT.
4. THESE VERTICAL ASSIGNMENTS ARE BASED ON TOP OF CURB ELEVATIONS.
5. STREET LIGHTS TO BE TYPICALLY LOCATED ON OPPOSITE SIDES OF STREET FROM WATERMAIN.
6. THIS TYPICAL SECTION IS BASED ON THE ASSUMPTION THAT SIDEWALKS, IF ANY, WILL BE PLACED AS PART OF THE DWELLING CONSTRUCTION.