Document No. 03:

Technical Specifications
INDEX – DOCUMENT 03: TECHNICAL SPECIFICATIONS

1. TXDOT STANDARD SPECIFICATIONS

1.1. GENERAL REQUIREMENTS AND COVENANTS (ITEMS 1-9) ................................................................. 6
  1.1.1. DEFINITION OF TERMS .................................................................................................................. 6
  1.1.2. SCOPE OF WORK ............................................................................................................................... 19
  1.1.3. CONTROL OF MATERIALS ............................................................................................................ 27

1.2. EARTH WORK AND LANDSCAPE (ITEMS 100) ............................................................................. 31
  1.2.1. PREPARING RIGHT OF WAY ......................................................................................................... 31
  1.2.2. REMOVING CONCRETE .............................................................................................................. 32
  1.2.3. EXCAVATION ................................................................................................................................. 32
  1.2.4. EMBANKMENT ............................................................................................................................... 33
  1.2.5. BACKFILLING PAVEMENT EDGES ........................................................................................... 37
  1.2.6. BULLDOZER WORK ....................................................................................................................... 39

1.3. SURFACE COURSES AND PAVEMENT (ITEMS 300) ............................................................... 40
  1.3.1. ASPHALTS, OILS, AND EMULSIONS ......................................................................................... 40
  1.3.2. ASPHALT ANTI-STRIPPING AGENTS ......................................................................................... 55
  1.3.3. AGgregates FOR SURFACE TREATMENTS ................................................................................. 56
  1.3.4. SALVAGING, HAULING, AND STOCKPILING RECLAIMABLE ASPHALT PAVEMENT ............... 59
  1.3.5. EMULSIFIED ASPHALT TREATMENT .......................................................................................... 60
  1.3.6. EQUIPMENT FOR ASPHALT CONCRETE PAVEMENT ............................................................... 61
  1.3.7. ASPHALT CONCRETE SURFACE REHABILITATION ................................................................. 64
  1.3.8. CONCRETE PAVEMENT ............................................................................................................. 65
  1.3.9. FULL-DEPTH REPAIR OF CONCRETE PAVEMENT ................................................................. 77
  1.3.10. CONCRETE PAVEMENT TERMINALS ...................................................................................... 78

1.4. STRUCTURES (ITEMS 400) ............................................................................................................ 80
  1.4.1. EXCAVATION AND BACKFILL FOR STRUCTURES ................................................................. 80
  1.4.2. FLOWABLE BACKFILL .................................................................................................................. 86
  1.4.3. TRENCH EXCAVATION PROTECTION ...................................................................................... 88
  1.4.4. TEMPORARY SPECIAL SHORING ............................................................................................... 88
  1.4.5. DRIVING PILING .......................................................................................................................... 89
  1.4.6. FOUNDATION TEST LOAD ......................................................................................................... 95
  1.4.6. DRILLED SHAFT FOUNDATIONS ............................................................................................... 96
  1.4.7. CONCRETE STRUCTURES ......................................................................................................... 102
  1.4.8. HYDRAULIC CEMENT CONCRETE ............................................................................................. 123
  1.4.9. REINFORCED CONCRETE SLAB .............................................................................................. 138
  1.4.10. PRECAST CONCRETE STRUCTURES (FABRICATION) ............................................................ 139
  1.4.11. PRECAST PRESTRESSED CONCRETE STRUCTURAL MEMBERS ........................................... 156
  1.4.12. SURFACE FINISHES FOR CONCRETE ..................................................................................... 157
  1.4.13. CONCRETE SURFACE TREATMENT ......................................................................................... 162
  1.4.14. CONCRETE STRUCTURE REPAIR ............................................................................................ 164
  1.4.15. EXTENDING CONCRETE STRUCTURES ................................................................................. 167
  1.4.16. REINFORCING STEEL ............................................................................................................... 168
  1.4.17. MANHOLES AND INLETS ........................................................................................................ 176

1.5. MISCELLANEOUS CONSTRUCTION ............................................................................................ 181
1.5.1. BARRICADES, SIGNS, AND TRAFFIC HANDLING .................................................. 181
1.5.2. CONSTRUCTING DETOURS ............................................................................. 182
1.5.3. CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER ............. 182
1.5.4. SIDEWALKS ..................................................................................................... 183
1.6. LIGHTING, SIGNING, MARKINGS, AND SIGNALS .................................................. 185
  1.6.1. ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS .............. 185
  1.6.2. PAVEMENT SURFACE PREPARATION FOR MARKINGS ............................... 186
  1.6.3. INSTALLATION OF HIGHWAY TRAFFIC SIGNALS ...................................... 187
  1.6.4. TEMPORARY TRAFFIC SIGNALS ................................................................. 189
  1.6.5. VEHICLE AND PEDESTRIAN SIGNAL HEADS .............................................. 189
1.7. MAINTENANCE ..................................................................................................... 197
  1.7.1. CLEANING AND SEALING JOINTS AND CRACKS (ASPHALT CONCRETE) .... 197
  1.7.2. REPAIR OF SPALLING IN CONCRETE PAVEMENT ....................................... 197
  1.7.3. LITTER REMOVAL .......................................................................................... 199
  1.7.4. DEBRIS REMOVAL ........................................................................................ 199
2. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) ................................... 201
  2.1. SUBCHAPTER C: CONVENTIONAL COLLECTION SYSTEMS ................................ 201
    2.1.1. Applicability.................................................................................................. 201
    2.1.2. Edwards Aquifer .......................................................................................... 201
    2.1.3. Pipe Design .................................................................................................. 201
    2.1.4. Criteria for Laying Pipe ................................................................................. 209
    2.1.5. Manholes and Related Structures ................................................................. 211
    2.1.6. Trenchless Pipe Installation ......................................................................... 213
    2.1.7. Testing Requirements for Installation of Gravity Collection System Pipes ....... 215
    2.1.8. Testing Requirements for Manholes ............................................................... 219
    2.1.9. Lift Station Site Requirements ....................................................................... 219
    2.1.10. Lift Station, Wet Well, and Dry Well Designs .............................................. 220
    2.1.11. Lift Station Pumps ......................................................................................... 223
    2.1.12. Lift Station Pipes ......................................................................................... 224
    2.1.13. Emergency Provisions for Lift Stations ....................................................... 225
    2.1.15. Force Main Pipe Joints ............................................................................... 227
    2.1.16. Identification of Force Main Pipes .............................................................. 227
    2.1.17. Force Main Design ...................................................................................... 227
    2.1.18. Force Main Testing ..................................................................................... 228
    2.1.19. Reclaimed Water Facilities ........................................................................ 229

ANNEX 3 – CITY OF FORT WORTH WASTEWATER UTILITIES SPECIFICATIONS ................. 233
  3.1. SECTIONS ........................................................................................................... 236
    3.1.1. 01 45 23 – Testing and Inspection Services .................................................. 236
    3.1.2. 01 50 00 – Temporary Facilities and Controls .............................................. 238
    3.1.3. 01 55 26 – Street Use Permit and Modifications to Traffic Control ............... 242
    3.1.4. 01 57 13 – Storm Water Pollution Prevention .............................................. 245
    3.1.5. 01 60 00 – Product Requirements ................................................................ 248
    3.1.6. 01 66 00 – Product Storage and Handling Requirements ............................ 250
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Construction Staking and Survey</td>
</tr>
<tr>
<td>01</td>
<td>Cleaning</td>
</tr>
<tr>
<td>01</td>
<td>Closeout Requirements</td>
</tr>
<tr>
<td>01</td>
<td>Operation and Maintenance Data</td>
</tr>
<tr>
<td>01</td>
<td>Project Record Documents</td>
</tr>
<tr>
<td>02</td>
<td>Selective Site Demolition</td>
</tr>
<tr>
<td>02</td>
<td>Utility Removal/Abandonment</td>
</tr>
<tr>
<td>02</td>
<td>Paving Removal</td>
</tr>
<tr>
<td>03</td>
<td>Cast-in-Place Concrete</td>
</tr>
<tr>
<td>03</td>
<td>Controlled Low Strength Material (CLSM)</td>
</tr>
<tr>
<td>03</td>
<td>Concrete Base Material for Trench Repair</td>
</tr>
<tr>
<td>03</td>
<td>Modifications to Existing Concrete Structures</td>
</tr>
<tr>
<td>31</td>
<td>Site Clearing</td>
</tr>
<tr>
<td>31</td>
<td>Borrow</td>
</tr>
<tr>
<td>31</td>
<td>Erosion and Sediment Control</td>
</tr>
<tr>
<td>32</td>
<td>Temporary Asphalt Paving Repair</td>
</tr>
<tr>
<td>32</td>
<td>Concrete Paving Repair</td>
</tr>
<tr>
<td>32</td>
<td>Flexible Base Courses</td>
</tr>
<tr>
<td>32</td>
<td>Concrete Sidewalks, Driveways and Barrier Free Ramps</td>
</tr>
<tr>
<td>32</td>
<td>Concrete Paving Joint Sealants</td>
</tr>
<tr>
<td>32</td>
<td>Concrete Curb and Gutters and Valley Gutters</td>
</tr>
<tr>
<td>32</td>
<td>Pavement Markings</td>
</tr>
<tr>
<td>32</td>
<td>Hydromulching, Seeding and Sodding</td>
</tr>
<tr>
<td>33</td>
<td>Sewer and Manhole Testing</td>
</tr>
<tr>
<td>33</td>
<td>Closed Circuit Television (CCTV) Inspection</td>
</tr>
<tr>
<td>33</td>
<td>Bypass Pumping of Existing Sewer Systems</td>
</tr>
<tr>
<td>33</td>
<td>Cleaning and Acceptance Testing of Water Mains</td>
</tr>
<tr>
<td>33</td>
<td>Utility Trench Excavation, Embedment, and Backfill</td>
</tr>
<tr>
<td>33</td>
<td>Frame, Cover, and Grade Rings</td>
</tr>
<tr>
<td>33</td>
<td>Adjusting Manholes, Inlets, Valve Boxes, and Other Structures to Grade</td>
</tr>
<tr>
<td>33</td>
<td>Installation of Carrier Pipe in Casing or Tunnel Liner Plate</td>
</tr>
<tr>
<td>33</td>
<td>Utility Markers/Locator</td>
</tr>
<tr>
<td>33</td>
<td>Exploratory Excavation for Existing Utilities</td>
</tr>
<tr>
<td>33</td>
<td>Ductile Iron Pipe</td>
</tr>
<tr>
<td>33</td>
<td>Ductile Iron Fittings</td>
</tr>
<tr>
<td>33</td>
<td>Polyvinyl Chloride (PVC) Pressure Pipe</td>
</tr>
<tr>
<td>33</td>
<td>Polyvinyl Chloride (PVC) Gravity Sanitary Sewer Pipe</td>
</tr>
<tr>
<td>33</td>
<td>Sanitary Sewer Service Connections and Service Line</td>
</tr>
<tr>
<td>33</td>
<td>Cast-in-Place Concrete Manhole</td>
</tr>
<tr>
<td>33</td>
<td>Precast Concrete Manhole</td>
</tr>
<tr>
<td>33</td>
<td>Epoxy Liners for Sanitary Sewer Structures</td>
</tr>
<tr>
<td>34</td>
<td>Traffic Control</td>
</tr>
</tbody>
</table>
1. TxDOT Standard Specifications

1.1. GENERAL REQUIREMENTS AND COVENANTS (ITEMS 1-9)

1.1.1. DEFINITION OF TERMS

1.1. Applicability. Wherever the following terms are used in these specifications or other Contract documents, the intent and meaning will be interpreted as shown below.

1.2. Abbreviations:
AAR Association of American Railroads
AASHTO American Association of State Highway and Transportation Officials
ACI American Concrete Institute
ACPA American Concrete Pipe Association
AI Asphalt Institute
AIA American Institute of Architects
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute
AITC American Institute of Timber Construction ALSA American Lumber Standard Committee, Inc. AMRL AASHTO Materials Reference Laboratory ANLA American Nursery and Landscape Association ANSI American National Standards Institute
API American Petroleum Institute
APWA American Public Works Association
AREMA American Railway Engineering and Maintenance-of-Way Association
ASBI American Segmental Bridge Institute
ASCE American Society of Civil Engineers
AWG American Wire Gage
AWPA American Wood-Preservers’ Association
AWPI American Wood Preservers Institute
AWS American Welding Society
AWWA American Water Works Association
COE U.S. Army Corps of Engineers
CRSI Concrete Reinforcing Steel Institute DMS Departmental Material Specification EIA Electronic Industries Alliance
EPA United States Environmental Protection Agency
FHWA Federal Highway Administration, U.S. Department of Transportation
FSS Federal Specifications and Standards (General Services Administration) GSA General Services Administration
ICEA Insulated Cable Engineers Association
IEEE Institute of Electrical and Electronics Engineers IESNA Illuminating Engineering Society of North America IMSA International Municipal Signal Association
ISO International Organization for Standardization
ITE Institute of Transportation Engineers
LRFD Load Resistance Factor Design
MIL Military Specifications
NCHRP National Cooperative Highway Research Program
NEC National Electrical Code (Published by NFPA) NEMA National Electrical Manufacturers Association NEPA National Environmental Policy Act
NESC National Electrical Safety Code
NFPA National Fire Protection Association
NIST National Institute of Standards and Technology NRMCA National Ready Mixed Concrete Association NSBA National Steel Bridge Alliance
OSHA Occupational Safety & Health Administration, U.S. Department of Labor
PCA Portland Cement Association
PCI Precast/Prestressed Concrete Institute
PSI Pounds Per Square Inch
PPI Plastics Pipe Institute
PS&E Plans, Specifications, and Estimate
RCP Reinforced Concrete Pipe
RPLS Registered Public Land Surveyor RRC Railroad Commission of Texas SAE Society of Automotive Engineers
SFPA Southern Forest Products Association
SI International System of Units
SPIB Southern Pine Inspection Bureau SSPC The Society for Protective Coatings TAC Texas Administrative Code
TCEQ Texas Commission on Environmental Quality
TDLR Texas Department of Licensing and Regulation
TMUTCD Texas Manual on Uniform Traffic Control Devices for Streets and Highways
UL Underwriters Laboratory, Inc. USC United States Code
WRI Wire Reinforcement Institute
WWPA Western Wood Products Association

1.3. **A+B Bidding.** A cost-plus-time bidding procedure.

1.4. **Abrasive Blasting.** Spraying blasts of pressurized air combined with abrasive media.
1.5. Actual Cost. Contractor’s actual cost to provide labor, material, equipment, and project overhead necessary for the work.

1.6. Addendum. Change in proposal forms developed between advertising and bid submittal deadline.

1.7. Advertisement. The public announcement required by law inviting bids for work to be performed or materials to be furnished.

1.8. Air Blasting. Spraying blasts of pressurized air free of oil and moisture.

1.9. Air Temperature. The temperature measured in degrees Fahrenheit (°F) in the shade, not in the direct rays of the sun, and away from artificial heat.

1.10. Anticipated Profit. Profit for work not performed.

1.11. Apparent Low Bidder. The Bidder determined to have the numerically lowest total bid as a result of the tabulation of bids by the Department.

1.12. Architect of Record. A person registered as an architect or licensed as a landscape architect, in accordance with State law, exercising overall responsibility for the design or a significant portion of the design and performs certain Contract administration responsibilities as described in the Contract; or a firm employed by the State to provide professional architectural services.

1.13. Arterial Highway. A highway used primarily for through traffic and usually on a continuous route.


1.15. Award. The Commission’s acceptance of a Contractor’s bid for a proposed Contract that authorizes the Department to enter into a Contract.

1.16. Bid Bond. The security executed by the Contractor and the Surety furnished to the Department to guarantee payment of liquidated damages if the Contractor fails to enter into an awarded Contract.

1.17. Bid Error. A mathematical mistake made by the prime Contractor in the unit price entered into the proposal.

1.18. Bidder. An individual, partnership, limited liability company, corporation, or joint venture submitting a bid for a proposed Contract.

1.20. **Bidding Capacity.** The maximum dollar value a Contractor may have under Contract with the Department at any given time.

1.21. **Blast Cleaning.** Using 1 of the blasting methods including, but not limited to, water blasting, low-pressure water blasting, high-pressure water blasting, abrasive blasting, water-abrasive blasting, shot blasting, slurry blasting, water injected abrasive blasting, and brush blasting.

1.22. **Bridge.** A structure, including supports, erected over a depression or an obstruction (e.g., water, a highway, or a railway) having a roadway or track for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 ft. between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts.

1.23. **Brush Blasting.** Sweeping lightly with an abrasive blast to remove loose material.

1.24. **Building Contract.** A Contract entered under Transportation Code, Chapter 223, Subchapter A, “Competitive Bids,” for the construction or maintenance of a Department building or appurtenance facilities. Building Contracts are considered to be construction Contracts.

1.25. **Callout Work.** Contracts, or work items in Contracts, that require a Contractor’s response on an as-needed basis (e.g., see Item 351, “Flexible Pavement Structure Repair”).

1.26. **Certificate of Insurance.** A form approved by the Department covering insurance requirements stated in the Contract.

1.27. **Change Order.** Written order to the Contractor detailing changes to the specified work, item quantities or any other modification to the Contract.

1.28. **Commission.** The Texas Transportation Commission or authorized representative.

1.29. **Construction Bulletin C-8.** Manual of procedures for driving and test loading piling.

1.30. **Construction Bulletin C-9.** Manual of procedures for constructing and test loading drilled shafts.

1.31. **Construction Contract.** A Contract entered under Transportation Code, Chapter 223, Subchapter A, for the construction, reconstruction, or maintenance of a segment of the State highway system.

1.32. **Consultant.** The licensed professional engineer or engineering firm, or the architect or architectural firm, registered in the State of Texas and under Contract to the Department to perform professional services. The consultant may be the Engineer or architect of record or may provide services through and be subcontracted to the Engineer or architect of record.
1.33. Contract. The agreement between the Department and the Contractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.

1.34. Contract Documents. Elements of the Contract including but not limited to the plans, specifications incorporated by reference, special provisions, special specifications, Contract bonds, change orders, and supplemental agreements.

1.35. Contract Time. The number of working days specified for completion of the work including authorized additional working days.

1.36. Contractor. The individual, partnership, limited liability company, corporation, or joint venture and all principals and representatives with which the Contract is made by the Department.

1.37. Controlled Access Highway. Any highway to or from which access is denied or controlled, in whole or in part, from or to abutting land or intersecting streets, roads, highways, alleys, or other public or private ways.

1.38. Control of Access. The condition in which the right to access of owners or occupants of abutting land or other persons in connection with a highway is fully or partially controlled by public authority.

1.39. Control Point. An established point shown on the plans to provide vertical and horizontal references for geometric control for construction.

1.40. Cross-Sections. Graphic representations of the original ground and the proposed facility, at right angles to the centerline or base line.

1.41. Culvert. Any buried structure providing an opening under a roadway for drainage or other purposes. Culverts may also be classified as bridges. (See Article 1.22, “Bridge.”)

1.42. Cycle. The activity necessary for performing the specified work within the right of way project limits once.

1.43. Daily Road-User Cost. Damages based on the estimated daily cost of inconvenience to the traveling public resulting from the work.

1.44. Date of Written Authorization. Date of the written work order authorizing the Contractor to begin work.

1.45. Debar (Debarment). Action taken by the Department or federal government pursuant to regulation that prohibits a person or company from entering into a Contract, or from participating as a subcontractor, or supplier of materials or equipment used in a highway improvement Contract as defined in Transportation Code, Chapter 223, Subchapter A.

1.46. Detour. A temporary traffic route around a closed portion of a road.
1.47. **Department.** The Texas Department of Transportation (TxDOT).

1.48. **Departmental Material Specifications (DMS).** Reference specifications for various materials published by the Construction Division.

1.49. **Direct Traffic Culvert.** Concrete box culvert whose top slab is used as the final riding surface or is to have an overlay or other riding surface treatment.

1.50. **Disadvantaged Business Enterprise (DBE).** A small business, certified by the Department, that is 51% owned by 1 or more minorities or women, or in the case of a publicly owned business, at least 51% of the stock is owned by 1 or more minorities or women, and whose management and daily business operations are controlled by 1 or more of these individuals.

1.51. **Divided Highway.** A highway with separate roadways intended to move traffic in opposite directions.

1.52. **Easement.** A real property right acquired by 1 party to use land belonging to another party for a specified purpose.

1.53. **Engineer.** The Executive Director of the Department or the authorized representative of the Executive Director.

1.54. **Expressway.** A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

1.55. **Force Account.** Payment for directed work based on the actual cost of labor, equipment, and materials furnished with markups for project overhead and profit.

1.56. **Freeway.** An expressway with full control of access.

1.57. **Frontage Road.** A local street or road auxiliary to and located along an arterial highway for service to abutting property and adjacent areas and for control of access (sometimes known as a service road, access road, or insulator road).

1.58. **Hazardous Materials or Waste.** Hazardous materials or waste include but are not limited to explosives, compressed gas, flammable liquids, flammable solids, combustible liquids, oxidizers, poisons, radioactive materials, corrosives, etiologic agents, and other material classified as hazardous by 40 CFR 261, or applicable state and federal regulations.

1.59. **High-Pressure Water Blasting.** Water blasting with pressures between 5,000 and 10,000 psi.

1.60. **Highway, Street, or Road.** General terms denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas is highway or street; in rural areas, highway or road.
1.61. Historically Underutilized Business (HUB). A corporation, sole proprietorship, partnership, or joint venture formed for the purpose of making a profit certified by the Texas Building and Procurement Commission, and 51% owned by 1 or more persons who are economically disadvantaged because of their identification as members of certain groups, including African Americans, Hispanic Americans, Asian-Pacific Americans, Native Americans, or women, and have a proportionate interest and demonstrate active participation in the control, operation, and management of the business’ affairs. Individuals meeting the HUB definition are required to be residents of the State of Texas. Businesses that do not have their primary headquarters in the State of Texas are not eligible for HUB certification.

1.62. Incentive/Disincentive Provisions. An adjustment to the Contract price of a predetermined amount for each day the work is completed ahead of or behind the specified milestone, phase, or Contract completion dates.

The amount of the incentive/disincentive is determined based on estimated costs for engineering, traffic control, delays to the motorists, and other items involved in the Contract.

1.63. Independent Assurance Tests. Tests used to evaluate the sampling and testing techniques and equipment used in the acceptance program. The tests are performed by the Department and are not used for acceptance purposes.

1.64. Inspector. The person assigned by the Engineer to inspect for compliance with the Contract any or all parts of the work and the materials used.

1.65. Intersection. The general area where 2 or more highways, streets, or roads join or cross, including the roadway and roadside facilities for traffic movements within it.

1.66. Island. An area within a roadway from which vehicular traffic is intended to be excluded, together with any area at the approach occupied by protective deflecting or warning devices.

1.67. Joint venture. Any combination of individuals, partnerships, limited liability companies, or corporations submitting a single bid proposal.

1.68. Lane Rental. A method to assess the Contractor daily or hourly rental fees for each lane, shoulder, or combination of lanes and shoulders taken out of service.

1.69. Letting. The receipt, opening, tabulation, and determination of the apparent low Bidder.

1.70. Letting Official. The Executive Director or any Department employee empowered by the Executive Director to officially receive bids and close the receipt of bids at a letting.

1.71. Licensed Professional Engineer. A person who has been duly licensed by the Texas Board of Professional Engineers to engage in the practice of engineering in the State of Texas; also referred to as a Professional Engineer.
1.72. **Limits of Construction.** An area with established boundaries, identified within the highway right of way and easements, where the Contractor is permitted to perform the work.

1.73. **Local Street or Road.** A street or road primarily for access to residence, business, or other abutting property.

1.74. **Low-Pressure Water Blasting.** Water blasting with pressures between 3,000 and 5,000 psi.

1.75. **Major Item.** An item of work included in the Contract that has a total cost equal to or greater than 5% of the original Contract or $100,000 whichever is less.

1.76. **Manual of Testing Procedures.** Department manual outlining test methods and procedures maintained by the Materials and Pavements Section of the Construction Division.

1.77. **Materially Unbalanced Bid.** A bid that generates a reasonable doubt that award to the Bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the State.

1.78. **Mathematically Unbalanced Bid.** A bid containing bid prices that do not reflect reasonable actual costs plus a reasonable proportionate share of the Bidder’s anticipated profit, overhead costs, and other indirect costs.

1.79. **Median.** The portion of a divided highway separating the traffic lanes in opposite directions.

1.80. **Milestone Date.** The date that a specific portion of the work is to be completed, before the completion date for all work under the Contract.

1.81. **Multiple Work Order Contracts.** Contracts with recurring maintenance or non-site-specific work.

1.82. **National Holiday.** January 1, the last Monday in May, July 4, the first Monday in September, the fourth Thursday in November, December 24, or December 25.

1.83. **Nonhazardous Recyclable Material (NRM).** A material recovered or diverted from the nonhazardous waste stream for the purposes of reuse or recycling in the manufacture of products that may otherwise be produced using raw or virgin materials.

1.84. **Nonresident Bidder.** A Bidder whose principal place of business is not in Texas. This includes a Bidder whose ultimate parent company or majority owner does not have its principal place of business in Texas.

1.85. **Nonresponsive Proposal.** A proposal that does not meet the criteria for acceptance contained in the proposal form.
1.86. **Non-Site-Specific Contracts.** Contracts in which a geographic region is specified for the work and for which work orders, with or without plans, further detail the limits and work to be performed.

1.87. **Notification.** Either written or oral instruction to the Contractor concerning the work. Voice mail is oral notification.

1.88. **Pavement.** That part of the roadway having a constructed surface for the use of vehicular traffic.

1.89. **Pavement Structure.** Combination of surface course and base course placed on a subgrade to support the traffic load and distribute it to the roadbed.

   A. **Surface Course.** Pavement structure layers designed to accommodate the traffic load. The top layer resists skidding, traffic abrasion, and the disintegrating effects of climate and is sometimes called the wearing course.

   B. **Base Course.** One or more layers of specified material thickness placed on a subgrade to support a surface course.

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

   D. **Subgrade Treatment.** Modifying or stabilizing material in the subgrade.

1.90. **Payment Bond.** The security executed by the Contractor and the Surety, furnished to the Department to guarantee payment of all legal debts of the Contractor pertaining to the Contract.

1.91. **Performance Bond.** The security executed by the Contractor and the Surety, furnished to the Department to guarantee the completion of the work in accordance with the terms of the Contract.

1.92. **Plans.** The drawings approved by the Engineer including true reproductions of the drawings that show the location, character, dimensions, and details of the work and are a part of the Contract.

1.93. **Power of Attorney for Surety Bonds.** An instrument under corporate seal appointing an attorney-in-fact to act on behalf of a Surety in signing bonds.

1.94. **Prequalification.** The process for determining a Contractor’s eligibility to bid work.

1.95. **Prequalification Statement.** The forms on which required information is furnished concerning the Contractor’s ability to perform and finance the work.

1.96. **Project-Specific Location (PSL).** A material source, plant, waste site, parking area, storage area, field office, staging area, haul road, or other similar location either outside the project limits or within the project limits but not specifically addressed in the PS&E. PSLs defined here are the work areas that exist only for the specific Contract.
1.97. Proposal. The offer of the Bidder submitted on the prescribed form, including addenda issued, giving unit bid prices for performing the work described in the plans and specifications.

1.98. Proposal Form. The document issued by the Department for a proposed Contract that includes:
• the specific locations (except for non-site-specific work) and description of the proposed work;
• an estimate of the various quantities and kinds of work to be performed or materials to be furnished;
• a schedule of items for which unit prices are requested;
• the number of working days within which the work is to be completed (or reference to the requirements); and
• the special provisions and special specifications applicable to the proposed Contract.

1.99. Proposal Guaranty. The security designated in the proposal and furnished by the Bidder as a guarantee that the Bidder will enter into a Contract if awarded the work.

1.100. Quality Assurance (QA). Sampling, testing, inspection, and other activities conducted by the Engineer to determine payment and make acceptance decisions.

1.101. Quality Control (QC). Sampling, testing, and other process control activities conducted by the Contractor to monitor production and placement operations.

1.102. Ramp. A section of highway for the primary purpose of making connections with other highways.

1.103. Recurring Maintenance Work Contracts. Contracts or work for which maintenance is needed at the same location on more than one occasion (e.g., mowing contracts for which mowing cycles are requested on multiple occasions).

1.104. Referee Tests. Tests requested to resolve differences between Contractor and Engineer test results. The referee laboratory is the Construction Division, Materials and Pavements Section.

1.105. Regular Item. A bid item contained in a proposal and not designated as an alternate bid item.

1.106. Rental Rate Blue Book for Construction Equipment. Publication containing equipment rental rates.

1.107. Responsive Bid. A proposal that meets all requirements of the proposal form for acceptance.

1.108. Right of Way. A general term denoting land or property devoted to transportation purposes.
1.109. **Roadbed.** The graded portion of a highway prepared as foundation for the pavement structure and shoulders. On divided highways, the depressed median type and the raised median type highways are considered to have 2 roadbeds. Highways with a flush median are considered to have 1 roadbed.

1.110. **Road Master.** A railroad maintenance official in charge of a division of railway.

1.111. **Roadside.** The areas between the outside edges of the shoulders and the right of way boundaries. Unpaved median areas between inside shoulders of divided highways and areas within interchanges are included.

1.112. **Roadway.** The portion of the highway (including shoulders) used by the traveling public.

1.113. **Routine Maintenance Contract (RMC).** A Contract let through the routine maintenance contracting procedure to preserve and repair roadways, rights of way, and appurtenances.

1.114. **Sandblasting, Dry.** Spraying blasts of pressurized air combined with sand.

1.115. **Sandblasting, Wet.** Spraying blasts of pressurized water combined with sand.

1.116. **Shoulder.** That portion of the roadway contiguous with the traffic lanes for accommodation of stopped vehicles for emergency use or for lateral support of base and surface courses.

1.117. **Shot Blasting.** Spraying blasts of pressurized air combined with metal shot.

1.118. ** Sidewalk.** Portion of the right of way constructed exclusively for pedestrian use.

1.119. ** Slurry Blasting.** Spraying blasts of pressurized air combined with a mixture of water and abrasive media.

1.120. **Special Provisions.** Additions or revisions to these standard specifications or special specifications.

1.121. **Special Specifications.** Supplemental specifications applicable to the Contract not covered by these standard specifications.

1.122. **Specifications.** Directives or requirements issued or made pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the Contract. References to DMSs, ASTM or AASHTO specifications, or Department bulletins and manuals, imply the latest standard or tentative standard in effect on the date of the proposal. The Engineer will consider incorporation of subsequent changes to these documents in accordance with Item 4, “Scope of Work.”
1.123. **Small Business Enterprise (SBE).** A firm (including affiliates) whose annual gross receipts do not exceed the U.S. Small Business Administration’s size standards for 4 consecutive years.

1.124. **State.** The State of Texas.

1.125. **State Holiday.** A holiday authorized by the State Legislature excluding optional state holidays and not listed in Article 1.82, “National Holidays.” Contact the Construction Division for a list.

1.126. **Station.** A unit of measurement consisting of 100 horizontal feet.

1.127. **Subcontract.** The agreement between the Contractor and subcontractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.

1.128. **Subcontractor.** An individual, partnership, limited liability company, corporation, or any combination thereof that the Contractor sublets, or proposes to sublet, any portion of a Contract, excluding a material supplier, truck owner-operator, wholly owned subsidiary, or specialty-type businesses such as security companies and rental companies.

1.129. **Subsidiary.** Materials, labor, or other elements that because of their nature or quantity have not been identified as a separate item and are included within the items on which they necessarily depend.

1.130. **Substructure.** The part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls, and wing walls of abutments are considered as parts of the substructure.

1.131. **Superintendent.** The representative of the Contractor who is available at all times and able to receive instructions from the Engineer or authorized Department representatives and to act for the Contractor.

1.132. **Superstructure.** The part of the structure above the bridge seats or above the springing lines of arches.

1.133. **Supplemental Agreement.** Written agreement entered into between the Contractor and the State and approved by the Surety, covering alterations and changes in the Contract. A supplemental agreement is used by the Department whenever the modifications include assignment of the Contract from 1 entity to another or other cases as desired by the Department.

1.134. **Surety.** The corporate body or bodies authorized to do business in Texas bound with and for the Contractor for the faithful performance of the work covered by the Contract and for the payment for all labor and material supplied in the prosecution of the work.
1.136. **Traffic Lane.** The strip of roadway intended to accommodate the forward movement of a single line of vehicles.

1.137. **Traveled Way.** The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

1.138. **Truck Owner-Operator.** An individual who owns and operates 1 truck for hire.

1.139. **Utility.** Privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, heat, gas, oil, water, waste, or storm water that are not connected with the highway drainage, signal systems, or other products that directly or indirectly serve the public; the utility company.

1.140. **Verification Tests.** Tests used to verify accuracy of QC and QA and mixture design testing.

1.141. **Water-Abrasive Blasting.** Spraying blasts of pressurized water combined with abrasive media.

1.142. **Water Blasting.** Spraying blasts of pressurized water of at least 3,000 psi.

1.143. **Water-Injected Abrasive Blasting.** Abrasive blasting with water injected into the abrasive/air stream at the nozzle.

1.144. **Wholly Owned Subsidiary.** A legal entity owned entirely by the Contractor or subcontractor.

1.145. **Work.** The furnishing of all labor, materials, equipment, and other incidentals necessary for the successful completion of the Contract.

1.146. **Work Order.** Written notice to the Contractor to begin the work. The work order may include the date on which work or time charges are to begin, the number of working days for specified work (for multiple work order Contracts), and plan sheets providing additional details specific to a location or to an item of work for non-site-specific work.

1.147. **Written Notice.** Written notice is considered to have been duly given if delivered in person to the individual or member to whom it is intended or if sent by regular, registered, or certified mail and delivered to the last known business address; sent by facsimile to the last known phone number; or sent by e-mail to the last known address. The date of the letter will serve as the beginning day of notice. Unclaimed mail or failure to provide current mailing address will not be considered a failure to provide written notice.
1.1.2. SCOPE OF WORK

4.1. Contract Intent. The intent of the Contract is to describe the completed work to be performed. Furnish materials, supplies, tools, equipment, labor, and other incidentals necessary for the proper prosecution and completion of the work in accordance with Contract documents.

4.2. Changes in the Work. The Engineer reserves the right to make changes in the work including addition, reduction, or elimination of quantities and alterations needed to complete the Contract. Perform the work as altered. These changes will not invalidate the Contract nor release the Surety.

If the changes in quantities or the alterations do not significantly change the character of the work under the Contract, the altered work will be paid for at the Contract unit price. If the changes in quantities or the alterations significantly change the character of the work, the Contract will be amended by a change order. If no unit prices exist, this will be considered extra work and the Contract will be amended by a change order. Provide cost justification as requested, in an acceptable format. Payment will not be made for anticipated profits on work that is eliminated.

Agree upon the scope of work and the basis of payment for the change order before beginning the work. If there is no agreement, the Engineer may order the work to proceed under Article 9.5, “Force Account,” or by making an interim adjustment to the Contract. In the case of an adjustment, the Engineer will consider modifying the compensation after the work is performed.

A significant change in the character of the work occurs when:
• the character of the work for any Item as altered differs materially in kind or nature from that in the Contract or
• a major item of work varies by more than 25% from the original Contract quantity. (The 25% variance is not applicable to non-sitespecific Contracts.)

When the quantity of work to be done under any major item of the Contract is more than 125% of the original quantity stated in the Contract, then either party to the Contract may request an adjustment to the unit price on the portion of the work that is above 125%.

When the quantity of work to be done under any major item of the Contract is less than 75% of the original quantity stated in the Contract, then either party to the Contract may request an adjustment to the unit price. For routine maintenance Contracts only, if an adjusted unit price cannot be agreed upon, the Engineer may determine the unit price by multiplying the Contract unit price by the factor in Table 1.

<table>
<thead>
<tr>
<th>Quantity-Based Price Adjustment Factors</th>
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</thead>
<tbody>
<tr>
<td>% of Original Quantity</td>
</tr>
<tr>
<td>≥ 50 and &lt; 75</td>
</tr>
<tr>
<td>≥ 25 and &lt; 50</td>
</tr>
<tr>
<td>&lt; 25</td>
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</tbody>
</table>
If the changes require additional working days to complete the Contract, Contract working days will be adjusted in accordance with Item 8, “Prosecution and Progress.”

4.3. Differing Site Conditions. During the progress of the work, differing subsurface or latent physical conditions may be encountered at the site. The two types of differing site conditions are defined as:
• those that differ materially from those indicated in the Contract and
• unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract.

Notify the Engineer in writing when differing site conditions are encountered. The Engineer will notify the Contractor when the Department discovers differing site conditions. Unless directed otherwise, suspend work on the affected items and leave the site undisturbed. The Engineer will investigate the conditions and determine whether differing site conditions exist. If the differing site conditions cause an increase or decrease in the cost or number of working days specified for the performance of the Contract, the Engineer will make adjustments, excluding the loss of anticipated profits, in accordance with the Contract. Additional compensation will be made only if the required written notice has been provided.

4.4. Requests and Claims for Additional Compensation. Notify the Engineer in writing of any intent to request additional compensation once there is knowledge of the basis for the request. An assessment of damages is not required to be part of this notice but is desirable. The intent of the written notice requirement is to provide the Engineer an opportunity to evaluate the request and to keep an accurate account of the actual costs that may arise. Minimize impacts and costs.

If written notice is not given, the Contractor waives the right to additional compensation unless the circumstances could have reasonably prevented the Contractor from knowing the cost impact before performing the work. Notice of the request and the documentation of the costs will not be construed as proof or substantiation of the validity of the request. Submit the request in sufficient detail to enable the Engineer to determine the basis for entitlement, adjustment in the number of working days specified in the Contract, and compensation.

A. Delay Claims. The intent of paying for delay damages is to reimburse the Contractor for actual expenses arising out of a compensable impact. No profit or force account markups, other than labor burden, will be allowed. If the Contractor requests compensation for delay damages and the delay is determined to be compensable, then standby equipment costs and project overhead compensation will be based on the duration of the compensable delay and will be limited as follows:

1. Standby Equipment Costs.
   • Standby costs will not be allowed during periods when the equipment would have otherwise been idle.
   • No more than 8 hr. of standby will be paid during a 24-hr. day, nor more than 40 hr. per week, nor more than 176 hr. per month.
• Standby will be paid at 50% of the rental rates found in the Rental Rate Blue Book for Construction Equipment and calculated by dividing the monthly rate by 176 and multiplying by the regional adjustment factor and the rate adjustment factor. Operating costs will not be allowed.

2. Project Overhead. Project overhead will be determined from actual costs that the Contractor will be required to document. Project overhead is defined as the administrative and supervisory expenses incurred at the work locations.

3. Home Office Overhead. The Department will not compensate the Contractor for home office overhead.

B. Dispute or Claims Procedure. Work with the Engineer to resolve all issues. If an issue cannot be resolved within a time frame agreed to by the Engineer, elevate the issue to appropriate District staff. If the issue cannot be resolved within the time frame established by the District, the Contractor may submit a contract claim to be handled in accordance with the Department’s contract claim procedure maintained by the Construction Division. It is the Contractor’s responsibility to prove or justify all claims and requests in a timely manner.

4.5. Maintenance of Traffic. In accordance with the approved traffic control plan and as specified in the Contract, keep existing roadways open to traffic or construct and maintain detours and temporary structures for safe public travel. Maintain the work in passable condition, including proper drainage, to accommodate traffic. Provide and maintain temporary approaches and crossings of intersecting highways in a safe and passable condition. Construct and maintain necessary access to adjoining property as shown in the plans or as directed. Furnish, install, and maintain traffic control devices in accordance with the Contract. The cost of maintaining traffic will be paid for in accordance with the Contract.

The Engineer will notify the Contractor if, in the opinion of the Engineer, the above requirements are not met. The Department may perform the work necessary for compliance, but this does not change the legal responsibilities set forth in the Contract. The cost to the Department will be deducted from money due or to become due to the Contractor.

4.6. Final Cleanup. Upon completion of the work, remove litter, debris, objectionable material, temporary structures, excess materials, and equipment from the work locations. Clean and restore property damaged by the Contractor’s operations during the prosecution of the work. Leave the work locations in a neat and presentable condition. This work will not be paid for directly but will be considered subsidiary to Items of the Contract.

Remove from the right of way cofferdams, construction buildings, material and fabrication plants, temporary structures, excess materials, and debris resulting from construction. Where work is in a stream, remove debris to the ground line of the bed of the stream. Leave stream channels and rights of way in a neat and presentable condition. Clean structures to the flow line or the elevation of the outfall channel, whichever is higher. Dispose of all excess material in accordance with federal, state, and local regulations.
5.1. Authority of Engineer. The Engineer has the authority to observe, test, inspect, approve, and accept the work. The Engineer decides all questions about the quality and acceptability of materials, work performed, work progress, Contract interpretations, and acceptable Contract fulfillment. The Engineer has the authority to enforce and make effective these decisions.

The Engineer acts as a referee in all questions arising under the terms of the Contract. The Engineer’s decisions will be final and binding.

5.2. Plans and Working Drawings. When required, provide working drawings to supplement the plans with all necessary details not included on the Contract plans. Prepare and furnish working drawings in a timely manner and obtain approval, if required, before the beginning of the associated work. For all working drawing submittal requirements, the Engineer may allow electronic and other alternative submission procedures. Have a licensed professional engineer sign, seal, and date the working drawings as indicated in Table 1.

Prepare working drawings using United States standard measures and in the English language. The routing of submittals for review and approval will be established at the preconstruction conference. The Contractor is responsible for the accuracy, coordination, and conformity of the various components and details of the working drawings. Department approval of the Contractor’s working drawings will not relieve the Contractor of any responsibility under the Contract. The work performed under this Article will not be measured or paid for directly, but will be subsidiary to pertinent Items.
Table 1

<table>
<thead>
<tr>
<th>Working Drawings For</th>
<th>Requires Licensed Professional Engineer’s Signature, Seal, and Date</th>
<th>Requires Departmental Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alternate or optional designs submitted by Contractor</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Supplementary shop and fabrication drawings for structural items</td>
<td>No unless required on the plans</td>
<td>See applicable Item</td>
</tr>
<tr>
<td>3. Contractor-proposed temporary facilities that affect the public safety, not included on the plans</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Form and falsework details</td>
<td>Bridges, retaining walls, and other major structures</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes unless otherwise shown on the plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor structures</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>No unless otherwise shown on the plans</td>
<td></td>
</tr>
<tr>
<td>5. Erection drawings</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6. Contractor-proposed major modifications to traffic control plan</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1. The Engineer may require that the Contractor have a licensed professional engineer certify that the temporary works are constructed according to the sealed drawings.


Furnish materials and perform work in reasonably close conformity with the lines, grades, cross-sections, dimensions, details, gradations, physical and chemical characteristics of materials, and other requirements shown in the Contract (including additional plans for non-site-specific work). Reasonably close conformity limits will be as defined in the respective Items of the Contract or, if not defined, as determined by the Engineer. Obtain approval before deviating from the plans and approved working drawings. Do not perform work beyond the lines and grades shown on the plans or any extra work without the Engineer’s authority. Work performed beyond the lines and grades shown on the plans or any extra work performed without authority is considered unauthorized and excluded from pay consideration. The Department will not pay for material rejected due to improper fabrication, excess quantity, or any other reasons within the Contractor’s control.

A. Acceptance of Defective or Unauthorized Work. When work fails to meet Contract requirements, but is adequate to serve the design purpose, the Engineer will decide the extent to which the work will be accepted and remain in place. The Engineer will document the basis of acceptance by a letter and may adjust the Contract price.
B. Correction of Defective or Unauthorized Work. When work fails to meet Contract requirements and is inadequate to serve the design purpose it will be considered defective. Correct, or remove and replace, the work at the Contractor’s expense, as directed. The Department has the authority to correct or to remove and replace defective or unauthorized work. The cost may be deducted from any money due or to become due to the Contractor.

5.4. Coordination of Plans, Specifications, and Special Provisions. The specifications, accompanying plans (including additional plans for non-sitespecific work), special provisions, change orders, and supplemental agreements are intended to work together and be interpreted as a whole.

Numerical dimensions govern over scaled dimensions. Special provisions govern over plans (including general notes), which govern over standard specifications and special specifications. Job-specific plan sheets govern over standard plan sheets.

However, in the case of conflict between plans (including general notes) and specifications regarding responsibilities for hazardous materials and traffic control in Items 1 through 9 and Item 502, “Barricades, Signs, and Traffic Handling,” special provisions govern over standard specifications and special specifications, which govern over the plans.

Notify the Engineer promptly of any omissions, errors, or discrepancies discovered so that necessary corrections and interpretations can be made. Failure to promptly notify the Engineer will constitute a waiver of all claims for misunderstandings or ambiguities that result from the errors, omissions, or discrepancies discovered.

5.5. Cooperation of Contractor. Cooperate with the Engineer, other Contractors, and utility and railroad companies. All work associated with fulfilling this requirement is subsidiary to the various Items of the Contract and no direct compensation will be made. Provide all information necessary to administer the Contract. Maintain at least one copy of the Contract at the work locations at all times.

Designate in writing a competent, English-speaking Superintendent employed by the Contractor. The Superintendent must be experienced with the work being performed and capable of reading and understanding the Contract. Ensure the Superintendent is available at all times and able to receive instructions from the Engineer or authorized Department representatives and to act for the Contractor. The Engineer may suspend work if a Superintendent is not available or does not meet the above criteria; however, working day charges will not be suspended.

A. Cooperating with the Engineer. Cooperate with the Engineer in every way possible. Respond promptly to instructions from the Engineer.

B. Cooperating with Utilities. Use established safety practices when working near utilities. Consult with the appropriate utilities before beginning work. Notify the Engineer immediately of utility conflicts. The Engineer will decide whether to adjust utilities or adjust the work to eliminate or lessen the conflict. Unless otherwise shown on the plans, the
Engineer will make necessary arrangements with the utility owner when utility adjustments are required. Use work procedures that protect utilities or appurtenances that remain in place during construction. Cooperate with utilities to remove and rearrange utilities to avoid service interruption or duplicate work by the utilities. Allow utilities access to the right of way. Immediately notify the appropriate utility of service interruptions resulting from damage due to construction activities. Cooperate with utilities until service is restored. Maintain access to fire hydrants when necessary.

C. Cooperation Between Contractors. Cooperate and coordinate with other Contractors working within the limits or adjacent to the limits.

D. Cooperation with Railroads. Plan and prosecute portions of the work involving a railway to avoid interference with or hindrance to the railroad company.

5.6. Construction Surveying. Use Method A unless otherwise specified in the Contract. Upon request, the Engineer will allow the Contractor to copy available earthwork cross-sections, computer printouts or data files, and other information necessary to establish and control work. Maintain the integrity of control points. Preserve all control points, stakes, marks, and right of way markers. Assume cost and responsibility of replacing disturbed control points, stakes, marks, and right of way markers. If the Department repairs disturbed control points, stakes, marks, or right of way markers, the cost of repair may be deducted from money due or to become due to the Contractor. Replace right of way markers under the direction of a RPLS. This work will be subsidiary to pertinent items. The Engineer reserves the right to make measurements and surveys to determine the accuracy of the work and determine pay quantities. The Engineer’s measurements and surveys do not relieve the Contractor’s responsibility for accuracy of work. Allow the Engineer adequate time to verify the surveying.

A. Method A. The Engineer will set control points for establishing lines, slopes, grades, and centerlines and for providing both vertical and horizontal control at maximum intervals of 1,500 ft. Use these control points as reference to perform the work. Furnish materials, equipment, and qualified workforce necessary for the construction survey work. Place construction points, stakes, and marks at intervals sufficient to control work to established tolerances. Place construction stakes at intervals of no more than 100 ft., or as directed. Place stakes and marks so as not to interfere with normal maintenance operations.

B. Method B. The Engineer will set adequate control points, stakes, and marks to establish lines, slopes, grades, and centerlines. Furnish additional work, stakes, materials, and templates necessary for marking and maintaining points and lines.

C. Method C. Set adequate control points, stakes, and marks to establish lines, slopes, grades, and centerlines.

5.7. Inspection. Inspectors are authorized representatives of the Engineer. Inspectors are authorized to examine all work performed and materials furnished, including preparation,
fabrication, and material manufacture. Inspectors inform the Contractor of failures to meet Contract requirements. Inspectors may reject work or materials and may suspend work until any issues can be referred to and decided by the Engineer. Inspectors cannot alter, add, or waive Contract provisions, issue instructions contrary to the Contract, act as foremen for the Contractor, or interfere with the management of the work. Inspection or lack of inspection will not relieve the Contractor from obligation to provide materials or perform the work in accordance with the Contract.

Provide safe access to all parts of the work and provide information and assistance to the Engineer to allow a complete and detailed inspection. Give the Engineer sufficient notice to inspect the work. Work performed without suitable inspection, as determined by the Engineer, may be ordered removed and replaced at Contractor’s expense. Remove or uncover portions of finished work as directed. Once inspected, restore work to Contract requirements. If the uncovered work is acceptable, the costs to uncover, remove, and replace or make good the parts removed will be paid for in accordance with Article 4.2, “Changes in the Work.” If the work is unacceptable, assume all costs associated with repair or replacement, including the costs to uncover, remove, and replace or make good the parts removed.

When a government entity, utility, railroad company, or other entity accepts or pays a portion of the Contract, that organization’s representatives may inspect the work but cannot direct the Contractor. The right of inspection does not make that entity a party to the Contract and does not interfere with the rights of the parties to the Contract.

5.8. Final Acceptance.

A. Routine Maintenance Contracts. The Engineer will perform final acceptance and notify the Contractor of acceptance. The Engineer may use final acceptance procedures shown for construction Contracts.

B. Construction Contracts. Final acceptance is made when all work is complete and the Engineer, in writing, accepts all work for the work locations in the Contract. Final acceptance relieves the Contractor from further Contract responsibilities.

1. Work Completed. Work completed must include work for vegetative establishment and maintenance, test, and performance periods and work to meet the requirements of Article 4.6, “Final Cleanup.”

2. Final Inspection. After all work is complete, the Engineer in charge of the work will request a final inspection by the Engineer authorized to accept the work.

The final inspection will be made as soon as possible, and not later than 10 calendar days after the request. No working day charges will be made between the date of request and final inspection.

After the final inspection, if the work is satisfactory, the Engineer will notify the Contractor in writing of the final acceptance of the work. If the final inspection finds any work to be unsatisfactory, the Engineer will identify in writing all deficiencies in the work requiring correction. Correct the deficiencies identified. Working day charges will resume if these deficiencies are not corrected within 7 calendar days, unless otherwise authorized by the Engineer. Upon correction, the Engineer will make an inspection to verify that all deficiencies were corrected satisfactorily. The Engineer will provide written notice of the final acceptance.
3. Final Measurement. Final measurements and pay quantity adjustments may be made after final acceptance.


C. Multiple Work Order Contracts. For contracts with multiple work orders (recurring maintenance work or non-site-specific Contracts), final acceptance may be made upon completion of the work for each work order, in accordance with Sections 5.8.A, “Routine Maintenance Contracts,” and 5.8.B, “Construction Contracts.”

1.1.3. CONTROL OF MATERIALS

6.1. Source Control. Use only materials that meet Contract requirements. Unless otherwise specified or approved, use new materials for the work. Secure the Engineer’s approval of the proposed source of materials to be used before their delivery. Materials can be approved at a supply source or staging area but may be reinspected in accordance with Article 6.4, “Sampling, Testing, and Inspection.”

A. Buy America. Comply with the latest provisions of Buy America as listed at 23 CFR 635.410. Use steel or iron materials manufactured in the United States except when:
- the cost of materials, including delivery, does not exceed 0.1% of the total Contract cost or $2,500, whichever is greater;
- the Contract contains an alternate Item for a foreign source steel or iron product and the Contract is awarded based on the alternate Item; or
- the materials are temporarily installed.

Provide a notarized original of the FORM D-9-USA-1 with the proper attachments for verification of compliance.

Manufacturing is any process that modifies the chemical content, physical shape or size, or final finish of a product. Manufacturing begins with initial melting and mixing and continues through fabrication (cutting, drilling, welding, bending, etc.) and coating (paint, galvanizing, epoxy, etc.).

B. Buy Texas. For construction or routine maintenance Contracts without federal funds, buy materials produced in Texas when the materials are available at a comparable price and in a comparable period of time.

Provide documentation of purchases or a description of good-faith efforts on request.

6.2. Material Quality. Correct or remove materials that fail to meet Contract requirements or that do not produce satisfactory results. Reimburse the Department for cost incurred if additional sampling and testing is required by a change of source.

Materials not meeting Contract requirements will be rejected, unless the Engineer approves corrective actions. Upon rejection, immediately remove and replace rejected materials.
If the Contractor does not comply with this Article, the Department may remove and replace defective material. The cost of testing, removal, and replacement will be deducted from the estimate.

6.3. Manufacturer Warranties. Transfer to the Department warranties and guarantees required by the Contract or received as part of normal trade practice.

6.4. Sampling, Testing, and Inspection. Incorporate into the work only material that has been inspected, tested, and accepted by the Department. Remove, at the Contractor’s expense, materials from the work locations that are used without prior testing and approval or written permission of the Engineer.

The material requirements and standard test methods in effect at the time the proposed Contract is advertised govern. Unless otherwise noted, the Department will perform testing at its expense. In addition to facilities and equipment required by the Contract, furnish facilities and calibrated equipment required for tests to control the manufacture of construction Items. If requested, provide a complete written statement of the origin, composition, and manufacture of materials.

All materials used are subject to inspection or testing at any time during preparation or use. Material which has been tested and approved at a supply source or staging area may be reinspected or tested before or during incorporation into the work, and rejected if it does not meet Contract requirements. Copies of test results are available upon request. Do not use material that, after approval, becomes unfit for use.

Unless otherwise noted in the Contract, all testing must be performed within the United States and witnessed by the Engineer. If materials or processes require testing outside the contiguous 48 United States, reimburse the Department for inspection expenses.

6.5. Plant Inspection and Testing. The Engineer may but is not obligated to inspect materials at the acquisition or manufacturing source. Material samples will be obtained and tested for compliance with quality requirements. Materials produced under Department inspection are for Department use only unless released in writing by the Engineer.

If inspection is at the plant, meet the following conditions unless otherwise specified:
• Cooperate fully and assist the Engineer during the inspection.
• Ensure the Engineer has full access to all parts of the plant used to manufacture or produce materials.
• In accordance with pertinent Items and the Contract, provide a facility at the plant for use by the Engineer as an office or laboratory.
• Provide and maintain adequate safety measures and restroom facilities.
• Furnish and calibrate scales, measuring devices, and other necessary equipment.

The Engineer may provide inspection for periods other than daylight hours if:
• continuous production of materials for Department use is necessary due to the production volume being handled at the plant and
• the lighting is adequate to allow satisfactory inspection.
6.6. Storage of Materials. Store and handle materials to preserve their quality and fitness for the work. Store materials so that they can be easily inspected and retested. Place materials under cover, on wooden platforms, or on other hard, clean surfaces as necessary or when directed.

Obtain approval to store materials on the right of way. Storage space off the right of way is at the Contractor’s expense.

6.7. Department-furnished Material. The Department will supply materials as shown on the plans. The cost of handling and placing materials supplied by the Department will not be paid for directly but is subsidiary to the Item in which they are used. Assume responsibility for materials upon receipt.

6.8. Use of Materials Found on the Right of Way. Material found in the excavation areas and meeting the Department’s specifications may be used in the work. This material will be paid for at the Contract bid price for excavation and under the Item for which the material is used.

Do not excavate or remove any material from within the right of way that is not within the limits of the excavation without written permission. If excavation is allowed within a right of way project-specific location (PSL), replace the removed material with suitable material at no cost to the Department as directed.

6.9. Recycled Materials. Hazardous wastes, as defined in 30 TAC 335, proposed for recycling will not be allowed in Department Contracts. Nonhazardous recyclable materials (NRM)s may be used unless disallowed or restricted by the Specification for the Item. Determine if NRMs are regulated under 30 TAC 312, 330, 332, 334, or 335, and comply with all general prohibitions and requirements. Furnish a written certification, sealed by a licensed professional engineer, that the NRMs are used in accordance with DMS-11000, “Evaluating and Using Nonhazardous Recyclable Materials Guidelines.”

6.10. Hazardous Materials. Use materials that are free of hazardous materials as defined in Item 1, “Definition of Terms.”

Notify the Engineer immediately when a visual observation or odor indicates that materials in required material sources or on sites owned or controlled by the Department may contain hazardous materials. The Department is responsible for testing and removing or disposing of hazardous materials not introduced by the Contractor on sites owned or controlled by the Department. The Contractor is not required to test, remediate, or remove hazardous materials that the Contractor did not introduce onto the work locations. The Engineer may suspend the work wholly or in part during the testing, removal, or disposition of hazardous materials on sites owned or controlled by the Department.

When a visual observation or odor indicates that materials delivered to the work locations by the Contractor may contain hazardous materials, have an approved commercial laboratory test the materials for contamination. Remove, remediate, and dispose of any of these materials found to be contaminated. Testing, removal, and disposition of hazardous materials introduced onto the work locations by the Contractor will be at the Contractor’s
expense. Working day charges will not be suspended and extensions of working days will not be granted for activities related to handling hazardous material delivered by the Contractor.

6.11. Surplus Materials. Take ownership of surplus materials unless otherwise shown on the plans or directed. Remove and dispose of materials in accordance with federal, state, and local regulations. If requested, provide an appropriate level of documentation to verify proper disposal. When materials are disposed of on private property, provide written authorization from the property owner for the use of the property for this purpose, upon request.
1.2. EARTH WORK AND LANDSCAPE (ITEMS 100)

1.2.1. PREPARING RIGHT OF WAY

100.1. Description. Prepare the right of way and designated easements for construction operations by removing and disposing of all obstructions when removal of such obstructions is not specifically shown on the plans to be paid by other Items.

100.2. Construction. Protect designated features on the right of way and prune trees and shrubs as directed. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation. When shown on the plans, treat cuts on trees with an approved tree wound dressing within 20 min. of making a pruning cut or otherwise causing damage to the tree. Follow all local and state regulations when burning. If burning of brush is approved, pile and burn at approved locations. When working in state or national forests or parks, coordinate work with state and federal authorities. Testing, removal, and disposal of hazardous materials will be in accordance with Article 6.10, “Hazardous Materials.”

Clear areas shown on the plans of all obstructions, except those landscape features that are to be preserved. Such obstructions include but are not limited to remains of houses and other structures, foundations, floor slabs, concrete, brick, lumber, plaster, septic tank drain fields, basements, abandoned utility pipes or conduits, equipment, fences, retaining walls, and other items as specified on the plans. Remove vegetation and other landscape features not designated for preservation, curb and gutter, driveways, paved parking areas, miscellaneous stone, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, and debris, whether above or below ground. Removal of live utility facilities is not included in this Item. Remove culverts, storm sewers, manholes, and inlets in proper sequence to maintain traffic and drainage.

In areas receiving embankment, remove obstructions not designated for preservation to 2 ft. below natural ground. In areas to be excavated, remove obstructions to 2 ft. below the excavation level. In all other areas, remove obstructions to 1 ft. below natural ground. When allowed by the plans or directed, cut trees and stumps off to ground level. Plug the remaining ends of abandoned underground structures over 3 in. in diameter with concrete to form a tight closure. Backfill, compact, and restore areas where obstructions have been removed, unless otherwise directed. Use approved material for backfilling. Dispose of wells in accordance with Item 103, “Disposal of Wells.”

Accept ownership, unless otherwise directed, and dispose of removed materials and debris at locations off the right of way in accordance with local, state, and federal requirements.

100.3. Measurement. This Item will be measured by the acre; by the 100-foot station, regardless of the width of the right of way; or by each tree removed.
1.2.2. REMOVING CONCRETE

104.1. Description. Break, remove, and salvage or dispose of existing hydraulic cement concrete.

104.2. Construction. Remove existing hydraulic cement concrete from locations shown on the plans. Avoid damaging concrete that will remain in place. Saw-cut and remove the existing concrete to neat lines. Replace any concrete damaged by the Contractor at no expense to the Department. Unless otherwise shown on the plans, accept ownership and properly dispose of broken concrete in accordance with federal, state, and local regulations.

104.3. Measurement. Removing concrete pavement, floors, porches, patios, riprap, medians, foundations, sidewalks, driveways, and other appurtenances will be measured by the square yard (regardless of thickness) or by the cubic yard of calculated volume, in its original position.

Removing curb, curb and gutter, and concrete traffic barrier will be measured by the foot in its original position. The removal of monolithic concrete curb or dowelled concrete curb will be included in the concrete pavement measurement.

Removing retaining walls will be measured by the square yard along the front face from the top of the wall to the top of the footing.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

1.2.3. EXCAVATION

110.1. Description. Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.

110.2. Construction. Accept ownership of unsuitable or excess material and dispose of material in accordance with local, state, and federal regulations at locations outside the right of way.

Maintain drainage in the excavated area to avoid damage to the roadway section. Correct any damage to the subgrade caused by weather, at no additional cost to the Department.

Shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides as directed.

A. Rock Cuts. Excavate to finish subgrade. Manipulate and compact subgrade in accordance with Article 132.3.D, “Compaction Methods,” unless excavation is to clean homogenous rock at finish subgrade elevation. If excavation extends below finish subgrade, use approved
embankment material compacted in accordance with Article 132.3.D to replace undercut material at no additional cost.

B. Earth Cuts. Excavate to finish subgrade. In areas where base or pavement structure will be placed on subgrade, scarify subgrade to a uniform depth at least 6 in. below finish subgrade elevation. Manipulate and compact subgrade in accordance with Article 132.3.D, “Compaction Methods.” If unsuitable material is encountered below subgrade elevations, take corrective measures as directed. Drying required deeper than 6 in. below subgrade elevation will be paid for in accordance with Article 9.4, “Payment for Extra Work.” Excavation and replacement of unsuitable material below subgrade elevations will be performed and paid for in accordance with the applicable bid items. However, if Item 132, “Embarkment,” is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.4.

C. Subgrade Tolerances. For turnkey construction, excavate to within 1/2 in. in cross-section and 1/2 in. in 16 ft. measured longitudinally. For staged construction, excavate to within 0.1 ft. in cross-section and 0.1 ft. in 16 ft. measured longitudinally.

110.3. Measurement. This Item will be measured by the cubic yard in its original position as computed by the method of average end areas.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

Limits of measurement for excavation in retaining wall areas will be as shown on the plans.

Shrinkage or swelling factors will not be considered in determining the calculated quantities.

1.2.4. EMBANKMENT

132.1. Description. Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.

132.2. Materials. Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide 1 or more of the following types as shown on the plans:

• Type A. Granular material that is free from vegetation or other objectionable material and meets the requirements of Table 1.
Table 1
Testing Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Specification Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid limit</td>
<td>Tex-104-E</td>
<td>≤ 45</td>
</tr>
<tr>
<td>Plasticity index (PI)</td>
<td>Tex-106-E</td>
<td>≤ 15</td>
</tr>
<tr>
<td>Bar linear shrinkage</td>
<td>Tex-107-E</td>
<td>≥ 2</td>
</tr>
</tbody>
</table>

The Linear Shrinkage test only needs to be performed as indicated in Tex-104-E.

- **Type B.** Materials such as rock, loam, clay, or other approved materials.
- **Type C.** Material meeting the specification requirements shown on the plans.
- **Type D.** Material from required excavation areas shown on the plans.

Retaining wall backfill material must meet the requirements of the pertinent retaining wall Items.

**132.3. Construction.** Meet the requirements of Item 7, “Legal Relations and Responsibilities to the Public,” when off right of way sources are used. To allow for required testing, notify the Engineer before opening a material source. Complete preparation of the right of way, in accordance with Item 100, “Preparing Right of Way,” for areas to receive embankment.

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling in accordance with Item 204, “Sprinkling,” and by rolling using equipment complying with Item 210, “Rolling,” when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6 in., unless otherwise shown on the plans. Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed the layer depth specified in Section 132.3.D, “Compaction Methods.”

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross sections, unless otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

**A. Earth Embankments.** Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Obtain approval to incorporate rock and broken concrete produced by the construction project in the lower layers of the embankment. When the size of approved rock or broken concrete exceeds the layer thickness requirements in Section 132.3.D, “Compaction Methods,”
place the rock and concrete outside the limits of the completed roadbed. Cut and remove all exposed reinforcing steel from the broken concrete. Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or mix abutting layers of dissimilar material for at least 100 ft. to ensure there are no abrupt changes in the material. Break down clods or lumps of material and mix embankment until a uniform material is attained. Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction. When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 132.3.D.1, “Ordinary Compaction.” When density control is specified, compact the layer to the required density in accordance with Section 132.3.D.2, “Density Control.”

B. Rock Embankments. Rock embankment is mainly composed of rock. Construct rock embankments in successive layers for the full width of the roadway cross-section with a depth of 18 in. or less. Increase the layer depth for large rock sizes as approved. Do not exceed a depth of 2-1/2 ft. in any case. Fill voids created by the large stone matrix with smaller stones during the placement and filling operations.

Ensure the depth of the embankment layer is greater than the maximum dimension of any rock. Do not place rock greater than 2 ft. in its maximum dimension, unless otherwise approved. Construct the final layer with graded material so that the density and uniformity is in accordance with Section 132.3.D, “Compaction Methods.” Break up exposed oversized material as approved.

When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 132.3.D.1, “Ordinary Compaction.” When density control is specified, compact each layer to the required density in accordance with Section 132.3.D.2, “Density Control.” When directed, proof-roll each rock layer where density testing is not possible, in accordance with Item 216, “Proof Rolling,” to ensure proper compaction.

C. Embankments Adjacent to Culverts and Bridges. Compact embankments adjacent to culverts and bridges in accordance with Item 400, “Excavation and Backfill for Structures.”

D. Compaction Methods. Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. On super elevated curves, begin rolling at the lower side and progress toward the high side. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with one of the following methods as shown on the plans:

1. Ordinary Compaction. Use approved rolling equipment complying with Item 210, “Rolling,” to compact each layer. The plans or the Engineer may require specific equipment. Do not allow the loose depth of any layer to exceed 8 in., unless otherwise approved. Before and during rolling operations, bring each layer to the moisture content directed. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and rework the subgrade at no additional expense to the Department.

2. Density Control. Compact each layer to the required density using equipment complying with Item 210, “Rolling.” Determine the maximum lift thickness based on the ability of the
compacting operation and equipment to meet the required density. Do not exceed layer thickness of 16 in. loose or 12 in. compacted material, unless otherwise approved. Maintain a level layer to ensure uniform compaction. The Engineer will use Tex-114-E to determine the maximum dry density (Da) and optimum moisture content (Wopt). Meet the requirements for field density and moisture content in Table 2, unless otherwise shown on the plans.

<table>
<thead>
<tr>
<th>Description</th>
<th>Density&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Moisture Content&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI ≤ 15</td>
<td>≥ 98% Da</td>
<td></td>
</tr>
<tr>
<td>15 &lt; PI ≤ 35</td>
<td>≥ 98% Da and ≤ 102% Da</td>
<td>≥ Wopt.</td>
</tr>
<tr>
<td>PI &gt; 35</td>
<td>≥ 95% Da and ≤ 100% Da</td>
<td>≥ Wopt.</td>
</tr>
</tbody>
</table>

Each layer is subject to testing by the Engineer for density and moisture content. During compaction, the moisture content of the soil should not exceed the value shown on the moisture-density curve, above optimum, required to achieve
- 98% dry density for soils with a PI greater than 15 but less than or equal to 35 or
- 95% dry density for soils with PI greater than 35.

When required, remove small areas of the layer to allow for density tests. Replace the removed material and recompact at no additional expense to the Department. Proof-roll in accordance with Item 216, “Proof Rolling,” when shown on the plans or as directed. Correct soft spots as directed.

**E. Maintenance of Moisture and Reworking.** Maintain the density and moisture content once all requirements in Table 2 are met. For soils with a PI greater than 15, maintain the moisture content no lower than 4 percentage points below optimum. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.

**F. Acceptance Criteria.**

1. **Grade Tolerances.**
   a. **Staged Construction.** Grade to within 0.1 ft. in the crosssection and 0.1 ft. in 16 ft. measured longitudinally.
   b. **Turnkey Construction.** Grade to within 1/2 in. in the crosssection and 1/2 in. in 16 ft. measured longitudinally.
2. Gradation Tolerances. When gradation requirements are shown on the plans, material is acceptable when not more than 1 of the 5 most recent gradation tests is outside the specified limits on any individual sieve by more than 5 percentage points.

3. Density Tolerances. Compaction work is acceptable when not more than 1 of the 5 most recent density tests is outside the specified density limits, and no test is outside the limits by more than 3 lb. per cubic foot.

4. Plasticity Tolerances. Material is acceptable when not more than 1 of the 5 most recent PI tests is outside the specified limit by no more than 2 points.

132.4. Measurement. Embankment will be measured by the cubic yard. Measurement will be further defined for payment as follows:

A. Final. The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. In areas of salvaged topsoil, payment for embankment will be made in accordance with Item 160, “Topsoil.” Shrinkage or swell factors will not be considered in determining the calculated quantities.

B. Original. The cubic yard will be measured in its original and natural position using the average end area method.

C. Vehicle. The cubic yard will be measured in vehicles at the point of delivery.

When measured by the cubic yard in its final position, this is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

Shrinkage or swell factors are the Contractor’s responsibility. When shown on the plans, factors are for informational purposes only.

Measurement of retaining wall backfill in embankment areas is paid for as embankment, unless otherwise shown on plans. Limits of measurement for embankment in retaining wall areas are shown on the plans.

1.2.5. BACKFILLING PAVEMENT EDGES

134.1. Description. Backfill pavement edges in conformance with the typical sections shown on the plans.

134.2. Materials.

A. Backfill Material. Use backfill material capable of sustaining vegetation unless otherwise specified on the plans. Furnish backfill material of one of the following types:
1. **Type A.** Backfill secured from a source outside the right of way and according to the requirements as shown on the plans.

2. **Type B.** Backfill secured from within the existing right of way as shown on the plans or as directed.

3. **Type C.** Mulch sodding backfill secured from an approved source in accordance with Article 162.2.B, “Mulch Sod.”

**B. Emulsified Asphalt.** Furnish the type specified on the plans and meeting the requirements of Item 300, “Asphalts, Oils, and Emulsions.”

**C. Fertilizer.** Furnish fertilizer in accordance with Article 166.2, “Materials,” if specified on the plans.

**D. Water.** Furnish water required for proper compaction, promotion of plant growth, or emulsion dilution in accordance with Article 168.2, “Materials.”

**134.3. Construction.** Haul the backfill material to the required location before placing the finish surface course unless directed otherwise. After placing the finish surface course, spread, compact, and shape the backfill material in accordance with the typical sections.

**A. Types A and B Backfill.** After placing the finish surface course, bring the backfill material to the approved moisture content. Shape to the lines and grades shown on the plans, and compact as directed. After compacting the backfill, blade the roadway side-slopes to a smooth surface.

**B. Type C Backfill.** Place mulch sod in a uniform windrow, and keep moist as directed. After placing the finish surface course, cultivate the area to receive mulch sod to a depth of 4 in. Blade and shape the mulch sod across the area in varying depths as shown on the typical sections to produce a smooth and uniform slope. Roll with a light roller or other suitable equipment. After applying fertilizer, moisten to the maximum depth of the backfill as directed.

**C. Fertilizer.** When fertilizer is specified on the plans, after final finishing of the backfill material, distribute the fertilizer uniformly in accordance with Article 166.3, “Construction.” After applying fertilizer, moisten to a depth of 4in. or to the maximum depth of the backfill, whichever is less.

**D. Emulsified Asphalt.** When specified on the plans, after final finishing of the backfill material, apply the emulsified asphalt mixture in accordance with Article 314.4, “Construction,” at the specified amount and rate of application as shown on the plans.

**134.4. Measurement.** This Item will be measured by the 100-ft. station along the baseline of each roadbed.
1.2.6. **BULLDOZER WORK**

156.1. **Description.** Excavate, remove, utilize, or dispose of materials with a bulldozer. Construct, shape, and finish earthwork in conformity with the required lines, grades, and typical cross sections as shown on the plans, or as directed.

156.2. **Equipment.** Use a tractor, crawler or rubber tired type, with a blade attachment. Use a scarifier or ripper with the required tractor when necessary. The blade attachment must be at least 8 ft. long. Use equipment of the type specified on the plans, meeting the following requirements:

   **A. Type A.** Manufacturer’s rated net flywheel power of less than 150 horsepower based on SAE standard J1349.

   **B. Type B.** Manufacturer’s rated net flywheel power of 150 or greater horsepower based on SAE standard J1349.

156.3. **Construction.** Perform bulldozer work on the areas as specified on the plans, utilizing equipment as specified above. Where plans designate “Bulldozer Work” and “Blading,” or “Road Grader Work,” within the same limits, rough in with bulldozer work. Finish in accordance with specifications for “Blading” or “Road Grader Work.” Compact embankment to ordinary compaction in accordance with Item 132, “Embankment,” unless otherwise shown on the plans.

156.4. **Measurement.** This Item will be measured by the actual number of hours of use of the specified type of equipment operated.
1.3. SURFACE COURSES AND PAVEMENT (ITEMS 300)

1.3.1. ASPHALTS, OILS, AND EMULSIONS

300.1. Description. Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as specified on the plans.

300.2. Materials. Provide asphalt materials that meet the stated requirements when tested in accordance with the referenced Department, AASHTO, and ASTM test methods. Refer to the Material Inspection Guide (maintained by the Construction Division), Section 11. “Asphalt Inspection, Quality Control and Quality Assurance,” for sampling and testing requirements. Acronyms used in this Item are defined in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tex</td>
<td>Test Procedure Designations</td>
</tr>
<tr>
<td>T or R</td>
<td>Department</td>
</tr>
<tr>
<td>D</td>
<td>AASHTO</td>
</tr>
<tr>
<td>P</td>
<td>Polymer Modifier Designations</td>
</tr>
<tr>
<td>P</td>
<td>polymer-modified</td>
</tr>
<tr>
<td>SBR or L</td>
<td>styrene-butadiene rubber (latex)</td>
</tr>
<tr>
<td>SBS</td>
<td>styrene-butadiene-styrene block co-polymer</td>
</tr>
<tr>
<td>TR</td>
<td>tire rubber (from ambient temperature grinding of truck and passenger tires)</td>
</tr>
<tr>
<td>AC</td>
<td>asphalt cement</td>
</tr>
<tr>
<td>AE</td>
<td>asphalt emulsion</td>
</tr>
<tr>
<td>AE-P</td>
<td>asphalt emulsion prime</td>
</tr>
<tr>
<td>A-R</td>
<td>asphalt-rubber</td>
</tr>
<tr>
<td>C</td>
<td>cationic</td>
</tr>
<tr>
<td>EAP&amp;T</td>
<td>emulsified asphalt prime and tack</td>
</tr>
<tr>
<td>H-suffix</td>
<td>harder residue (lower penetration)</td>
</tr>
<tr>
<td>HF</td>
<td>high float</td>
</tr>
<tr>
<td>MC</td>
<td>medium-curing</td>
</tr>
<tr>
<td>MS</td>
<td>medium-setting</td>
</tr>
<tr>
<td>PCE</td>
<td>prime, cure, and erosion control</td>
</tr>
<tr>
<td>PG</td>
<td>performance grade</td>
</tr>
<tr>
<td>RC</td>
<td>rapid-curing</td>
</tr>
<tr>
<td>RS</td>
<td>rapid-setting</td>
</tr>
<tr>
<td>S-suffix</td>
<td>stockpile usage</td>
</tr>
<tr>
<td>SCM</td>
<td>special cutback material</td>
</tr>
<tr>
<td>SS</td>
<td>slow-setting</td>
</tr>
</tbody>
</table>
A. Asphalt Cement. Asphalt cement must be homogeneous, water-free, and non-foaming when heated to 347°F, and must meet Table 2 requirements.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>AC-0.6 Min/Max</th>
<th>AC-1.5 Min/Max</th>
<th>AC-3 Min/Max</th>
<th>AC-5 Min/Max</th>
<th>AC-10 Min/Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, 140°F, poise</td>
<td>T 202</td>
<td>40 - 80</td>
<td>100 - 200</td>
<td>250 - 350</td>
<td>400 - 600</td>
<td>800 - 1,200</td>
</tr>
<tr>
<td>Viscosity, 275°F, poise</td>
<td></td>
<td>0.4 - 0.7</td>
<td>1.1 - 1.4</td>
<td>1.9 - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, 77°F, 100g, 5 sec</td>
<td>T 49</td>
<td>350 - 250</td>
<td>210 - 135</td>
<td>85 - -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash point, C.O.C., °F</td>
<td>T 48</td>
<td>425 - 425</td>
<td>425 - 425</td>
<td>450 - 450</td>
<td>85 - -</td>
<td></td>
</tr>
<tr>
<td>Solubility in trichloroethylene, %</td>
<td>T 44</td>
<td>99.0 - 99.0</td>
<td>99.0 - 99.0</td>
<td>99.0 - 99.0</td>
<td>99.0 - -</td>
<td></td>
</tr>
</tbody>
</table>

1. If AC-0.6 or AC-1.5 ductility at 77°F is less than 100 cm, material is acceptable if ductility at 60°F is more than 100 cm.

B. Polymer-Modified Asphalt Cement. Polymer-modified asphalt cement must be smooth and homogeneous, and comply with the requirements of Table 3. If requested, supply samples of the base asphalt cement and polymer additives.
### Table 3: Polymer-Modified Asphalt Pavement

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Polymer content, % (solids basis)</th>
<th>Dynamic shear, G* sin δ, 64°F, 10.0 rad/s, kPa</th>
<th>Viscosity, 140°F, poise</th>
<th>Density, 77°F, lb/ft³</th>
<th>Permeability, 7.5 cm/min, 30.2°F, cm/hr</th>
<th>Elongation at break, %</th>
<th>Creep stiffness, S, -18°C, MPa</th>
<th>M-value, -18°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-5</td>
<td>2.0</td>
<td>700</td>
<td>1.00</td>
<td>100.0</td>
<td>150</td>
<td>75</td>
<td>425</td>
<td>0.60</td>
</tr>
<tr>
<td>AC-10</td>
<td>3.0</td>
<td>800</td>
<td>1.50</td>
<td>150.0</td>
<td>200</td>
<td>80</td>
<td>425</td>
<td>1.00</td>
</tr>
<tr>
<td>AC-20-5T</td>
<td>5.0</td>
<td>1,200</td>
<td>2.00</td>
<td>200.0</td>
<td>250</td>
<td>115</td>
<td>425</td>
<td>0.60</td>
</tr>
<tr>
<td>AC-20-5R</td>
<td>10.0</td>
<td>2,000</td>
<td>10.0</td>
<td>300.0</td>
<td>300</td>
<td>100</td>
<td>425</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Test Procedure:**
- Tex553-C: T 5.15
- Tex552-C: T 5.1 course
- Tex559-C: T 5.3 course
- Tex540-C: T 1.79 course
- Test on residue from Thin-Film Oven Test: T 1.79 course
- Test on residue from KF-20 aging and pressure aging: T 1.79 course
C. Cutback Asphalt. Cutback asphalt must meet the requirements of Tables 4, 5, and 6 for the specified type and grade. If requested, supply samples of the base asphalt cement and polymer additives.

### Table 4

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Type-Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RC-250 RC-800 RC-3000</td>
</tr>
<tr>
<td>Kinematic viscosity, 140°F, cSt</td>
<td>T 201</td>
<td>Min Max Min Max Min Max</td>
</tr>
<tr>
<td>Water, %</td>
<td>T 55</td>
<td>250 400 800 1,600 3,000 6,000</td>
</tr>
<tr>
<td>Flash point, T.O.C., °F</td>
<td>T 79</td>
<td>80 80 80 80 80 80</td>
</tr>
<tr>
<td>Distillation test:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distillate, percentage by volume of total distillate to 680°F</td>
<td>T 78</td>
<td></td>
</tr>
<tr>
<td>to 437°F</td>
<td></td>
<td>40 75 35 70 20 55</td>
</tr>
<tr>
<td>to 500°F</td>
<td></td>
<td>65 90 55 85 45 75</td>
</tr>
<tr>
<td>to 600°F</td>
<td></td>
<td>85 80 80 70 70 70</td>
</tr>
<tr>
<td>Residue from distillation, volume %</td>
<td></td>
<td>70 75 75 82 82 82</td>
</tr>
</tbody>
</table>

### Table 5

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Type-Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MC-30 MC-250 MC-800 MC-300</td>
</tr>
<tr>
<td>Kinematic viscosity, 140°F, cSt</td>
<td>T 201</td>
<td>Min Max Min Max Min Max Min Max</td>
</tr>
<tr>
<td>Water, %</td>
<td>T 55</td>
<td>30 60 250 300 800 1,600 3,000 6,000</td>
</tr>
<tr>
<td>Flash point, T.O.C., °F</td>
<td>T 79</td>
<td>100 150 150 150 150 150</td>
</tr>
<tr>
<td>Distillation test:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distillate, percentage by volume of total distillate to 680°F</td>
<td>T 78</td>
<td></td>
</tr>
<tr>
<td>to 437°F</td>
<td></td>
<td>25 10 10 10 10 10</td>
</tr>
<tr>
<td>to 500°F</td>
<td></td>
<td>40 70 15 35 35 15</td>
</tr>
<tr>
<td>to 600°F</td>
<td></td>
<td>75 93 60 87 45 80 15 75</td>
</tr>
<tr>
<td>Residue from distillation, volume %</td>
<td></td>
<td>50 67 75 80 80 80</td>
</tr>
</tbody>
</table>

1. If the penetration of residue is more than 200 and the ductility at 77°F is less than 100 cm, the material is acceptable if its ductility at 60°F is more than 100 cm.
Table 6
Special-Use Cutback Asphalt

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>MC-2400L</th>
<th>SCM I</th>
<th>SCM II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematic viscosity, 140°F, cSt</td>
<td>T 201</td>
<td>2.400</td>
<td>4.800</td>
<td>500</td>
</tr>
<tr>
<td>Water, %</td>
<td>T 35</td>
<td>-</td>
<td>0.2</td>
<td>-</td>
</tr>
<tr>
<td>Flash point, T.O.C., °F</td>
<td>T 79</td>
<td>130</td>
<td>-</td>
<td>175</td>
</tr>
<tr>
<td>Distillation test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distillate, percentage by volume of total distillate to 680°F</td>
<td>T 78</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>to 437°F</td>
<td></td>
<td></td>
<td>35</td>
<td>0.5</td>
</tr>
<tr>
<td>to 500°F</td>
<td></td>
<td></td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>to 600°F</td>
<td></td>
<td></td>
<td>78</td>
<td>-</td>
</tr>
<tr>
<td>Residue from distillation, volume %</td>
<td></td>
<td></td>
<td>76</td>
<td>-</td>
</tr>
</tbody>
</table>

D. Emulsified Asphalt. Emulsified asphalt must be homogeneous, not separate after thorough mixing, and meet the requirements for the specified type and grade in Tables 7, 8, 9, and 10.
Table 7
Emulsified Asphalt

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Type–Grade</th>
<th>Rapid-Setting</th>
<th>Medium-Setting</th>
<th>Slow-Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HFRS-2</td>
<td>MS-2</td>
<td>AES-300</td>
<td>SS-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol</td>
<td>T 72</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>77°F, sec.</td>
<td></td>
<td>150</td>
<td>400</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>122°F, sec.</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sieve test, %</td>
<td>T 59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Miscibility</td>
<td>T 59</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Cement mixing, %</td>
<td>T 59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coating ability and water resistance:</td>
<td>T 59</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>dry aggregate/after spray</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>wet aggregate/after spray</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Demulsibility, 35 ml of 0.02 N CaCl₂, %</td>
<td>T 59</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Storage stability, 1 day, %</td>
<td>T 59</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Freezing test, 3 cycles¹</td>
<td>T 59</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Distillation test.</td>
<td>T 59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Residue by distillation, % by wt.</td>
<td></td>
<td>65</td>
<td>-</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Oil distillate, % by volume of emulsion</td>
<td></td>
<td>0.5</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Tests on residue from distillation:</td>
<td>T 49</td>
<td>100</td>
<td>140</td>
<td>160</td>
<td>300</td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec.</td>
<td></td>
<td>120</td>
<td>160</td>
<td>300</td>
<td>-</td>
</tr>
<tr>
<td>Solubility in trichloroethylene, %</td>
<td>T 44</td>
<td>97.5</td>
<td>-</td>
<td>97.5</td>
<td>-</td>
</tr>
<tr>
<td>Ductility, 77°F, 5 cm/min., cm</td>
<td>T 51</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Float test, 140°F, sec.</td>
<td>T 50</td>
<td>1,200</td>
<td>-</td>
<td>1,200</td>
<td>-</td>
</tr>
</tbody>
</table>

¹ Applies only when the Engineer designates material for winter use.
<table>
<thead>
<tr>
<th>Property</th>
<th>Type-Grade</th>
<th>Slow-Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol</td>
<td>T 72</td>
<td>T 72</td>
</tr>
<tr>
<td>77°F, sec.</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>127°F, sec.</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Sieve test, %</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Cement mixing, %</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Coating ability and water resistance:</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>dry aggregate/after spray</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>wet aggregate/after spray</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Demulsibility, 3.5 ml of 0.02 N CaCl₂, %</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Storage stability, 1 day, %</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Freezing test, 3 cycles</td>
<td>T 59</td>
<td>T 59</td>
</tr>
<tr>
<td></td>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>Distillation test:</td>
<td>T 49</td>
<td>T 49</td>
</tr>
<tr>
<td>Oildistillate, % by wt.</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Tests on residue from distillation:</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Solubility, 77°F, 5 cm/min. cm</td>
<td>L 200</td>
<td>L 200</td>
</tr>
</tbody>
</table>

1. Applies only when the Engineer designates material for winter use.
| Property                                      | CRS-2 | CRS-2H | CMS-2S | CMS-2S | CSS-I | CSS-II | CSS-III | Min/Max | Min/Max | Min/Max | Min/Max | Min/Max |
|---------------------------------------------|-------|--------|--------|--------|-------|--------|---------|---------|---------|---------|---------|---------|---------|
| Viscosity (sec)                             | 150   | 400    | 100    | 100    | 300   | 100    | 100     | 0.1     | 0.1     | 0.1     | 0.1     | 0.1     |
| Water content, %                            | 1.5   | 1.5    | 1.5    | 1.5    | 1.5   | 1.5    | 1.5     | 1.5     | 1.5     | 1.5     | 1.5     | 1.5     |
| Stability, %                                | 1     | 1      | 1      | 1      | 1     | 1      | 1       | 1       | 1       | 1       | 1       | 1       |
| Distillation, % by weight of emulsion       | T59   | T59    | T59    | T59    | T59   | T59    | T59     | T59     | T59     | T59     | T59     | T59     |
| Penetration, 77°F, 100, 5 sec.              | T49   | T49    | T49    | T49    | T49   | T49    | T49     | T49     | T49     | T49     | T49     | T49     |
| Solubility in chloroform, %                 | T51   | T51    | T51    | T51    | T51   | T51    | T51     | T51     | T51     | T51     | T51     | T51     |

**Table 8: Cationic Emulsified Asphalt**

**Greenway/Pharr Area (Fort Worth, TX) Sewer Utility System Relocation due to I-35W Development Project (NTE3A)**

Enginyeria de Camins, Canals i Ports.
## Table 9: Polymer-Modified Emulsified Asphalt

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>MVI, 100°C</th>
<th>Grading, %</th>
<th>Marshall %</th>
<th>Demulsibility, 35 mL of 0.02 M CaCl₂, %</th>
<th>Storage stability, 1 day, %</th>
<th>Breakdown index, g</th>
<th>Polymer content, wt. % (solid basis)</th>
<th>Residue by distillation, % by volume of emulsion</th>
<th>Oil distillate, % by volume of emulsion</th>
<th>Tests on residue from distillation</th>
<th>Elatic recovery, 50°F, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol, sec</td>
<td>1.72</td>
<td>≥ 10</td>
<td>≥ 50</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
<td>≥ 60</td>
</tr>
<tr>
<td>77°F, sec</td>
<td>1.50</td>
<td>≥ 200</td>
<td>≥ 50</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
<td>≥ 65</td>
</tr>
<tr>
<td>Swell test, %</td>
<td>1.59</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Marshall %</td>
<td>1.59</td>
<td>50</td>
<td>60</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Demulsibility, 35 mL of 0.02 M CaCl₂, %</td>
<td>1.59</td>
<td>60</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Storage stability, 1 day, %</td>
<td>1.59</td>
<td>60</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Breakdown index, g</td>
<td>1.59</td>
<td>65</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Polymer content, wt. % (solid basis)</td>
<td>1.59</td>
<td>65</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Residue by distillation, % by volume of</td>
<td>1.59</td>
<td>65</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol, sec</td>
<td>1.59</td>
<td>65</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>77°F, sec</td>
<td>1.59</td>
<td>65</td>
<td>65</td>
<td>80</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
</tbody>
</table>

1. HIPS-2P must meet one of either the ductility or elastic recovery requirements.
2. Maintain a temperature of 70°F. Maintain at this temperature for 20 min. Complete all distillation in 10 min.
### Table 10

**Polymer-Modified Cationic Emulsified Asphalt**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Type-Grade</th>
<th>Rapid-Setting</th>
<th>Slow-Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol 77°F, sec.</td>
<td>T 72</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSS-1P</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>Sieve test, %</td>
<td>T 59</td>
<td>CRS-1P</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %</td>
<td>T 59</td>
<td>CRS-1P</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Storage stability, 1 day, %</td>
<td>T 59</td>
<td>CRS-1P</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Breaking index, g</td>
<td>Tex-542-C</td>
<td>CRS-1P</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Particle charge</td>
<td>T 59</td>
<td>CRS-1P</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Distillation test.(^1)</td>
<td>T 59</td>
<td>CRS-1P</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Residue by distillation, % by weight</td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>Oil distillate, % by volume of emulsion</td>
<td></td>
<td>CSS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Tests on residue from distillation:</td>
<td>Tex-533-C</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Polymer content, wt. % (solids basis)</td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec</td>
<td>T 49</td>
<td>CRS-1P</td>
<td>225</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Viscosity, 140°F, poise</td>
<td>T 202</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Solubility in trichloroethylene, %</td>
<td>T 44</td>
<td>CRS-1P</td>
<td>97.0</td>
<td>97.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Softening point, °F</td>
<td>T 53</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ductility, 77°F, 5 cm/min., cm</td>
<td>T 51</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ductility(^2), 39.2°F, 5 cm/min., cm</td>
<td>T 51</td>
<td>CRS-1P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Elastic recovery(^2), 50°F, %</td>
<td>Tex-539-C</td>
<td>CRS-1P</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS-2P</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^1\) Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ±5°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ±5 min. from the first application of heat.

\(^2\) CRS-2P must meet one of either the ductility or elastic recovery requirements.

**E. Specialty Emulsions.** Specialty emulsions may be either asphalt-based or resin-based and must meet the requirements of Table 11.
Table 12
Recycling Agent and Emulsified Recycling Agent

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Recycling Agent</th>
<th>Emulsified Recycling Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol, 77°F, sec.</td>
<td>T 72</td>
<td>–</td>
<td>15</td>
</tr>
<tr>
<td>Sieve test, %</td>
<td>T 59</td>
<td>–</td>
<td>0.1</td>
</tr>
<tr>
<td>Miscibility</td>
<td>T 59</td>
<td>–</td>
<td>No coagulation</td>
</tr>
<tr>
<td>Residue by evaporation, % by wt</td>
<td>T 59</td>
<td>–</td>
<td>60</td>
</tr>
<tr>
<td>Tests on recycling agent or residue from evaporation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash point, C.O.C., °F</td>
<td>T 48</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Kinematic viscosity, 140°F, cSt</td>
<td>T 201</td>
<td>75</td>
<td>200</td>
</tr>
<tr>
<td>275°F, cSt</td>
<td></td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

1. Exception to T 59: Use 0.02 N CaCl₂ solution in place of water.
2. Exception to T 59: Maintain sample at 300°F until foaming ceases, then cool and weigh.

G. Crumb Rubber Modifier. Crumb rubber modifier (CRM) consists of automobile and truck tires processed by ambient temperature grinding.

CRM must be:
- free from contaminants including fabric, metal, and mineral and other nonrubber substances;
- free-flowing; and
- nonfoaming when added to hot asphalt binder.

When tested in accordance with Tex-200-F, Part I, using a 50-g sample, the rubber gradation must meet the requirements of the grades in Table 13.

Table 13
CRM Gradations

<table>
<thead>
<tr>
<th>Sieve Size (% Passing)</th>
<th>Grade A</th>
<th>Grade B</th>
<th>Grade C</th>
<th>Grade D</th>
<th>Grade E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>As shown on the plans</td>
</tr>
<tr>
<td>#8</td>
<td>100</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>#10</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>#16</td>
<td>–</td>
<td>–</td>
<td>70</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>#30</td>
<td>–</td>
<td>–</td>
<td>25</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>#40</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>45</td>
</tr>
<tr>
<td>#50</td>
<td>0</td>
<td>10</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>#200</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>5</td>
<td>–</td>
</tr>
</tbody>
</table>
H. Crack Sealer. Polymer modified asphalt-emulsion crack sealer must meet the requirements of Table 14. Rubber-asphalt crack sealer must meet the requirements of Table 15.

**Table 14**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational viscosity, 77°F, cP</td>
<td>D 2196, Method A</td>
<td>10,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Sieve test, %</td>
<td>T 59</td>
<td>–</td>
<td>0.1</td>
</tr>
<tr>
<td>Storage stability, 1 day, %</td>
<td>T 59</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Evaporation</td>
<td>Tex-543-C</td>
<td>65</td>
<td>–</td>
</tr>
<tr>
<td>Tests on residue from evaporation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec.</td>
<td>T 49</td>
<td>35</td>
<td>75</td>
</tr>
<tr>
<td>Softening point, °F</td>
<td>T 53</td>
<td>140</td>
<td>–</td>
</tr>
<tr>
<td>Ductility, 39.2°F, 5 cm/min., cm</td>
<td>T 51</td>
<td>100</td>
<td>–</td>
</tr>
</tbody>
</table>

**Table 15**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Class A</th>
<th>Class B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRM content, Grade A or B, % by wt.</td>
<td>Tex-544-C</td>
<td>22 : 26</td>
<td>– : –</td>
</tr>
<tr>
<td>CRM content, Grade B, % by wt.</td>
<td>Tex-544-C</td>
<td>– : –</td>
<td>13 : 17</td>
</tr>
<tr>
<td>Virgin rubber content, % by wt.</td>
<td>Tex-544-C</td>
<td>– : –</td>
<td>2 : –</td>
</tr>
<tr>
<td>Flash point, °COC</td>
<td>T 48</td>
<td>400 : –</td>
<td>400 : –</td>
</tr>
<tr>
<td>Penetration, 77°F, 150 g, 5 sec.</td>
<td>T 49</td>
<td>30 : 50</td>
<td>30 : 50</td>
</tr>
<tr>
<td>Penetration, 32°F, 200 g, 60 sec.</td>
<td>T 49</td>
<td>12 : –</td>
<td>12 : –</td>
</tr>
<tr>
<td>Softening point, °F</td>
<td>T 53</td>
<td>– : –</td>
<td>170 : –</td>
</tr>
<tr>
<td>Bond</td>
<td>D5329</td>
<td>–</td>
<td>Pass</td>
</tr>
</tbody>
</table>

1. Provide certification that the min. % virgin rubber was added.
2. Before passing the test flame over the cup, agitate the sealing compound with a 3/8- to 1/2- in. (9.5- to 12.7-mm) wide, square-end metal spatula in a manner so as to bring the material on the bottom of the cup to the surface, i.e., turn the material over. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8 to 10 rapid circular strokes. Accomplish agitation in 3 to 4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in ASTM D 217 for the penetration needle.
4. No crack in the crack sealing materials or break in the bond between the sealer and the mortar blocks over 1/4 in. deep for any specimen after completion of the test.

I. **Asphalt-Rubber Binders.** Asphalt-rubber (A-R) binders are mixtures of asphalt binder and CRM, which have been reacted at elevated temperatures. The A-R binders meet D 6114 and
contain a minimum of 15% CRM by weight. Types I or II, containing CRM Grade C, are used for hot mixed aggregate mixtures. Types II or III, containing CRM Grade B, are used for surface treatment binder. Table 16 describes required binder properties.

### Table 16

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Procedure</th>
<th>Binder Type</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent viscosity, 347°F, cP</td>
<td>D 2196, Method A</td>
<td>Min</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec.</td>
<td>T 49</td>
<td>25</td>
<td>75</td>
<td>75</td>
<td>50 100</td>
</tr>
<tr>
<td>Penetration, 39.2°F, 200 g, 60 sec.</td>
<td>T 49</td>
<td>10</td>
<td>-</td>
<td>15</td>
<td>- 25</td>
</tr>
<tr>
<td>Softening point, °F</td>
<td>T 53</td>
<td>135</td>
<td>-</td>
<td>130</td>
<td>- 125</td>
</tr>
<tr>
<td>Resilience, 77°F, %</td>
<td>D 5329</td>
<td>25</td>
<td>-</td>
<td>20</td>
<td>- 10</td>
</tr>
<tr>
<td>Flash point, C.O.C., °F</td>
<td>T 48</td>
<td>450</td>
<td>-</td>
<td>450</td>
<td>- 450</td>
</tr>
<tr>
<td>Tests on residue from Thin-Film Oven Test:</td>
<td>T 179</td>
<td>75</td>
<td>-</td>
<td>75</td>
<td>- 75</td>
</tr>
<tr>
<td>Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original</td>
<td>T 49</td>
<td>75</td>
<td>-</td>
<td>75</td>
<td>- 75</td>
</tr>
</tbody>
</table>

**J. Performance-Graded Binders.** PG binders must be smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet Table 17 requirements.

Separation testing is not required if:
- a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer,
- the binder is blended on site in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot mix plant after the addition of modifiers.
<table>
<thead>
<tr>
<th>Property and Test Method</th>
<th>PG 68</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. penetration design temperature, °C</td>
<td>&gt;22</td>
<td>&gt;28</td>
<td>&gt;34</td>
<td>&gt;41</td>
</tr>
<tr>
<td>Max. penetration design temperature, °C</td>
<td>&lt;38</td>
<td>&lt;44</td>
<td>&lt;50</td>
<td>&lt;56</td>
</tr>
<tr>
<td>Flash point, °C</td>
<td>184</td>
<td>186</td>
<td>188</td>
<td>190</td>
</tr>
<tr>
<td>Viscosity, max. 3.0 Pa·s, test temperature, °C</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Dynamic shear, T 315, G’/G’’(0) Max., 100 kPa</td>
<td>38</td>
<td>42</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Elastomer recovery, D, 80/80, % Min</td>
<td>70</td>
<td>75</td>
<td>80</td>
<td>85</td>
</tr>
<tr>
<td>Rolling thin film test at 144°C</td>
<td>76</td>
<td>78</td>
<td>80</td>
<td>82</td>
</tr>
<tr>
<td>Original Binder</td>
<td>230</td>
<td>230</td>
<td>230</td>
<td>230</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property and Test Method</th>
<th>PG 68</th>
<th>PG 70</th>
<th>PG 76</th>
<th>PG 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. permeability, cm³/100 cm²·min</td>
<td>&gt;22</td>
<td>&gt;28</td>
<td>&gt;34</td>
<td>&gt;41</td>
</tr>
<tr>
<td>Max. permeability, cm³/100 cm²·min</td>
<td>&lt;38</td>
<td>&lt;44</td>
<td>&lt;50</td>
<td>&lt;56</td>
</tr>
<tr>
<td>Dynamic shear, T 315, G’/G’’(0) Min., 20 kPa</td>
<td>58</td>
<td>64</td>
<td>70</td>
<td>76</td>
</tr>
<tr>
<td>Test temperature @ 10 rad/sec, °C</td>
<td>76</td>
<td>78</td>
<td>80</td>
<td>82</td>
</tr>
<tr>
<td>Pressure aging vessel (PAV) residue (120°C)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
### Table 17 (continued)

#### Performance-Graded Binders

<table>
<thead>
<tr>
<th>Property and Test Method</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 max pavement design temperature, °C</td>
<td>-22</td>
<td>-28</td>
<td>-34</td>
<td>-22</td>
<td>-28</td>
</tr>
<tr>
<td>Min pavement design temperature, °C</td>
<td>&lt; 58</td>
<td>&lt; 64</td>
<td>&lt; 70</td>
<td>&lt; 70</td>
<td>&lt; 82</td>
</tr>
<tr>
<td>S, max, 300 MPa, m-value, min, 0.300</td>
<td>-12</td>
<td>-18</td>
<td>-24</td>
<td>-6</td>
<td>-12</td>
</tr>
<tr>
<td>Test temperature @ 60 sec. °C</td>
<td>Direct tension, T 314.8</td>
<td>Failure strain, min, 1.0%</td>
<td>Test temperature @ 1.0 mm/min, °C</td>
<td>-12</td>
<td>-18</td>
</tr>
</tbody>
</table>

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or by following the procedures outlined in AASHTO MP 2 and PP 28.
2. This requirement may be waived at the Department’s discretion 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 (T 201 or T 202) or rotational viscometry (T 316).
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 their mixing and compaction operations. Contractors are therefore responsible for addressing any constructibility issues that may arise.
4. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder 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 (T 201 or T 202) or rotational viscometry (T 316).
5. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
6. If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.
300.3. Equipment. Provide all equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils, and emulsions.

300.4. Construction.

A. Typical Material Use. Table 18 shows typical materials used for specific applications. These are typical uses only. Circumstances may require use of other material.

<table>
<thead>
<tr>
<th>Material Application</th>
<th>Typically Used Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-mixed, hot-laid asphalt mixtures</td>
<td>PG binders, A-R binders Types I and II</td>
</tr>
<tr>
<td>Surface treatment</td>
<td>AC-3, AC-10, AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P,</td>
</tr>
<tr>
<td></td>
<td>AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P,</td>
</tr>
<tr>
<td></td>
<td>CRS-2P, A-R binders Types II and III</td>
</tr>
<tr>
<td>Surface treatment (cool weather)</td>
<td>RS-1P, CRS-1P, RC-250, RC-800, RC-3000, MC-250, MC-800,</td>
</tr>
<tr>
<td></td>
<td>MC-3000, MC-2400L</td>
</tr>
<tr>
<td>Precasting</td>
<td>AC-5, AC-10, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H</td>
</tr>
<tr>
<td>Tack coat</td>
<td>PG Binders, SS-1H, CSS-1H, EAP&amp;T</td>
</tr>
<tr>
<td>Fog seal</td>
<td>SS-1, SS-1H, CSS-1H, CSS-1H</td>
</tr>
<tr>
<td>Hot-mixed, cold-laid asphalt mixtures</td>
<td>AC-0.6, AC-1.5, AC-3, AES-300, AES-300P, CMS-2, CMS-2S</td>
</tr>
<tr>
<td>Patching mix</td>
<td>MC-800, SCM I, SCM II, AES-300S</td>
</tr>
<tr>
<td>Recycling</td>
<td>AC-0.6, AC-1.5, AC-3, AES-150P, AES-300P, recycling agent,</td>
</tr>
<tr>
<td></td>
<td>emulsified recycling agent</td>
</tr>
<tr>
<td>Crack sealing</td>
<td>SS-1P, polymer mod AE crack sealant, rubber asphalt crack</td>
</tr>
<tr>
<td></td>
<td>sealers (Class A, Class B)</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>CSS-1P</td>
</tr>
<tr>
<td>Prime</td>
<td>MC-30, AE-P, EAP&amp;T, PCE</td>
</tr>
<tr>
<td>Curing membrane</td>
<td>SS-1, SS-1H, CSS-1, CSS-1H, PCE</td>
</tr>
<tr>
<td>Erosion control</td>
<td>SS-1, SS-1H, CSS-1, CSS-1H, PCE</td>
</tr>
</tbody>
</table>

B. Storage and Application Temperatures. Use storage and application temperatures in accordance with Table 19. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer’s instructions for any agitation requirements in storage. Manufacturer’s instructions regarding recommended application and storage temperatures supercede those of Table 19.
### Table 19

**Storage and Application Temperatures**

<table>
<thead>
<tr>
<th>Type–Grade</th>
<th>Application</th>
<th>Recommended Range, °F</th>
<th>Maximum Allowable (°F)</th>
<th>Storage Maximum (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-0.6, AC-1.5, AC-3</td>
<td></td>
<td>200–300</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>AC-5, AC-10</td>
<td></td>
<td>275–350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-20-5TR</td>
<td></td>
<td>300–375</td>
<td>375</td>
<td>360</td>
</tr>
<tr>
<td>RC-250</td>
<td></td>
<td>125–180</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>RC-800</td>
<td></td>
<td>170–230</td>
<td>260</td>
<td>260</td>
</tr>
<tr>
<td>RC-3000</td>
<td></td>
<td>215–275</td>
<td>285</td>
<td>285</td>
</tr>
<tr>
<td>MC-30, AE-P</td>
<td></td>
<td>70–150</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>MC-250</td>
<td></td>
<td>125–210</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>MC-800, SCM I, SCM II</td>
<td></td>
<td>175–260</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>MC-3000, MC-2400L</td>
<td></td>
<td>225–275</td>
<td>290</td>
<td>290</td>
</tr>
<tr>
<td>SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&amp;T, SS-1P, RS-1P, CRS-1P, CSS-1P, recycling agent, emulsified recycling agent, polymer mod AE crack sealant</td>
<td></td>
<td>50–130</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>PG binders</td>
<td></td>
<td>275–350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Rubber asphalt crack sealers (Class A, Class B)</td>
<td></td>
<td>350–375</td>
<td>400</td>
<td>–</td>
</tr>
<tr>
<td>A-R binders Types I, II, and III</td>
<td></td>
<td>325–425</td>
<td>425</td>
<td>425</td>
</tr>
</tbody>
</table>

**300.5. Measurement and Payment.** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary or is included in payment for other bid Items.
1.3.2. ASPHALT ANTISTRIPPING AGENTS

301.1. Description. Furnish and incorporate all required asphalt antistripping agents in asphalt concrete paving mixtures and asphalt-stabilized base mixtures to meet moisture resistance testing requirements.

301.2. Materials.

A. Lime. Provide hydrated lime or commercial lime slurry in accordance with DMS-6350, “Lime and Lime Slurry.”

B. Liquid Antistripping Agent. Provide a liquid antistripping agent that is uniform and shows no evidence of crystallization, settling, or separation. Ensure that all liquid antistripping agents arrive in:

- properly labeled and unopened containers, as shipped from the manufacturer, or
- sealed tank trucks with an invoice to show contents and quantities.

- Provide product information to the Engineer including:
  - material safety data sheet,
  - specific gravity of the agent at the manufacturer’s recommended addition temperature,
  - manufacturer’s recommended dosage range, and
  - handling and storage instructions.

301.3. Equipment. Provide all equipment to store, handle, dispense, meter, and mix asphalt antistripping agents.

301.4. Construction.

A. Laboratory Design Evaluation and Production Mixture Verification. Provide a laboratory mixture design and production mixture that meet moisture resistance requirements. During design and production, evaluate proposed asphalt pavement or base mixtures according to the moisture resistance requirements in the asphalt mixture specification.

Governing specifications require the Contractor or Engineer to design the mixture, and the party performing the design is responsible for the moisture susceptibility evaluation. If the Contractor designs the mixture, the Engineer verifies compliance.

If an antistripping agent is required, determine the dosage needed to achieve the moisture resistance requirements during design. Use this addition rate in the production mixture. When using lime, add between 0.5% and 2.0% of hydrated lime or commercial lime slurry solids by weight of the individual aggregate treated. When using a liquid antistripping agent, add it to the binder in accordance with the manufacturer’s instructions and do not exceed the manufacturer’s maximum recommended dosage rate. If the production mixture does not meet moisture resistance requirements, stop production and correct the problem.

B. Addition of Antistrip Agents at the Mix Plant. Connect the measuring device for the addition of the asphalt antistripping agent into the automatic plant controls to automatically adjust the supply to plant production and provide a consistent percentage in the mixture.
Set automatic plant controls so that an interruption of asphalt antistripping agent’s flow causes plant shutdown.

1. Lime. Incorporate lime in a manner that thoroughly and uniformly distributes lime onto the aggregate surface or into the mixture. Use metering equipment, as approved, to ensure the required quantity of lime is used.
   a. Hydrated Lime. Add to the aggregate by one of the following methods, unless otherwise shown on the plans:
      • Mix in an approved pug mill mixer with damp aggregate containing water at least 2% above saturated surface dry conditions.
      • Add into the drum-mix plant immediately before asphalt binder addition or in the pug mill of the weigh-batch plant before asphalt binder addition. If a weigh-batch plant is used, dry mix aggregates and lime before adding asphalt binder.
   b. Commercial Lime Slurry. Add to the aggregate by one of the following methods, unless otherwise shown on the plans:
      • Mix in a suitable pug mill mixer with the aggregate.
      • During mixture production, mix with aggregate between the plant cold feeds and the dryer or mixing drum.

2. Liquid Antistripping Agent. Incorporate into the binder as follows:
   • Handle in accordance with the manufacturer’s recommendations.
   • Add at the manufacturer’s recommended addition temperature.
   • Add into the asphalt line by means of an in-line-metering device, in accordance with Item 520, “Weighing and Measuring Equipment,” and a blending device to disperse the agent.
   • Place the metering and blending devices in an approved location.

301.5. Measurement and Payment. The work performed, materials furnished, equipment, labor, tools, and incidental will not be measured or paid for directly, but is subsidiary or is included in payment quantity for pertinent items.

1.3.3. AGGREGATES FOR SURFACE TREATMENTS

302.1. Description. Furnish aggregate for surface treatments in conformance to the type, grade, and surface aggregate classification (SAC) shown on the plans.

302.2. Materials. Furnish uncontaminated materials of uniform quality throughout that meet the requirements of the plans and specifications. Notify the Engineer of all proposed material sources and of changes to material sources. The Engineer will designate the sampling location.

A. Aggregate. Stockpile aggregates for each source and type separately. Do not add materials to approved stockpiles without the approval of the Engineer. Furnish aggregate of the type shown on the plans and listed in Table 1. Use Tex-100-E material definitions.
Table 1

<table>
<thead>
<tr>
<th>Type</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Gravel, crushed slag, crushed stone, or limestone rock asphalt (LRA)</td>
</tr>
<tr>
<td>B</td>
<td>Crushed gravel, crushed slag, crushed stone, or LRA</td>
</tr>
<tr>
<td>C</td>
<td>Gravel, crushed slag, or crushed stone</td>
</tr>
<tr>
<td>D</td>
<td>Crushed gravel, crushed slag, or crushed stone</td>
</tr>
<tr>
<td>E</td>
<td>Aggregate as shown on plans</td>
</tr>
<tr>
<td>L</td>
<td>Lightweight Aggregate</td>
</tr>
<tr>
<td>PA</td>
<td>Precoated gravel, crushed slag, crushed stone, or LRA</td>
</tr>
<tr>
<td>PB</td>
<td>Precoated crushed gravel, crushed slag, crushed stone, or LRA</td>
</tr>
<tr>
<td>PC</td>
<td>Precoated gravel, crushed slag, or crushed stone</td>
</tr>
<tr>
<td>PD</td>
<td>Precoated crushed gravel, crushed slag, crushed stone</td>
</tr>
<tr>
<td>PE</td>
<td>Precoated aggregate as shown on the plans</td>
</tr>
<tr>
<td>PL</td>
<td>Precoated lightweight aggregate</td>
</tr>
</tbody>
</table>

When tested in accordance with Tex-200-F, Part I, the aggregate gradation must meet the requirements in Table 2 for the specified grade.

Furnish aggregates that meet the quality requirements shown in Table 3, unless otherwise shown on the plans. Provide aggregates from sources listed in the Department’s Bituminous Rated Source Quality Catalog (BRSQC). If a source is not listed in the catalog or its listed ratings do not meet requirements of the plans, material from that source may be used only when tested by the Engineer and approved before use. Allow 30 calendar days for testing of material from such sources.

Provide aggregates for final surfaces that meet the SAC shown on the plans. Do not blend to meet the SAC. Unless otherwise shown, the SAC requirement will apply only to the aggregate used on the travel lanes. The BRSQC lists the SAC for sources on the Aggregate Quality Monitoring Program (AQMP).

Table 2

<table>
<thead>
<tr>
<th>Sieve</th>
<th>1</th>
<th>2</th>
<th>3S²</th>
<th></th>
<th>Grade</th>
<th>3</th>
<th>4</th>
<th>5S²</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Non-lightweight</td>
<td>Lightweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/8”</td>
<td>0-2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0-2</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3/4”</td>
<td>20-35</td>
<td>0-2</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8”</td>
<td>85-100</td>
<td>20-40</td>
<td>0-5</td>
<td>0-2</td>
<td>0-2</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2”</td>
<td></td>
<td></td>
<td></td>
<td>80-100</td>
<td>55-85</td>
<td>20-40</td>
<td>10-25</td>
<td>0-5</td>
<td>0-5</td>
</tr>
<tr>
<td>3/8”</td>
<td>95-100</td>
<td>95-100</td>
<td>95-100</td>
<td>80-100</td>
<td>60-80</td>
<td>60-85</td>
<td>20-40</td>
<td>0-5</td>
<td>0-5</td>
</tr>
<tr>
<td>1/4”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>95-100</td>
<td>95-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>99-100</td>
<td>99-100</td>
<td>99-100</td>
<td>99-100</td>
<td>98-100</td>
<td>98-100</td>
<td>98-100</td>
<td>98-100</td>
<td>98-100</td>
</tr>
</tbody>
</table>

1. Round test results to the nearest whole number.
Table 3
Aggregate Quality Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAC</td>
<td>AQMP</td>
<td>As shown on the plans</td>
<td></td>
</tr>
<tr>
<td>Deleterious material, %, max</td>
<td>Tex-217-F, Part I</td>
<td>2.0</td>
<td>Not required for lightweight aggregate. For LRA, deleterious material includes iron pyrites</td>
</tr>
<tr>
<td>Decantation, %, max</td>
<td>Tex-406-A</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Flakiness index, max</td>
<td>Tex-224-F</td>
<td>17</td>
<td>Unless otherwise shown on the plans</td>
</tr>
<tr>
<td>Los Angeles abrasion, %, max</td>
<td>Tex-410-A</td>
<td>35</td>
<td>All aggregates except LRA</td>
</tr>
<tr>
<td>Magnesium sulfate soundness, 5 Cycle, %, max</td>
<td>Tex-411-A</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Micro-Deval abrasion, %, max</td>
<td>Tex-461-A</td>
<td>–</td>
<td>Not used for acceptance purposes. Used by the Engineer as an indicator for further investigation.</td>
</tr>
<tr>
<td>Coarse aggregate angularity, 2 crushed faces, %, Min</td>
<td>Tex-460-A, Part I</td>
<td>85</td>
<td>Unless otherwise shown on the plans. Only required for crushed gravel</td>
</tr>
</tbody>
</table>

Additional Requirements for Lightweight Aggregate

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry loose unit wt., lb./cu. ft.</td>
<td>Tex-404-A</td>
<td>35–60</td>
</tr>
<tr>
<td>Pressure slaking, %, max</td>
<td>Tex-431-A</td>
<td>6.0</td>
</tr>
<tr>
<td>Freeze-thaw loss, %, max</td>
<td>Tex-432-A</td>
<td>10.0</td>
</tr>
<tr>
<td>Water absorption, 24 hr., %, max</td>
<td>Tex-433-A</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Requirements for Natural LRA

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally impregnated bitumen content, % by wt.</td>
<td>Tex-236-F</td>
<td>4.0–7.0</td>
</tr>
<tr>
<td>White rock content, % by wt.</td>
<td>Tex-220-F and Tex-236-F</td>
<td>15–35</td>
</tr>
</tbody>
</table>

B. Precoating. When precoating is shown on the plans, precoat aggregate uniformly and adequately with asphalt material to the satisfaction of the Engineer. When shown on the plans, specific aggregates may be prohibited from being precoated. Do not precoat LRA aggregate that contains visual surface moisture or excessive quantities of fines. Meet Table 2 and 3 requirements before precoating. Furnish precoated aggregate that spreads uniformly using approved mechanical spreading equipment.

The Engineer retains the right to select a target value for the desired percent by weight of residual bitumen coating on the aggregate. Furnish precoated aggregate that is within ±0.3%
of the target value when tested in accordance with Tex-236-F. The Engineer may require trial batches to assist in selecting the target value.

The Engineer retains the right to remove precoat material from aggregate samples in accordance with Tex-210-F and test the aggregate to verify compliance with Table 2 and 3 requirements. Gradation testing may be performed with precoat intact.

1. Asphalt Material. Precoat the aggregates with asphalt material that meets the requirements of Item 300, “Asphalts, Oils, and Emulsions.” Precoat the LRA with flux oil meeting the requirements of Item 330, “Limestone Rock Asphalt Pavement.” Unless a specific precoat material is specified on the plans, use any asphalt material that meets the requirements of Item 300.

2. Additives. When shown on the plans, use the type and rate of additive specified. Add in accordance with Item 301, “Asphalt Antstripping Agents.” Tex-530-C will be used for verification during production testing, unless otherwise directed.

302.3. Equipment. Manufacture precoated aggregate in a mixing plant that produces uniformly coated aggregate.

302.4. Construction. Deliver aggregate to the locations shown on the plans. Prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials when aggregates are stockpiled. The Engineer will reject contaminated stockpiles.

Provide adequate initial cooling of precoated aggregate to prevent asphalt or aggregate damage due to excessive heat buildup in stockpiles. When asphalt cement is the precoating material, limit stockpile height to 3 ft. immediately after production. Consolidate stockpiles after adequate cooling, as approved. The Engineer will reject stockpiles showing evidence of damage due to excessive heat buildup.

302.5. Measurement and Payment. The work performed, materials furnished, equipment, tools, and incidentals will not be measured or paid for directly but is subsidiary to or is included under “Payment” in other pertinent Items.

1.3.4. SALVAGING, HAULING, AND STOCKPILING RECLAIMABLE ASPHALT PAVEMENT

305.1. Description. Salvage, haul, and stockpile existing asphalt material.

305.2. Construction. Remove dirt, raised pavement markings, and other debris, as directed. Remove the reclaimable asphalt material as shown on the plans or as directed. Unless otherwise shown on the plans, ensure that 95% of the reclaimed material passes a 2-in. sieve. Do not contaminate asphalt material during its removal, transportation, or storage. Repair pavement to remain that is damaged by the removal operations. Provide a clean, smooth, and well-drained stockpile area free of trash, weeds, and grass. Separate different types or quality of asphalt material into different stockpiles as directed. Stockpile material as shown on the plans or as directed. The Department retains ownership of the reclaimed
asphalt material, unless otherwise shown on the plans. The plans or the Engineer may allow or require the use of salvaged material for other Items in the Contract. If not used in other construction items of this Contract, stockpile the salvaged material at the location shown on the plans or as directed.

305.3. Measurement. This Item will be measured by the cubic yard of material calculated by the average end area method in the stockpile, or by the square yard in its original position.

1.3.5. EMULSIFIED ASPHALT TREATMENT

314.1. Description. Apply an emulsified asphalt and water mixture as a base or subgrade treatment; for erosion control, including dust prevention; or as a prime coat.

314.2. Materials. Furnish materials in accordance with the following:

• Item 204, “Sprinkling”
• Item 300, “Asphalts, Oils, and Emulsions.”

Use emulsified asphalt of the type and grade shown on the plans. Use a quantity of emulsified asphalt in the mixture, expressed as a percent of total volume, in accordance with the percentage shown on the plans or as directed.

314.3. Equipment. Provide a self-propelled sprinkler in accordance with Article 204.3, “Equipment.” Provide calibration documentation for the tank used for distribution.

314.4. Construction. Agitate the water and emulsified asphalt to produce a uniform blend. Evenly distribute at the rate selected by the Engineer to locations shown on the plans or as directed.

A. Base or Subgrade Treatment. Treat the base or subgrade to the depth and width shown on the plans or as directed. Regulate the percentage of emulsified asphalt in the mixture and distribute successive applications to achieve the specified rate. Maintain the proper moisture content of the treated material. Mix the treated material, then shape and compact as required by the specification for the course. Finish the course to the line, grade, and typical section shown on the plans. While curing the course, maintain the surface with light applications of the emulsified asphalt mixture, as directed.

B. Erosion Control. Apply the mixture as shown on the plans or as directed.

C. Prime Coat. Regulate the percentage of emulsified asphalt in the mixture and distribute successive applications to achieve the specified rate.

314.5. Measurement. The treatment will be measured by the gallon of emulsified asphalt used in the emulsified asphalt and water mixture.
1.3.6. EQUIPMENT FOR ASPHALT CONCRETE PAVEMENT

320.1. Description. Provide equipment to produce, haul, place, compact, and core asphalt concrete pavement.

320.2. Equipment. Ensure weighing and measuring equipment complies with Item 520, “Weighing and Measuring Equipment.” Synchronize equipment to produce a mixture meeting the required proportions.

A. Production Equipment. Provide:
- drum-mix type, weigh-batch, or modified weigh-batch mixing plants that ensure a uniform, continuous production;
- automatic proportioning and measuring devices with interlock cutoff circuits that stop operations if the control system malfunctions;
- visible readouts indicating the weight or volume of asphalt and aggregate proportions;
- safe and accurate means to take required samples by inspection forces;
- permanent means to check the output of metering devices and to perform calibration and weight checks; and
- additive-feed systems to ensure a uniform, continuous material flow in the desired proportion.

1. Drum-Mix Plants. Provide a mixing plant that complies with the requirements below.
   a. Aggregate Feed System. Provide:
      - a minimum of 1 cold aggregate bin for each stockpile of individual materials used to produce the mix;
      - bins designed to prevent overflow of material;
      - scalping screens or other approved methods to remove any oversized material, roots, or other objectionable materials;
      - a feed system to ensure a uniform, continuous material flow in the desired proportion to the dryer;
      - an integrated means for moisture compensation;
      - belt scales, weigh box, or other approved devices to measure the weight of the combined aggregate; and
      - cold aggregate bin flow indicators that automatically signal interrupted material flow.
   b. Reclaimed Asphalt Pavement (RAP) Feed System. Provide a separate system to weigh and feed RAP into the hot mix plant.
   c. Mineral Filler Feed System. Provide a closed system for mineral filler that maintains a constant supply with minimal loss of material through the exhaust system. Interlock the measuring device into the automatic plant controls to automatically adjust the supply of mineral filler to plant production and provide a consistent percentage to the mixture.
   d. Heating, Drying, and Mixing Systems. Provide:
      - a dryer or mixing system to agitate the aggregate during heating;
      - a heating system that controls the temperature during production to prevent aggregate and asphalt binder damage;
      - a heating system that completely burns fuel and leaves no residue; and
      - a recording thermometer that continuously measures and records the mixture discharge temperature.
e. **Asphalt Binder Equipment.** Supply equipment to heat binder to the required temperature. Equip the heating apparatus with a continuously recording thermometer located at the highest temperature point. Produce a 24-hr. chart of the recorded temperature. Place a device with automatic temperature compensation that accurately meters the binder in the line leading to the mixer.

Furnish a sampling port on the line between the storage tank and mixer. Supply an additional sampling port between any additive blending device and mixer.

f. **Mixture Storage and Discharge.** Provide a surge-storage system to minimize interruptions during operations unless otherwise approved. Furnish a gob hopper or other device to minimize segregation in the bin. Provide an automated system that weighs the mixture upon discharge and produces a ticket showing:

- date,
- project identification number,
- plant identification,
- mix identification,
- vehicle identification,
- total weight of the load,
- tare weight of the vehicle,
- weight of mixture in each load, and
- load number or sequential ticket number for the day.

g. **Truck Scales.** Provide standard platform scales at an approved location.

2. **Weigh-Batch Plants.** Provide a mixing plant that complies with Section 320.2.A.1, “Drum-Mix Plants,” except as required below.

a. **Screening and Proportioning.** Provide enough hot bins to separate the aggregate and to control proportioning of the mixture type specified. Supply bins that discard excessive and oversized material through overflow chutes. Provide safe access for inspectors to obtain samples from the hot bins.

b. **Aggregate Weigh Box and Batching Scales.** Provide a weigh box and batching scales to hold and weigh a complete batch of aggregate. Provide an automatic proportioning system with low bin indicators that automatically stop when material level in any bin is not sufficient to complete the batch.

c. **Asphalt Binder Measuring System.** Provide bucket and scales of sufficient capacity to hold and weigh binder for 1 batch.

d. **Mixer.** Equip mixers with an adjustable automatic timer that controls the dry and wet mixing period and locks the discharge doors for the required mixing period. Furnish a pug mill with a mixing chamber large enough to prevent spillage.

3. **Modified Weigh-Batch Plants.** Provide a mixing plant that complies with Section 320.2.A.2, “Weigh-Batch Plants,” except as specifically described below.

a. **Aggregate Feeds.** Aggregate control is required at the cold feeds. Hot bin screens are not required.

b. **Surge Bins.** Provide 1 or more bins large enough to produce 1 complete batch of mixture.

B. **Hauling Equipment.** Provide trucks with enclosed sides to prevent asphalt mixture loss. Cover each load of mixture with waterproof tarps. Before use, clean all truck beds to ensure the mixture is not contaminated. When necessary, coat the inside truck beds with an approved release agent from the list maintained by the Construction Division.
C. Placement and Compaction Equipment. Provide equipment that does not damage underlying pavement. Comply with laws and regulations concerning overweight vehicles. When permitted, other equipment that will consistently produce satisfactory results may be used.

1. Asphalt Paver. Furnish a paver that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Ensure the paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affect the finished pavement quality. Equip the paver with an automatic, dual, longitudinal-grade control system and an automatic, transverse-grade control system.

   a. Tractor Unit. Supply a tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch sufficient to maintain contact between the hauling equipment’s rear wheels and the finishing machine’s pusher rollers while mixture is unloaded.

   b. Screed. Provide a heated compacting screed that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Screed extensions must provide the same compacting action and heating as the main unit unless otherwise approved.

   c. Grade Reference. Provide a grade reference with enough support that the maximum deflection does not exceed 1/16 in. between supports. Ensure that the longitudinal controls can operate from any longitudinal grade reference including a string line, ski, mobile string line, or matching shoes. Furnish paver skis or mobile string line at least 40 ft. long unless otherwise approved.

2. Material Transfer Devices. Provide the specified type of device when shown on the plans. Ensure the devices provide a continuous, uniform mixture flow to the asphalt paver. When used, provide windrow pick-up equipment constructed to pick up substantially all roadway mixture placed in the windrow.

3. RemiXing Equipment. When required, provide equipment that includes a pug mill, variable pitch augers, or variable diameter augers operating under a storage unit with a minimum capacity of 8 tons.

4. Motor Grader. When allowed, provide a self-propelled grader with a blade length of at least 12 ft. and a wheelbase of at least 16 ft.

5. Handheld Infrared Thermometer. Provide a handheld infrared thermometer meeting the requirements of Tex-244-F.

6. Rollers. Provide rollers meeting the requirements of Item 210, “Rolling,” for each type of roller required for compaction.

7. Straightedges and Templates. Furnish 10-ft. straightedges and other templates as required or approved.

D. Field Laboratory. Unless otherwise shown on the plans, provide and maintain a Type D Structure (Asphalt Mix Control Laboratory) in accordance with Item 504, “Field Office and Laboratory,” and details shown on the plans.

E. Coring Equipment. When coring is required, provide equipment suitable to obtain a pavement specimen meeting the dimensions for testing.
320.3. Measurement and Payment. The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent items.

1.3.7. ASPHALT CONCRETE SURFACE REHABILITATION

358.1. Description. Heat; scarify; if required, add asphalt, recycling agent, and fresh hot mix asphalt; mix; place; level; and compact recycled asphalt concrete.

358.2. Materials.


B. Asphalt and Recycling Agent. If required, furnish asphalt, recycling agent, or both according to the requirements of Section 358.4.A, “Mixture Design,” and meeting requirements of Item 300, “Asphalt, Oils, and Emulsions.”

358.3. Equipment.

A. Processing Equipment. Provide equipment for heating, scarifying, mixing, placing, and finishing that meets the following requirements.

1. Heating Mechanism. Supply a heating mechanism, under a closed or shielded hood, capable of heating asphalt concrete pavement to a temperature that allows scarification to the desired depth without producing undesirable pollutants.

2. Scarifier. Provide scarifier sections capable of uniformly loosening the asphalt concrete pavement. When shown on the plans, furnish a scarifier with height adjustments to clear manholes or other obstructions.

3. Gathering, Adding Materials, Mixing, Distributing, Spreading, and Finishing. Provide equipment capable of:
   • gathering heated, scarified hot-mix asphalt concrete;
   • adding asphalt or recycling agent at the required rate;
   • adding fresh hot-mix asphalt at the required rate;
   • uniformly mixing all ingredients;
   • distributing the blended mixture over the width being processed; and
   • spreading and finishing to produce a smooth surface meeting the requirements of the typical cross section.

4. Onboard Pug Mill. If required on the plans, provide an onboard pug mill.


C. Mobile Testing Laboratory. If shown on the plans, furnish a mobile testing laboratory meeting the requirements of Tex-237-F and a Level 1A certified laboratory technician who is qualified under the Department’s approved program. Perform tests necessary to control plant production. The Department will perform all acceptance testing.
358.4. Construction. Rehabilitate existing asphalt concrete pavement to meet the typical sections shown on the plans and the lines and grades established by the Engineer.

A. Mixture Design. Obtain a representative sample, to the depth specified, of the in-place asphalt concrete for rehabilitation. Using materials described in Article 358.2, “Materials,” provide a mixture design by weight in accordance with Tex-204-F, Part I, to restore the in-place asphalt concrete pavement to the mixture type and binder properties shown on the plans or as approved.

B. Heating, Scarifying, and Placement. Protect from heat damage all trees, shrubs, and other landscaping that is adjacent to the pavement. Before beginning heating and scarifying, remove all dirt and other debris from the pavement surface by blading, brooming, or other approved methods. Heat, scarify, and rework pavement surface to the widths and depths shown on the plans. Control heating to ensure uniform heat penetration and to prevent differential softening of the pavement. Do not char the asphalt or break aggregate particles. Keep the temperature of material immediately behind the scarifier between 225°F and 325°F. Gather the scarified material and uniformly add asphalt, recycling agent, and fresh hot-mix asphalt to the scarified material in accordance with the mixture design developed in Section 358.4.A, “Mixture Design.” Mix all ingredients uniformly. Distribute the homogenous mixture over the width being processed. Spread and finish to produce a smooth surface according to the typical cross section.

When making a pass adjacent to a previously placed mat, locate the longitudinal joint at least 2 in. horizontally into the previously placed mat.

C. Compaction. Begin compaction before material temperature falls below 190°F, and complete all rolling before material temperature drops below 175°F. The Engineer may modify the temperature requirements if necessary for proper compaction.

Use at least 1 tandem roller, 1 pneumatic-tire roller, and 1 finish roller. Use other compaction equipment producing equivalent compaction as approved. Continue rolling until no further compaction can be obtained and all roller marks are eliminated. Use tamps to compact areas not accessible to rollers or in areas where rollers will not provide thorough compaction.

D. Ride Quality. Use Surface Test Type A to evaluate ride quality in accordance with Item 585, “Ride Quality for Pavement Surfaces,” unless otherwise shown on the plans.

358.5. Measurement. Asphalt concrete surface rehabilitation will be measured by the square yard.

1.3.8. CONCRETE PAVEMENT

360.1. Description. Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.

360.2. Materials.
A. Hydraulic Cement Concrete. Provide hydraulic cement concrete in accordance with Item 421, “Hydraulic Cement Concrete,” except that strength over-design is not required. Provide Class P concrete designed to meet a minimum average flexural strength of 570 psi or a minimum average compressive strength of 3,500 psi at 7 days or a minimum average flexural strength of 680 psi or a minimum average compressive strength of 4,400 psi at 28 days. Test in accordance with Tex-448-A or Tex-418-A.

When shown on the plans or allowed, provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic. Design Class HES to meet the requirements of Class P and a minimum average flexural strength of 400 psi or a minimum average compressive strength of 2,600 psi in 24 hr., unless other early strength and time requirements are shown on the plans or allowed. No strength overdesign is required. Type III cement is allowed for Class HES concrete.

Use Class A or P concrete for curbs that are placed separately from the pavement. Provide concrete that is workable and cohesive, possesses satisfactory finishing qualities, and conforms to the mix design and mix design slump.

B. Reinforcing Steel. Provide Grade 60 deformed steel for bar reinforcement in accordance with Item 440, “Reinforcing Steel.” Provide approved positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving. Provide corrosion protection when shown on the plans.

1. Dowels. Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 440, “Reinforcing Steel.” Coat dowels with a thin film of grease or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.

2. Tie Bars. Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Provide multiple-piece tie bars composed of 2 pieces of deformed reinforcing steel with a coupling capable of developing a minimum tensile strength of 125% of the design yield strength of the deformed steel when tensile-tested in the assembled configuration. Provide a minimum length of 33 diameters of the deformed steel in each piece. Use multiple-piece tie bars from the list of “Prequalified Multiple Piece Tie Bar Producers” maintained by the Construction Division, or submit samples for testing in accordance with Tex-711-I.

C. Curing Materials. Provide Type 2 membrane curing compound conforming to DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.” Provide SS-1 emulsified asphalt conforming to Item 300, “Asphalts, Oils, and Emulsions,” for concrete pavement to be overlayed with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 420, “Concrete Structures.”

D. Epoxy. Provide Type III epoxy in accordance with DMS-6100, “Epoxies and Adhesives,” for installing all drilled-in reinforcing steel.
E. Evaporation Retardant. Provide evaporation retardant conforming to DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.”

F. Joint Sealants and Fillers. Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with DMS-6310, “Joint Sealants and Fillers.”

360.3. Equipment. Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 421, “Hydraulic Cement Concrete.” Obtain approval for other equipment used.

A. Placing, Consolidating, and Finishing Equipment. Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist. Provide mechanically operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer’s recommendations. Provide immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators. For small or irregular areas or when approved, the paving equipment described in this Section is not required.

B. Forming Equipment.
1. Pavement Forms. Provide metal side forms of sufficient crosssection, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100-ft. radius or less.

2. Curb Forms. Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 529, “Concrete Curb, Gutter, and Combined Curb and Gutter.”

C. Reinforcing Steel Inserting Equipment. Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details.

D. Texturing Equipment.
1. **Carpet Drag.** Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications. Use an artificial grass-type carpet having a molded polyethylene pile face with a blade length of 5/8 in. to 1 in., a minimum weight of 70 oz. per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.

2. **Tining Equipment.** Provide a self-propelled transverse metal tine device equipped with 4-in. to 6-in. steel tines and with crosssection approximately 1/32 in. thick by 1/12 in. wide, spaced at 1 in., center-to-center. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas or, when permitted, in emergencies due to equipment breakdown.

**E. Curing Equipment.** Provide a self-propelled machine for applying membrane curing compound using mechanically pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when production rates are such that the first application of membrane curing compound cannot be accomplished immediately after texturing and after free moisture has disappeared. Hand-operated pressurized spraying equipment with atomizing nozzles may only be used on small or irregular areas or, when permitted, in emergencies due to equipment breakdown.

**F. Sawing Equipment.** Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations. Provide adequate illumination for nighttime sawing.

**G. Grinding Equipment.** When required, provide self-propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades. Provide equipment with automatic grade control capable of grinding at least a 3-ft. width longitudinally in each pass without damaging the concrete.

**H. Testing Equipment.** Provide testing equipment regardless of jobcontrol testing responsibilities in accordance with Item 421, “Hydraulic Cement Concrete,” unless otherwise shown in the plans or specified.

**I. Coring Equipment.** When required, provide coring equipment capable of extracting cores in accordance with the requirements of Tex-424-A.

**J. Miscellaneous Equipment.** Furnish both 10-ft. and 15-ft. steel or magnesium long-handled standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations. Furnish date stencils to impress pavement placement dates into the fresh concrete, with numerals approximately 2 in. high by 1 in. wide by 1/4 in. deep.
360.4. Construction. Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water sufficiently in advance of placing pavement concrete. Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.

A. Paving and Quality Control Plan. Submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.

B. Job-Control Testing. Unless otherwise shown on the plans, perform all fresh and hardened concrete job-control testing at the specified frequency. Provide job-control testing personnel meeting the requirements of Item 421, “Hydraulic Cement Concrete.” Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump, air, and temperature on start-up production days to check for concrete conformance and consistency. Sample and prepare strength test specimens (2 specimens per test) on the first day of production and for each 3,000 sq. yd. or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump, air, and temperature tests each time strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

When job-control testing by the Contractor is waived by the plans, the Engineer will perform the testing; however, this does not waive the Contractor’s responsibility for providing materials and work in accordance with this item.

1. Job-Control Strength. Unless otherwise shown on the plans or permitted by the Engineer, use 7-day job-control concrete strength testing in accordance with Tex-448-A or Tex-418-A. For 7-day job-control by flexural strength, use a flexural strength of 520 psi or a lower job-control strength value proven to meet a 28-day flexural strength of 680 psi as correlated in accordance with Tex-427-A. For 7-day job-control by compressive strength, use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,400 psi as correlated in accordance with Tex-427-A.
Job control of concrete strength may be correlated to an age other than 7 days in accordance with Tex-427-A when approved. Job control strength of Class HES concrete is based on the required strength and time.

When a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive jobcontrol strength values fall below the required job-control strength, investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low strength test values in a timely manner. If any job-control strength is more than 15% below the required job-control strength, the Engineer will evaluate the structural adequacy of the pavements. When directed, remove and replace pavements found to be structurally inadequate at no additional cost.

2. Split-Sample Verification Testing. Perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 jobcontrol samples. The Engineer will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or when the average of 10 job-control strength results and the Engineer’s split-sample strength result differ by more than 10%.

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Allowable Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, Tex-422-A</td>
<td>2°F</td>
</tr>
<tr>
<td>Slump, Tex-415-A</td>
<td>1 in.</td>
</tr>
<tr>
<td>Air content, Tex-414-A or Tex-416-A</td>
<td>1%</td>
</tr>
<tr>
<td>Flexural strength, Tex-448-A</td>
<td>19%</td>
</tr>
<tr>
<td>Compressive strength, Tex-418-A</td>
<td>10%</td>
</tr>
</tbody>
</table>

C. Reinforcing Steel and Joint Assemblies. Accurately place and secure in position all reinforcing steel as shown on the plans. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the longitudinal reinforcement splices to avoid having more than 1/3 of the splices within a 2-ft. longitudinal length of each lane of the pavement. Use multiple-piece tie bars or drill and epoxy grout tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of 3/4 of the yield strength of the steel after 7 days. Test 15 bars using ASTM E 488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. If any of the test results do not meet the required minimum pullout strength, perform corrective measures to provide equivalent pullout resistance. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.
1. Manual Placement. Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.

2. Mechanical Placement. If mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies, complete the work using manual methods.

D. Joints. Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with Item 438, “Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks).” Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. When placing of concrete is stopped, install a rigid transverse bulkhead, accurately notched for the reinforcing steel and shaped accurately to the cross-section of the pavement.

1. Placing Reinforcement at Joints. Where the plans require an assembly of parts at pavement joints, complete and place the assembly at the required location and elevation with all parts rigidly secured in the required position. Accurately notch joint materials for the reinforcing steel.

2. Transverse Construction Joints.
   a. Continuously Reinforced Concrete Pavement (CRCP). Install additional longitudinal reinforcement through the bulkhead when shown on the plans. Protect the reinforcing steel immediately beyond the construction joint from damage, vibration, and impact.
   b. Concrete Pavement Contraction Design (CPCD). When the placing of concrete is intentionally stopped, install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location. When the placing of concrete is unintentionally stopped, install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints. For mid-slab construction joints, install tie bars of the size and spacing used in the longitudinal joints.
   c. Curb Joints. Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. For non-monolithic curbs, place reinforcing steel into the plastic concrete pavement as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 529, “Concrete Curb, Gutter, and Combined Curb and Gutter.”

E. Placing and Removing Forms. Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement. Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement
will be met. Stop paving operations if forms settle or deflect more than 1/8 in. under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade. Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hr. after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hr. after a bulkhead for a transverse construction joint has been removed unless otherwise approved. When forms are removed before 72 hr. after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement. Forms that are not the same depth as the pavement but are within 2 in. of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100-ft. radius or less.

F. Concrete Delivery. Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 in. Segregated concrete is subject to rejection. Place agitated concrete within 60 min. after batching. Place non-agitated concrete within 45 min. after batching. In hot weather or under conditions causing quick setting of the concrete, times may be reduced by the Engineer. Time limitations may be extended if the Contractor can demonstrate that the concrete can be properly placed, consolidated, and finished without the use of additional water.

G. Concrete Placement. Do not allow the pavement edge to deviate from the established paving line by more than 1/2 in. at any point. Place the concrete as near as possible to its final location, and minimize segregation and rehandling. Where hand spreading is necessary, distribute concrete using shovels. Do not use rakes or vibrators to distribute concrete.

1. Pavement. Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete in areas not accessible to the machinemounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.

2. Date Imprinting. Imprint dates in the fresh concrete indicating the date of the concrete placement. Make impressions approximately 1 ft. from the outside longitudinal construction joint or edge of pavement and approximately 1 ft. from the transverse construction joint at the beginning of the placement day. Orient the impressions to be read from the outside shoulder in the direction of final traffic. Impress date in DD-MM-YY format. Imprinting of the Contractor name or logo in similar size characters to the date is allowed.

3. Curbs. Where curbs are placed separately, conform to the requirements of Item 529, “Concrete Curb, Gutter, and Combined Curb and Gutter.”

4. Temperature Restrictions. Place concrete that is between 40°F and 95°F when measured in accordance with Tex-422-A at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.
Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or above 40°F. When temperatures warrant protection against freezing, protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72 hr. after placement. Repair or replace all concrete damaged by freezing.

**H. Spreading and Finishing.** Finish all concrete pavement with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.

1. **Finished Surface.** Perform sufficient checks with long-handled 10-ft. and 15-ft. straightedges on the plastic concrete to ensure that the final surface is within the tolerances specified in Surface Test A in Item 585, “Ride Quality for Pavement Surfaces.” Check with the straightedge parallel to the centerline.

2. **Maintenance of Surface Moisture.** Prevent surface drying of the pavement before application of the curing system. Accomplish this by fog applications of evaporation retardant on the pavement surface. Apply evaporation retardant at the rate recommended by the manufacturer. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shut down of pavement operations.

3. **Surface Texturing.** Perform surface texturing using a combination of a carpet drag and metal tining. Complete final texturing before the concrete has attained its initial set. Draw the carpet drag longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. A metal-tine texture finish is required unless otherwise shown on the plans. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves spaced at 1 in., approximately 3/16 in. deep, with a minimum depth of 1/8 in., and approximately 1/12 in. wide. Do not overlap a previously tined area. Use manual methods for achieving similar results on ramps and other irregular sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid.

4. **Small or Irregular Placements.** Where machine placements and finishing of concrete pavement are not practical, use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade.

5. **Emergency Procedures.** Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.

**I. Curing.** Keep the concrete pavement surface from drying by water fogging until the curing material has been applied. Maintain and promptly repair damage to curing materials on
exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24-hr. period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hr. or when the surface temperature of the concrete is maintained above 40°F for 24 hr. Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 420, “Concrete Structures,” may be used when specified or approved.

1. Membrane Curing. After texturing and immediately after the free surface moisture has disappeared, spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of not more than 180 sq. ft. per gallon. Apply the first coat within 10 min. after completing texturing operations. Apply the second coat within 30 min. after completing texturing operations. Before and during application, maintain curing compounds in a uniformly agitated condition, free of settlement. Do not thin or dilute the curing compound. Where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage, apply additional compound at the same rate of coverage to correct the damage. Ensure that the curing compound coats the sides of the tining grooves.

2. Asphalt Curing. When an asphaltic concrete overlay is required, apply a uniform coating of asphalt curing at a rate of 90 to 180 sq. ft. per gallon as required. Apply curing immediately after texturing and just after the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.

3. Curing Class HES Concrete. For all Class HES concrete pavement, provide membrane curing in accordance with Section 360.4.1.1, “Membrane Curing,” followed promptly by water curing until opening strength is achieved but not less than 24 hr.

J. Sawing Joints. Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hr. of curing.

K. Protection of Pavement and Opening to Traffic. Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown in the plans or directed. Testing result interpretation for opening to traffic is subject to the approval of the Engineer.

1. Protection of Pavement. Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Before opening to traffic, protect the pavement from damage due to crossings using approved methods. Where a detour is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted.
for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required. Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

2. Opening Pavement to All Traffic. Pavement that is 7 days old may be opened to all traffic. Before opening to traffic, clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work.

3. Opening Pavement to Construction Equipment. Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hr. old and opening strength has been demonstrated in accordance with Section 360.4.K.4, “Early Opening to All Traffic,” before curing is complete. Keep delivery equipment at least 2 ft. from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 ft. from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.

4. Early Opening to All Traffic. Concrete pavement may be opened after curing is complete and the concrete has attained a flexural strength of 450 psi or a compressive strength of 2,800 psi, except that pavement using Class HES concrete may be opened after 24 hr. if the specified strength is achieved.
   a. Strength Testing. Test concrete specimens cured under the same conditions as the portion of the pavement involved.
   b. Maturity Method. Unless otherwise shown on the plans, the maturity method, Tex-426-A, may be used to estimate concrete strength for early opening pavement to traffic. Install at least 2 maturity thermocouples for each day’s placement in areas where the maturity method will be used for early opening. Thermocouples, when used, will be installed near the days final placement for areas being evaluated for early opening. Use test specimens to verify the strength–maturity relationship in accordance with Tex-426-A, starting with the first day’s placement corresponding to the early opening pavement section. After the first day, verify the strength–maturity relationship at least every 10 days of production. Establish a new strength–maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength–maturity relationship deviates by more than 10% until a new strength–maturity relationship is established. When the maturity method is used intermittently or for only specific areas, the frequency of verification will be as determined by the Engineer.

5. Emergency Opening to Traffic. Under emergency conditions, when the pavement is at least 72 hr. old, open the pavement to traffic when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.
L. Pavement Thickness. The Engineer will check the thickness in accordance with Tex-423-A unless other methods are shown on the plans. The Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of each lane every 500 ft. or fraction thereof. Core where directed in accordance with Tex-424-A to verify deficiencies of more than 0.2 in. from plan thickness and to determine the limits of deficiencies of more than 0.75 in. from plan thickness. Fill core holes using a concrete mixture and method approved by the Engineer.

1. Thickness Deficiencies Greater than 0.2 in. When any depth test measured in accordance with Tex-423-A is deficient by more than 0.2 in. from the plan thickness, take one 4-in. diameter core at that location to verify the measurement. If the core is deficient by more than 0.2 in. but not by more than 0.75 in. from the plan thickness, take 2 additional cores from the unit (as defined in Section 360.4.L.3, “Pavement Units for Payment Adjustment”) at intervals of at least 150 ft. and at locations selected by the Engineer, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 in. will be considered as the specified thickness plus 0.2 in.

2. Thickness Deficiencies Greater than 0.75 in. If a core is deficient by more than 0.75 in., take additional cores at 10 ft. intervals in each direction parallel to the centerline to determine the boundary of the deficient area. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 in. but not more than 1 in. As directed, remove and replace the deficient areas without additional compensation or retain deficient areas without compensation. Remove and replace any area of pavement found deficient in thickness by more than 1 in. without additional compensation.

3. Pavement Units for Payment Adjustment. Limits for applying a payment adjustment for deficient pavement thickness from 0.20 in. to not more than 0.75 in. are 500 ft. of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards. For greater than 0.75 in. deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 in. deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10 ft. interval investigation as determined by the Engineer. Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 ft. wide or wider will be considered as lanes. Shoulders less than 6 ft. wide will be considered part of the adjacent lane. Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 ft. in length. Areas less than 500 ft. in length will be individually evaluated for payment adjustment based on the plan area.

M. Ride Quality. Unless otherwise shown on the plans, measure ride quality in accordance with Item 585, “Ride Quality for Pavement Surfaces.“
360.5. **Measurement.** This Item will be measured as follows:

A. **Concrete Pavement.** Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.

B. **Curb.** Curb on concrete pavement will be measured by the foot in place.

1.3.9. **FULL-DEPTH REPAIR OF CONCRETE PAVEMENT**

361.1. **Description.** Repair concrete pavement to full depth.

361.2. **Materials.** Provide materials that meet the pertinent requirements of the following:

- Item 360, “Concrete Pavement”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- DMS 6100, “Epoxies and Adhesives.”

A. **Hydraulic Cement Concrete for Pavement.** If the time frame designated for opening to traffic is less than 72 hr. after concrete placement, provide Class HES concrete designed to attain a minimum average flexural strength of 255 psi or a minimum average compressive strength of 1,800 psi within the designated time frame. Otherwise provide Class P concrete conforming to Item 360, “Concrete Pavement.” Type III cement is permitted for Class HES concrete.

B. **Base Material.** Unless otherwise shown on the plans or permitted, furnish pavement concrete for replacement base material when required. The Engineer may waive quality control tests for base material.

C. **Asphalt Concrete.** Furnish asphalt concrete material for overlay and asphalt shoulder repair in accordance with Item 340, “Dense-Graded Hot-Mix Asphalt (Method),” as shown on the plans. The Engineer may waive quality control tests for this material.

361.3. **Construction.** Repair areas identified by the Engineer. Make repair areas rectangular, at least 6 ft. long and at least 1/2 a full lane in width unless otherwise shown on the plans. Unless otherwise shown on the plans, accept ownership of all removed material, and dispose of it in accordance with federal, state, and local regulations. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 in. outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Schedule work so that concrete placement follows full-depth saw cutting by no more than 7 days unless otherwise shown on the plans or approved.

Remove or repair loose or damaged base material, and replace or repair it with approved base material to the original top of base grade. Place a polyethylene sheet at least 4 mils thick as a bond breaker at the interface of the base and new pavement. Allow concrete used as base
material to attain sufficient strength to prevent displacement when placing pavement concrete.

Use only drilling operations that do not damage the surrounding operations. Place new deformed reinforcing steel bars of the same size and spacing as the bars removed or as shown on the plans. Lap all reinforcing steel splices in accordance with Item 440, “Reinforcing Steel.” Place dowel bars and tiebars as shown on the plans. Epoxy-grout all tiebars for at least a 12-in. embedment into existing concrete. Completely fill the tiebar hole with Type III, Class A or Class C epoxy before inserting the tiebar into the hole. Provide grout retention disks for all tiebar holes. Provide and place approved supports to firmly hold the new reinforcing steel, tiebars, and dowel bars in place. Demonstrate, through simulated job conditions, that the bond strength of the epoxy-grouted tiebars meets a pullout strength of at least 3/4 of the yield strength of the tiebar when tested in accordance with ASTM E 488 within 18 hr. after grouting. Increase embedment depth and retest when necessary to meet testing requirements. Perform tiebar testing before starting repair work.

Mix, place, cure, and test concrete to the requirements of Item 360, “Concrete Pavement,” and Item 421, “Hydraulic Cement Concrete.” Broom-finish the concrete surface unless otherwise shown on the plans. Match the grade and alignment of existing concrete pavement. After concrete strength requirements have been met, replace any asphalt overlay and shoulder material removed with new asphalt concrete material in accordance with Item 340, “Dense-Graded Hot-Mix Asphalt (Method).”

For repair areas to be opened to traffic before 72 hr., use curing mats to maintain a minimum concrete surface temperature of 70°F when air temperature is less than 70°F. Cure repaired area for at least 72 hr. or until overlaid with asphalt concrete, if required, or until the area is opened to traffic. Saw and seal contraction joints in the repair area in accordance with Item 360, “Concrete Pavement.” Remove repair area debris from the right of way each day.

361.4. Measurement. This Item will be measured by the square yard of concrete surface area repaired. No measurement will be made for areas damaged because of Contractor negligence.

1.3.10. CONCRETE PAVEMENT TERMINALS


368.2. Materials. Furnish materials conforming to the following:

- Item 360, “Concrete Pavement”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- Item 442, “Metal for Structures.”

Use ASTM A 36 steel for wide-flange structural steel. Shop-fabricate wideflange beams in accordance with the plans. Unless otherwise shown on the plans, wide-flange beams are not required to be welded or spliced at longitudinal construction joints.

368.3. Construction. Construct concrete pavement terminals in accordance with the plans.
A. Excavation, Backfilling, and Base Preparation. Excavate and backfill in accordance with Item 400, “Excavation and Backfill for Structures,” and the plans. Avoid over-excavation. Restore subgrade and base layers damaged by excavation. Construct subgrade, base, and pavement layers in accordance with the plans.

B. Reinforcement and Structural Steel. Secure reinforcement in position before concrete placement in accordance with Item 440, “Reinforcing Steel,” and the plans. Accurately secure wide-flange beams in position in accordance with the plans and with sufficient supports to safely maintain alignment during concrete placement and finishing.

C. Concrete Placement and Finishing. Use Class P hydraulic cement concrete. Place hydraulic concrete pavement in accordance with Item 360, “Concrete Pavement.” Place bridge approach slabs in accordance with Item 420, “Concrete Structures.”

D. Opening to Traffic. Open concrete pavement terminal to traffic in conformance with Item 360, “Concrete Pavement.”

368.4. Measurement. This Item will be measured by the foot of concrete pavement terminal complete in place. Measurement will be made perpendicular to the direction of the flow of traffic.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurement or calculations will be made if adjustments of quantities are required.
1.4 STRUCTURES (ITEMS 400)

1.4.1. EXCAVATION AND BACKFILL FOR STRUCTURES

400.1. Description. Excavate for placement and construction of structures and backfill structures. Cut and restore pavement.

400.2. Materials. Use materials that meet the requirements of the following Items:
- Item 401, “Flowable Backfill”
- Item 421, “Hydraulic Cement Concrete”
- DMS-4600, “Hydraulic Cement.”

400.3. Construction. A. Excavation.

1. General. Excavate to the lines and grades shown on the plans or as directed. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations up to 5 ft. deep. Excavation protection for excavations deeper than 5 ft. are governed by Item 402, “Trench Excavation Protection,” and Item 403, “Temporary Special Shoring.” Use satisfactory excavated material as backfill or as embankment fill in accordance with Item 132, “Embarkment.” Dispose of material not incorporated into the final project off the right of way in accordance with federal, state, and local regulations. When excavating for installation of structures across private property or beyond the limits of the embankment, keep any topsoil removed separate, and replace it, as nearly as feasible, in its original position. Restore the area to an acceptable condition. Excavate drilled shafts in accordance with Item 416, “Drilled Shaft Foundations.”

a. Obstructions. Remove obstructions to the proposed construction, including trees and other vegetation, debris, and structures, over the width of the excavation to a depth of 1 ft. below the bottom of excavation. If abandoned storm drains, sewers, or other drainage systems are encountered, remove as required to clear the new structure, and plug in an approved manner. After removing obstructions, restore the bottom of the excavation to grade by backfilling in accordance with this Item. Dispose of surplus materials in accordance with federal, state, and local regulations.

b. Excavation in Streets. When structures are installed in streets, highways, or other paved areas, cut pavement and base to neat lines. Restore pavement structure after completion of excavation and backfilling. Maintain and control traffic in accordance with the approved traffic control plan and the TMUTCD.

c. Utilities. Comply with the requirements of Article 7.12, “Responsibility for Damage Claims.” Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners sufficiently before work begins to allow them time to identify, locate, reroute, or make other adjustments to utility lines.
Avoid cutting or damaging underground utility lines that are to remain in place. If damage occurs, promptly notify the utility company. If an active sanitary sewer line is damaged during excavation, provide temporary flumes across the excavation while open, and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

d. De-Watering. Do not construct or place structures in the presence of water unless approved. Place precast members, pipe, and concrete only on a dry, firm surface. Remove water by bailing, pumping, well-point installation, deep wells, underdrains, or other approved method.

If structures are approved for placement in the presence of water, remove standing water in a manner that does not allow water movement through or alongside concrete being placed. Do not pump or bail while placing structural concrete or for a period of at least 36 hr. thereafter unless from a suitable sump separated from the concrete work. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Do not pump or bail to de-water inside a sealed cofferdam until the seal has aged at least 36 hr.

If the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep reinforcing steel clean, place a stabilizing material in the bottom of the excavation. Stabilizing material may be flexible base, cement-stabilized base or backfill, lean concrete, or other approved material. If lean concrete is used, provide concrete with at least 275 lb. of cement per cubic yard, and place to a minimum depth of 3 in. Stabilizing material placed for the convenience of the Contractor will be at the Contractor’s expense.

2. Bridge Foundations and Retaining Walls. Do not disturb material below the bottom of footing grade. Do not backfill to compensate for excavation that has extended below grade. If excavation occurs below the proposed footing grade, fill the area with concrete at the time the footing is placed. The additional concrete placed will be at the Contractor’s expense. If requested, take cores to determine the character of the supporting materials. Provide an intact sample adequate to judge the character of the founding material. Take these cores when the excavation is close to completion. Cores should be approximately 5 ft. deeper than the proposed founding grade.

If the founding stratum is rock or other hard material, remove loose material, clean, and cut to a firm surface that is level, stepped, or serrated, as directed. Clean out soft seams, and fill with concrete at the time the footing is placed.

If the material at the footing grade of a retaining wall, bridge bent, or pier is a mixture of compressible and incompressible material, do not place the foundation until the Engineer has inspected the excavation and authorized changes have been made to provide a uniform bearing condition.

3. Cofferdams. The term “cofferdam” designates any temporary or removable structure constructed to hold surrounding earth, water, or both out of the excavation whether the structure is formed of soil, timber, steel, concrete, or a combination of these. Cofferdams may require the use of pumping wells or well points for dewatering.

For sheet-pile or other types of cofferdams requiring structural members, submit details and design calculations bearing the seal of a licensed professional engineer for review before constructing the cofferdam. The Department reserves the right to reject designs.

Design structural systems to comply with the AASHTO Standard Specifications for Highway Bridges or AASHTO LRFD Bridge Design Specifications. Interior dimensions of cofferdams must
provide sufficient clearance for the construction, inspection, and removal of required forms and, if necessary, sufficient room to allow pumping outside the forms. In general, extend sheet-pile cofferdams well below the bottom of the footings, and make concrete seals as well braced and watertight as practicable.
For foundation seals, use Class E concrete unless otherwise specified. Place concrete foundation seals in accordance with Item 420, “Concrete Structures.” Seals placed for the convenience of the Contractor will be at the Contractor’s expense.
When the Engineer judges it to be impractical to de-water inside a cofferdam and a concrete seal is to be placed around piling driven within the cofferdam, make the excavation deep enough to allow for swelling of the material at the base of the excavation during pile-driving operations. After driving the piling, remove swelling material to the bottom of the seal grade. Where it is possible to dewater inside the cofferdam without placing a seal, remove the foundation material to exact footing grades after driving piling. Do not backfill a foundation to compensate for excavation that has been extended below grade; fill such areas below grade with concrete at the time the seals or footings are placed.
Unless otherwise provided, remove cofferdams after completing the substructure without disturbing or damaging the structure.

4. Culverts and Storm Drains. When the design requires special bedding conditions for culverts or storm drains, an excavation diagram will be shown on the plans. Do not exceed these limits of excavation.

Unless otherwise shown on the plans, construct pipe structures in an open cut with vertical sides extending to a point 1 ft. above the pipe. When site conditions or the plans do not prohibit sloping the cut, the excavation may be stepped or laid back to a stable slope beginning 1 ft. above the pipe. Maintain the stability of the excavation throughout the construction period.

For pipe to be installed in fill above natural ground, construct the embankment to an elevation at least 1 ft. above the top of the pipe, and then excavate for the pipe.

a. Unstable Material. When unstable soil is encountered at established footing grade, remove the material to a depth of no more than 2 ft. below the grade of the structure unless the Engineer authorizes additional depth. Replace soil removed with stable material in uniform layers at most 8 in. deep (loose measurement). Each layer must have enough moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure. When it is not feasible to construct a stable foundation as outlined above, use special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other approved material.
b. Incompressible Material. If rock, part rock, or other incompressible material is encountered at established footing grade while placing prefabricated elements, remove the incompressible material to 6 in. below the footing grade, backfill with an approved compressible material, and compact in accordance with Section 400.3.C, “Backfill.”

B. Shaping and Bedding. For precast box sections, place at least 2 in. of fine granular material on the base of the excavation before placing the box sections. For pipe installations, use bedding as shown in Figure 1.
Use Class C bedding unless otherwise shown on the plans. The Engineer may require the use
of a template to secure reasonably accurate shaping of the foundation material. Where cement-stabilized backfill is indicated on the plans, undercut the excavation at least 4 in. and backfill with stabilized material to support the pipe or box at the required grade.

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<tr>
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<tr>
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<td>30” to 60”</td>
<td>4”</td>
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<tr>
<td></td>
<td>≥ 66”</td>
<td>6”</td>
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</table>

**CLASS A**

**CLASS B**

**CLASS C**

*Figure 1*

Bedding diagrams.
C. Backfill.

1. General. As soon as practical, backfill the excavation after placement of the permanent structure. Use backfill free from stones large enough to interfere with compaction; large or frozen lumps that will not break down readily under compaction; and wood or other extraneous material. Obtain backfill material from excavation or from other sources. In areas not supporting a completed roadbed, retaining wall, or embankment, place backfill in layers at most 10 in. deep (loose measurement). In areas supporting a portion of a roadbed, retaining wall, or embankment, place backfill in uniform layers at most 8 in. deep (loose measurement). Compact each layer to meet the density requirements of the roadbed, retaining wall, embankment material, or as shown on the plans. Bring each layer of backfill material to the moisture content needed to obtain the required density. Use mechanical tamps or rammers to compact the backfill. Rollers may be used to compact backfill if feasible. Cohesionless materials such as sand may be used for backfilling. Compact cohesionless materials using vibratory equipment, waterponding, or a combination of both.

2. Bridge Foundations, Retaining Walls, and Box Culverts. Do not place backfill against the structure until the concrete has reached the design strength required in Item 421, “Hydraulic Cement Concrete.” Backfill retaining walls with material meeting the requirements of Item 423, “Retaining Walls.” Backfill around bridge foundations and culverts using material with no particles more than 4 in. in greatest dimension and with a gradation that permits thorough compaction. Rock or gravel mixed with soil may be used if the percentage of fines is sufficient to fill all voids and ensure a uniform and thoroughly compacted mass of proper density. Where backfill material is being placed too close to the structure to permit compaction with blading and rolling equipment, use mechanical tamps and rammers to avoid damage to the structure. Avoid wedging action of backfill against structures. To prevent such action, step or serrate slopes bounding the excavation. Place backfill uniformly around bridge foundations. Place backfill along both sides of culverts equally and in uniform layers. The Engineer may require backfilling of structures excavated into hard, erosion-resistant material, and subject to erosive forces, with stone or lean concrete. Box culverts may be opened to traffic as soon as sufficient backfill and embankment has been placed over the top to protect culverts against damage from heavy construction equipment. Repair damage to culvert caused by construction traffic at no additional expense to the Department.

3. Pipe. After installing bedding and pipe as required, bring backfill material to the proper moisture condition and place it equally along both sides of the pipe in uniform layers at most 8 in. deep (loose measurement). Compact each lift mechanically. Thoroughly compact materials placed under the haunches of the pipe to prevent damage or displacement of the pipe. Continue to place backfill in this manner to the top-of-pipe elevation. Place and compact backfill above the top of the pipe in accordance with Section 400.3.C.1. “General.” The Engineer may reject backfill material containing more than 20% by weight of material retained on a 3-in. sieve; with large lumps not easily broken down; or that cannot be spread in loose layers. Material excavated by a trenching machine will generally meet the requirements of this Section as long as large stones are not present.
Where pipe extends beyond the toe of slope of the embankment and the depth of cover provided by backfill to the original ground level is less than the minimum required by the specifications for the type of pipe involved, place and compact additional material until the minimum cover has been provided.

4. Cement-Stabilized Backfill. When shown on the plans, backfill the excavation to the elevations shown with cement-stabilized backfill. Use cement-stabilized backfill that contains aggregate, water, and a minimum of 7% hydraulic cement based on the dry weight of the aggregate, in accordance with Tex-120-E. Use clean sand as aggregate for cement-stabilized backfill unless otherwise shown on the plans. Use only approved aggregate. Place cement-stabilized backfill equally along the sides of structures to prevent strain on or displacement of the structure. Fill voids when placing cement-stabilized backfill. Use hand operated tampers if necessary to fill voids.

5. Flowable Backfill. When shown on the plans, backfill the excavation with flowable backfill to the elevations shown. Prevent the structure from being displaced during the placement of the flowable fill, and prevent flowable fill from entering culverts and drainage structures.

400.4. Measurement. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

A. Structural Excavation. Unless shown on the plans as a pay item, structural excavation quantities shown are for information purposes only.

When structural excavation is specified as a pay item, structural excavation for pipe headwalls, inlets, manholes, culvert or storm drain extensions less than 15 ft. long, bridge abutments, retaining walls, and side road and private entrance pipe culverts will not be measured. No allowance will be made for variance from plans quantity incurred by an alternate bid.

When specified as a pay item, structural excavation will be measured by the cubic yard as computed by the average end areas method. Excavation diagrams on the plans take precedence over the provisions of this Article.

1. Boundaries of Measurement.
   a. Pipe.
      (1) Pipe up to 42 Inches. For pipe 42 in. or less in nominal or equivalent diameter, no material outside of vertical planes 1 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included.
      (2) Pipe Larger than 42 Inches. For pipes larger than 42-in. nominal or equivalent diameter, no material outside of vertical planes located 2 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included. Quantities for excavation in fill above natural ground include 1 ft. above the top of the pipe regardless of the height of completed fill. Excavation for pipe will be measured between the extreme ends of the completed structure including end appurtenances as shown on the plans and from centerline to centerline of inlets, manholes, etc.
b. **Structural Plate Structures.** No material outside of vertical planes 3 ft. beyond and parallel to the horizontal projection of the outside surfaces of the structure will be included. When the quality of the existing soil or embankment is less than that of the proposed backfill material, the limits of measurement will be extended to vertical planes located 1/2 of the span beyond the horizontal projection of the outside surfaces of the structure.

c. **Footings, Walls, Boxes, and Other Excavation.** No material outside of vertical planes 1 ft. beyond and parallel to the edges of the footings or outside walls will be included whether or not a cofferdam or shoring is used. When plans provide the option of cast-in-place or precast boxes, measurement will be based on the cast-in-place option. Where excavation in addition to that allowed for the footings is required for other portions of the structure, measurement for the additional excavation will be limited laterally by vertical planes 1 ft. beyond the face of the member and parallel to it, and vertically to a depth of 1 ft. below the bottom of the member.

d. **Excavation near Roadways and Channels.** At structure sites other than culverts and pipe excavations, the measurement of structural excavation will include only material below or outside the limits of the completed road or channel excavation. Roadway and channel excavation will be paid under Item 110, “Excavation.” For culverts except side road and private entrance culverts, excavation within the limits of the structure and below or outside the limits of the completed roadway excavation will be measured as structural excavation.

2. **Falsework.** No measurement will be made for excavation necessary for placing forms or falsework that exceeds the limits given in Section 400.4.B.1, “Boundaries of Measurement.”

3. **Swelling.** Measurement will not include materials removed below footing grades to compensate for anticipated swelling due to pile driving, nor will it include material required to be removed due to swelling beyond the specified limits during pile driving operations.

4. **Cave-ins.** Measurement will not include additional volume caused by slips, slides, cave-ins, silting, or fill material resulting from the action of the elements or the Contractor’s operation.

5. **Undercut.** Where rock or other incompressible or unstable material is undercut to provide a suitable foundation for pipe or box sections, such material below grade directed to be removed will be measured for payment.

6. **Grade Change.** Additional measurement will be made of the volume of excavation involved in the lowering or raising of the elevation of a footing, foundation, or structure unit, when such grade change is authorized.

B. **Cement-Stabilized Backfill.** Cement-stabilized backfill will be measured by the cubic yard as shown on the plans.

C. **Cutting and Restoring Pavement.** Cutting and restoring pavement will be measured by the square yard as shown on the plans. Excavation below pavement or base will be measured as structural excavation of the pertinent type.

**1.4.2. FLOWABLE BACKFILL**

401.1. **Description.** Furnish and place flowable backfill for trench, hole, or other void.

A. Cement. Furnish cement conforming to DMS-4600, “Hydraulic Cement.”


C. Chemical Admixtures. Furnish chemical admixtures conforming to DMS-4640, “Chemical Admixtures for Concrete.”

D. Fine Aggregate. Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1.

Table 1
Aggregate Gradation Chart

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
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</thead>
<tbody>
<tr>
<td>3/4 in.</td>
<td>100</td>
</tr>
<tr>
<td>No. 200</td>
<td>0–30</td>
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</table>

Test fine aggregate gradation in accordance with Tex-401-A. Plasticity Index (PI) must not exceed 6 when tested in accordance with Tex-106-A.

E. Mixing Water. Use mixing water conforming to the requirements of Item 421, “Hydraulic Cement Concrete.”

401.3. Construction. Submit a construction method and plan, including mix design and shrinkage characteristics of the mix, for approval. Provide a means of filling the entire void area, and be able to demonstrate that this has been accomplished. Prevent the movement of any inserted structure from its designated location. If voids are found in the fill or if any of the requirements are not met as shown on the plans, remove and replace or correct the problem without additional cost to the Department. Unless otherwise shown on the plans, furnish a mix meeting the requirements of Sections 01.3.A, “Strength,” and 401.3.B, “Consistency.”

A. Strength. The 28-day compressive strength range, when tested in accordance with Tex-418-A, must be between 80 psi and 150 psi unless otherwise directed. Two specimens are required for a strength test, and the compressive strength is defined as the average of the breaking strength of the 2 cylinders.

B. Consistency. Design the mix to be placed without consolidation and to fill all intended voids. Fill an open-ended, 3-in.-diameter-by-6-in.-high cylinder to the top to test the consistency. Immediately pull the cylinder straight up. The correct consistency of the mix must produce a minimum 8-in.-diameter circular spread with no segregation. When necessary, use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension. All admixtures must be used and proportioned in accordance with the manufacturer’s recommendations.
Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method. Furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removal, and disposal of test specimens. Furnish test molds meeting the requirements of Tex-447-A. Transport, strip, and cure the test specimens as scheduled at the designated location. Cure test specimens in accordance with Tex-447-A. The Engineer will sample, make, and test all specimens. Dispose of used, broken specimens in an approved location and manner. The frequency of job control testing will be at the direction of the Engineer.

401.4. Measurement. This Item will be measured by the cubic yard of material placed. Measurement will not include additional volume caused by slips, slides, or cave-ins resulting from the Contractor’s operations.

401.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Flowable Backfill.” This price is full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals.

1.4.3. TRENCH EXCAVATION PROTECTION

402.1. Description. Furnish and place excavation protection for trenches deeper than 5 ft.

402.2. Construction. Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, “Excavations.”

402.3. Measurement. This Item will be measured by the foot along the long axis of the trench where the depth of trench exceeds 5 ft. This measurement includes all required trench protection, including trench ends.

402.4. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Trench Excavation Protection.” This price is full compensation for excavation and backfill required for excavation protection; furnishing, placing, and removing shoring, sheeting, or bracing; dewatering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

1.4.4. TEMPORARY SPECIAL SHORING

403.1. Description. Furnish and install temporary shoring to hold the surrounding earth, water, or both out of the work area.
403.2. Materials. Furnish new or used materials. When using temporary mechanically stabilized earth (MSE) walls, furnish materials that comply with the requirements of Item 423, “Retaining Walls.”

403.3. Construction. Unless complete details are included in the plans, the Contractor is responsible for the temporary special shoring design. Submit details and design calculations bearing the seal of a licensed professional engineer before constructing the shoring. The Department reserves the right to reject designs. Design the shoring to comply with OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, “Excavations.” Design structural systems to comply with AASHTO Standard Specifications for Highway Bridges or AASHTO LRFD Bridge Design Specifications. Design shoring subject to railroad loading to comply with the AREMA Manual for Railway Engineering and any additional requirements of the railway being supported.
Provide vertical or sloped cuts, benches, shields, support systems, or other systems to provide the necessary protection in accordance with the approved design. Construct temporary MSE walls, when used, in accordance with the requirements of Item 423, “Retaining Walls.”

403.4. Measurement. This Item will be measured by the square foot of surface area of a vertical plane at the face of the shoring between the top of the ground being supported and the minimum protection grade line shown on the plans. If no minimum protection grade is shown on the plans, the lowest required excavated elevation will be used. Shoring projecting above the level of the ground being supported will not be measured. When excavation techniques (e.g., sloped cuts or benching) are used to provide the necessary protection, the surface area for payment will be calculated based on the area described by a vertical plane adjacent to the structure.

403.5. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Temporary Special Shoring.” This price is full compensation for excavation and backfill; furnishing, placing and removing shoring, sheeting, or bracing; dewatering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.
No payment will be made for special shoring made necessary by the selection of an optional design or sequence of work that creates the need for shoring.

1.4.5. DRIVING PILLING

404.1. Description. Drive piling.

404.2. Equipment.

A. Driving Equipment. Use power hammers for driving piling with specified bearing resistance. Use power hammers that comply with Table 1. Gravity hammers may be used for driving sheet piling and timber piling if no required design load is shown on the plans. For initial rating of diesel hammers to determine compliance with the requirements of Table 1, the height of fall of the ram of the singleacting (open-end) hammer must be 7 ft. For a double-acting (enclosed ram) hammer, the energy rating must be 85% of the rated output by the manufacturer. A
hammer that produces less energy than required by Table 1 may be approved if a wave equation analysis indicates that the hammer can drive the specified pile against a bearing resistance of 3 times the required design load before reaching 0.1 in. of penetration per blow. The bearing resistance of the piling driven with this particular equipment will be determined in accordance with the Wave Equation Method.

Use an air compressor that supplies the volume and pressure specified by the manufacturer of the hammer. Provide an accurate pressure gauge.

Maintain the valve mechanism and other parts of power hammers so that the hammer will operate at the speed and stroke length specified by the manufacturer.

Equip enclosed ram diesel hammers with a gauge and provide charts to evaluate the equivalent energy being produced. Calibrate the gauge before work begins, whenever gauge accuracy is in question, and at least once each 6 months.

<table>
<thead>
<tr>
<th>Piling Type</th>
<th>Hammer Type</th>
<th>Ram Weight (lb.)</th>
<th>Maximum Ram Stroke (ft.)</th>
<th>Minimum Hammer Energy (ft.-lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>Air, Hydraulic</td>
<td>2,000 min.</td>
<td>5</td>
<td>330R</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>2,000 min.</td>
<td>10</td>
<td>330R</td>
</tr>
<tr>
<td>Steel</td>
<td>Air, Hydraulic</td>
<td>3,000 min.</td>
<td>5</td>
<td>Larger of 250R or 2-1/2 Wp</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>2,000 min.</td>
<td>10</td>
<td>Larger of 250R or 2-1/2 Wp</td>
</tr>
<tr>
<td>Concrete</td>
<td>Air, Hydraulic</td>
<td>3,000 min., but not less than 1/4 Wp</td>
<td>5</td>
<td>250R, but not less than 1 ft.-lb. per lb. of pile weight</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>2,700 min., but not less than 1/4 Wp</td>
<td>8</td>
<td>250R, but not less than 1 ft.-lb. per lb. of pile weight</td>
</tr>
</tbody>
</table>

1. R = Design load in tons. Wp = Weight of pile in pounds based on plan length.
2. Diesel hammers with less ram weight or greater ram stroke are permitted if a wave equation analysis indicates that the combination of ram weight, stroke, and cushioning will not overstress the piling.
Cap block cushioning material, when used between the ram and anvil or follow block, must consist of layers of micarta plastic and aluminum or other material specifically produced and approved for this application.

When using gravity hammers, regulate the height of fall to avoid damage to the piling. Drive all test piling in a structure or in any approved segment of it with the same hammer, and use the same type and size hammer to drive the remainder of the piling in the structure or segment.

Equip pile drivers with leads constructed to allow freedom of movement of the hammer and to provide adequate support to the pile during driving. The longitudinal axis of the leads, hammer, and pile should coincide.

Except where piling is driven through water, ensure that leads are long enough that a follower will not be necessary. Where a follower is required when driving piling underwater, use 1 pile in each 10 that is long enough to permit driving without a follower. Drive it as a test pile for proper correlation of the follower-driven piling. Payment will be made as regular piling.

Hammers designed to operate underwater may be used for underwater driving without a follower and without the correlation required for other hammers.

B. Protection of Pile Heads. Use a steel driving head (helmet) suitable for the type and size of piling. Drive steel H-piling and sheet piling with a helmet compatible with the specific pile shape driven.

For concrete piling, provide a cushion block between the driving head and the top of the pile. Unless otherwise directed, use a cushion block that is a minimum of 4 in. thick for short piling (50 ft. or less) and at least 6 in. thick for longer piling. Use multiple layers of one of the following:

- 3/4-in. or 1-in. structural grade southern pine or fir plywood;
- green oak or gum, with the grain of the wood horizontal; or
- other approved material specifically produced for this application.

Pay special attention to the condition of the cushioning material. Do not drive more than 3 piles with one cushion block. Change cushioning more frequently if necessary to prevent damage. Immediately replace any cushion block that has ignited. Do not use a tight-fitting driving helmet for concrete piling. Allow room for slight movement, but ensure that the driving helmet is not large enough for the pile head to rotate freely. Center concrete piling and cushion within the helmet throughout the driving operation.

404.3. Construction. This Item uses the following terms:

- Foundation piling – Piling placed under interior bent footings or retaining wall abutment footings.
- Trestle piling – Piling embedded directly into the abutment cap or interior bent cap.
- Sheet piling – Retaining piling not considered either foundation or trestle piling.
- Test piling – Specific piling driven to investigate site conditions and determine regular piling lengths.
- Test-loaded piling – Specific piling driven and test-loaded to investigate site conditions and determine regular piling lengths. Do not fabricate regular piling until test loading and analysis is completed.
- Regular piling – All piling other than test piling and test-loaded piling. Do not fabricate regular piling until test pile driving and analysis or test loading and analysis is completed.
Complete the embankment at bridge ends before driving abutment piling. Refer to Item 423, “Retaining Walls,” for provisions on piling that passes through the structural volume of retaining walls.

Do not drive foundation piling until the footing excavation is approximately complete. Do not drive concrete piling until the piling concrete, including build-ups, has aged at least 14 days.

Do not drive piling in a saltwater environment until the piling concrete, including build-ups, has aged at least 21 days after concrete placement.

Re-drive any piling that is raised when driving adjacent piling. Withdraw and replace any broken, split, or displaced piling, or correct it as directed after a design analysis.

To control excessive stresses resulting in damage to the piling during driving, the following, alone or in combination, may be required:

- increase in cushion thickness,
- reduction of ram stroke,
- heavier ram with a shorter stroke,
- use of pilot holes or jetting when driving through hard or alternating hard and soft strata.

A. Tolerance for Driving. Drive piling to the required vertical or batter alignment, within the tolerances of this Section. Drive piling in pilot holes or with templates when necessary to comply with tolerances. Cut off piling reasonably square at the elevation shown on the plans, with a tolerance of not more than 2 in. above or below established cutoff grade. When tolerances are exceeded and the Engineer requires corrective action, submit for approval a structural analysis and proposed corrective action, signed and sealed by a licensed professional engineer.

1. Trestle Piling.
   - Transverse to the centerline of the bent, the top of the piling may be at most 2 in. from the position shown on the plans.
   - Parallel to the centerline of the bent, the top of the piling may be at most 4 in. from the position shown on the plans.

2. Foundation Piling.
   - The top of each pile may be at most 4 in. in any direction from the position shown on the plans.
   - The center of gravity of the piling group may be at most 3 in. from the center of gravity determined from plan location.
   - The minimum edge distance for piling in a footing is 5 in. Additional concrete required to obtain this edge distance and specified reinforcing steel cover will be at the Contractor’s expense.

B. Penetration. Piling lengths shown on the plans are the lengths estimated to give required bearing and are for estimating purposes only. Drive piling to within 5 ft. of plan length and to greater depths as necessary to obtain the required bearing resistance shown on the plans, unless other penetration requirements or bearing evaluation methods govern.

When test piling or test loaded piling is used, the Engineer will establish regular pile lengths on the basis of the test data. In these cases, drive regular piling to this approximate elevation and to greater depths as required to obtain the required bearing resistance.

For unusually hard driving conditions, typically less than 0.1 in. of penetration per blow, provide either pilot holes or jetting or a combination of both if plan penetration is not obtained. Penetration may be reduced upon approval if stability requirements are met.
C. Pilot Holes. Except as specified, do not extend pilot holes more than 5 ft. below the bottom of footings for foundation piling or 10 ft. below finished ground line for trestle piling, unless the specified penetration cannot be obtained by using the depth of holes indicated. When deeper pilot holes are required, determine their size and depth from the results of trial operations on the first piling driven or from available test pile data. Obtain approval for any excess depth or size of pilot holes. The maximum hole diameter permitted will be approximately 4 in. less than the diagonal of square piling or steel H-piling and 1 in. less than the diameter of round piling. The Engineer may vary hole size and depth to obtain penetration and bearing resistance.

Extend pilot holes through all embankments to natural ground when driving concrete piling. Where a pilot hole is required in granular material that cannot be sealed off by ordinary drilling methods, a casing may be required around the boring device deep enough to prevent loose material from falling into the pilot hole.

Drive the piling below the depth of the pilot hole a minimum of 1 ft. or 100 blows but not less than the required bearing resistance shown on the plans. Unless directed otherwise, do not drive piling beyond the point where the penetration per blow is less than 0.1 in. as determined by an average of 10 blows. If damage to the pile is apparent, stop driving.

D. Jetting. Jetting is permitted when the specified penetration cannot be obtained by driving and pilot holes or other methods are not feasible. Before jetting, submit details of the proposed methods for approval. The Engineer may authorize varying depths of jetting to achieve the desired results.

Jet as required in conjunction with driving but only to the approved depth. For jetting operations, use enough power to simultaneously operate at least two 2-1/2-in. diameter pipes equipped with 3/4-in. nozzles at a pressure of 150 psi. Perform the jetting with 1 or 2 jets as determined and approved from results of trial operations.

Drive the piling below the depth of the jetting a minimum of 1 ft. or 100 blows but not less than the required bearing resistance shown on the plans. Unless directed otherwise, do not drive piling beyond the point where the penetration per blow is less than 0.1 in. as determined by an average of 10 blows. If damage to the pile is apparent, stop driving.

E. Hammer Formula Method of Bearing Evaluation. Unless otherwise shown on the plans, determine the dynamic bearing resistance of piling by one of the hammer formulas in this Section. If the Engineer has determined a K factor based on test piling, test-loaded piling, or other methods, the computed resistance will be the driving resistance determined based on the appropriate formula multiplied by the K factor.

1. Single-Acting Power Hammers. Use the following formula:

\[ P = \frac{2WH}{S + 0.1} \]

where:
- \( P \) = dynamic resistance in pounds.
- \( W \) = weight of ram in pounds.
- \( H \) = height of fall of ram in feet.
- \( S \) = average penetration in inches per blow for the last 20 blows.
Determine $H$ by visual observation of the ram against a calibrated rod mounted on the hammer, by an approved stroke indicator and blow count logging device, or by the following formula:

$$H = 16.1 \times \left( \frac{30}{B} \right)^2 - 0.3$$

where $B =$ blows per minute.

2. **Double-Acting Power Hammers.** Use the following formula:

$$P = \frac{2E}{S + 0.1}$$

where:
- $P =$ dynamic resistance in pounds
- $E =$ manufacturer’s rated energy in foot-pounds (for double-acting power hammers), or the equivalent energy in footpounds determined by a calibrated gauge attached to the hammer and taken when the average penetration in inches per blow is determined (for enclosed ram diesel hammer)
- $S =$ average penetration in inches per blow for the last 20 blows.

F. **Wave Equation Method of Bearing Evaluation.** When plans specify that the bearing capacity of the piling be determined by the wave equation method, submit the following data:
- manufacturer’s specification data for the hammer proposed for use, including all modifications and
- complete description and dimensions of all cushioning material used between the pile and helmet and in the cap block, including total thickness of each, and the direction of grain if wood is used.

These data are used by the Engineer to determine the required number of blows per unit of penetration the hammer must deliver to obtain the required bearing resistance.

After evaluation by the wave equation method, any change in the driving equipment may require reevaluation. Such changes must be approved before further driving.

G. **Test Piling.** Drive test piling at locations shown on the plans or as directed. In general, make test piling part of the completed work, cut off or built up to grade as necessary. Use the required bearing evaluation method to determine bearing resistance.

Initially drive test piling to 3 ft. above plan tip elevation of the regular piling for the structure with the blow count recorded for each foot of driving (for example, drive test piling to 13 ft. above its plan tip elevation if the test piling is 10 ft. longer than regular piling). Retain the cushion if used.

At least 7 days after the original driving, re-drive the test piling the additional length required by the plans with the same hammer and cushion originally used. Record the blow count for each inch of driving for the first foot, for every 3 in. for the next 2 ft., and for each foot thereafter.

Provide the data to the Engineer for use in determining regular piling lengths and K factors. The K factor will be determined based on the following formula:

$$K = PR P$$
where:
\[ K = \text{a static correction factor applied to the evaluation method} \]
\[ PR = \text{re-drive bearing (tons) of the test pile determined by the evaluation method} \]
\[ P = \text{original bearing (tons) of test pile determined by the evaluation method} \]

**H. Test-Loaded Piling.** Conduct test load in accordance with Item 405, “Foundation Test Load.”

Provide the data to the Engineer for use in determining regular piling lengths and K factors. The K factor will be determined based on the following formula:

\[ K = L P \]

where:
\[ K = \text{a static correction factor applied to the evaluation method} \]
\[ L = \text{maximum safe static load proven by test load} \]
\[ P = \text{bearing resistance of the test loaded pile determined by the evaluation method} \]

**404.4. Measurement and Payment.** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to pertinent Items.

### 1.4.6. FOUNDATION TEST LOAD

**405.1. Description.** Test-load piling or drilled shafts.

**405.2. Materials.** Provide piling or drilled shafts for test loading as shown on the plans.

**405.3. Equipment.** Unless otherwise shown on the plans, the Department will furnish the jacking equipment, jacking beams, and displacement indicators. Furnish all necessary tools and equipment not furnished by the Department.

**405.4. Construction.** Furnish and drive the piling or construct the shaft to be test-loaded, and furnish necessary anchors. Drive anchor and test piling in accordance with Item 404, “Driving Piling.” Construct anchor and test shafts in accordance with Item 416, “Drilled Shaft Foundations.” To develop a satisfactory procedure for drilling the test shaft, construct anchor shafts first. Use the same procedure for drilling the test shaft as for the shafts required in the structure.

Keep a complete record of pile-driving data and shaft-drilling data for all foundations used in the test load. Apply the test load no earlier than the seventh day after driving the test piling or after placing concrete in the test shaft. Do not load the test shaft until the concrete design strength has been attained.

Construct a shelter to protect the test load equipment from weather and direct sunlight, and furnish incidentals necessary for the handling, transportation, and installation of the complete test load setup.
Apply incremental static loads to the pile or shaft and measure the resulting settlement. Apply loads by a hydraulic jack acting against suitable anchorage, transmitting the load directly to the pile or shaft. Carry all test loads to failure of the test pile or test shaft as directed. Load and record data in accordance with “Test Loading Piling,” Construction Bulletin C-8, \textit{Pile Driving Manual}; or “Test Loading Drilled Shafts,” Construction Bulletin C-9, \textit{Drilled Shaft Manual}. Provide the data to the Engineer for evaluation. Upon completion of the test load, remove piling or shafts that are not part of the structure, or cut off at least 1 ft. below the bottom of the footing or the finished grade. If permanent piling is raised during the test load, re-drive it to its original grade and bearing.

405.5. \textbf{Measurement.} Measurement will be made for each complete test load satisfactorily performed and accepted.

1.4.6. \textit{DRILLED SHAFT FOUNDATIONS}

416.1. \textbf{Description.} Construct foundations consisting of reinforced or non-reinforced concrete drilled shafts with or without bell footings.

416.2. \textbf{Materials.} Use materials that meet the requirements of the following Items:
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- Item 448, “Structural Field Welding.”

Unless otherwise shown on the plans, use concrete for drilled shafts that meets the requirements of Table 1.

<table>
<thead>
<tr>
<th>Drilled Shaft Type</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-reinforced</td>
<td>Class A</td>
</tr>
<tr>
<td>Reinforced</td>
<td>Class C</td>
</tr>
<tr>
<td>Slurry and underwater concrete placement</td>
<td>Class SS</td>
</tr>
</tbody>
</table>

Use coarse aggregate Grade 4, 5, or 6 for drilled shaft concrete in reinforced drilled shafts. Grade 2 or 3 may be used if the shaft is dry and reinforcing steel has a 5-in. minimum clear spacing.

Use a water-reducing, retarding admixture in accordance with DMS-4640, “Chemical Admixtures for Concrete,” in all concrete when using casing that will be pulled or when placing shafts underwater or under slurry.

Use concrete with slump that meets the requirements of Table 2 as determined by Tex-415-A.
Table 2

Slump Requirements

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>5-1/2</td>
<td>6-1/2</td>
<td>7-1/2</td>
</tr>
<tr>
<td>Underwater and under slurry</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

When casing is to be pulled or when concrete is to be placed underwater or under slurry, perform a slump loss test in accordance with Tex-430-A before beginning work. Provide concrete that will maintain a slump of at least 4 in. throughout the entire anticipated time of concrete placement. Time of concrete placement is described in Sections 416.3.F, “Concrete,” and 416.3.G, “Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods.” Note the temperature of the concrete mix at the beginning of the slump loss test. If concrete temperature at the time of placement into the drilled shaft is more than 10° higher than the slump loss test temperature, do not place the concrete. Use ice or other concrete cooling ingredients to lower concrete temperature, or run additional slump loss tests at the higher temperatures. Slump loss testing will be waived if anticipated time of concrete placement is less than 90 minutes.

Use drilling slurry that meets the requirements of Table 3, as determined by Tex-130-E.

Table 3

Slurry Requirements

<table>
<thead>
<tr>
<th>Before Introduction into the Excavation</th>
<th>Sampled from the Bottom of the Excavation before Concreting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>Sand Content</td>
</tr>
<tr>
<td>≤ 1.10</td>
<td>≤ 1%</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>Viscosity (seconds)</td>
</tr>
<tr>
<td>≤ 1.15</td>
<td>≤ 45</td>
</tr>
<tr>
<td>Sand Content</td>
<td>≤ 6%</td>
</tr>
</tbody>
</table>

Use mineral slurry consisting of processed bentonite or attapulgite clays mixed with clean fresh water. Do not use PHPA (partially hydrolized polyacrylamide) polymeric slurry or any other fluid composed primarily of a polymer solution.

Before placing concrete, sample slurry from the bottom of the hole, and test it in accordance with Tex-130-E. Use a pump or air lift to remove slurry that does not meet the requirements of Table 3 while adding fresh clean slurry to the top of the hole to maintain the slurry level. Continue this operation until the slurry sampled from the bottom of the hole meets the requirements.

416.3. Construction. Place the shaft to within the following tolerances.

- Vertical plumbness – 1 in. per 10 ft. of depth.
- Center of shaft located under column – 1 in. of horizontal plan position.
- Center of shaft located under footing – 3 in. of horizontal plan position.
Complete the embankment at bridge ends before installing drilled shafts that pass through the fill. Refer to Item 423, “Retaining Walls,” for provisions for drilled shafts passing through the structural volume of retaining walls.

A. Excavation. The plans indicate the expected depths and elevations for encountering satisfactory bearing material. Excavate as required for the shafts and bell footings through all materials encountered to the dimensions and elevations shown on the plans or required by the site conditions. Removal of man-made obstructions not shown on the plans will be paid for in accordance with Article 9.4, “Payment for Extra Work.” If satisfactory founding material is not encountered at plan elevation, adjust the bottom of the shaft or alter the foundation, as determined by the Engineer, to satisfactorily comply with design requirements. Blasting is not allowed for excavations.

If caving conditions are encountered, stop drilling and adopt a construction method that stabilizes the shaft walls.

Do not excavate a shaft within 2 shaft diameters (clear) of an open shaft excavation, or one in which concrete has been placed in the preceding 24 hours.

Dispose of material excavated from shafts and bells and not incorporated into the finished project. Dispose of excavated material in accordance with the plans and with federal, state, and local laws.

Provide suitable access, lighting, and equipment for proper inspection of the completed excavation and for checking the dimensions and alignment of shafts and bell excavation.

B. Core Holes. If directed, take cores to determine the character of the supporting materials. Use a method that will result in recovery of an intact sample adequate for judging the character of the founding material. Such cores should be at least 5 ft. deeper than the proposed founding grade or a depth equal to the diameter of the shaft, whichever is greater. Take these cores when the excavation is approximately complete.

C. Casing. Use casing when necessary to prevent caving of the material or to exclude ground water. Provide casing with an outside diameter not less than the specified diameter of the shaft. Use casing strong enough to withstand handling stresses and pressures of concrete and of the surrounding earth or water, and that is watertight, smooth, clean, and free of accumulations of hardened concrete.

Drill the portion of the shaft below the casing as close as possible to the specified shaft diameter. The portion of shaft below the casing may be as much as 2 in. smaller than the specified shaft diameter.

Use construction methods that result in a minimal amount of disturbed soil being trapped outside the casing. This does not apply to temporary undersized casings used to protect workers inside shafts or to drilled shafts designed for point bearing only.

Do not leave any casing in place unless authorized or shown on the plans. Do not extract casing until after placing the concrete to an appropriate level. Maintain sufficient concrete in the casing at all times to counteract soil and water pressure. Before and during concrete placement, rotate or move the casing up or down a few inches if necessary to facilitate extraction of the casing.

D. Requirements for Slurry Displacement Method. Unless otherwise shown on the plans, the slurry displacement method may be used to construct drilled shafts. Use this method to
support the sides of the excavation with processed mineral slurry that is then displaced by concrete to form a continuous concrete shaft.

Do not use casing other than surface casing. Do not use surface casing longer than 20 ft. without approval. Do not extract the surface casing until after placing the concrete.

For slurry mixed at the project site, pre-mix it in a reservoir of sufficient capacity to fill the excavation and for recovery of the slurry during concrete placement. Do not mix slurry in the shaft excavation or other hole. Allow adequate time for hydration of the slurry prior to introduction into the excavation.

During and after drilling maintain a head of slurry in the shaft excavation at or near ground level or higher as necessary to counteract ground water pressure.

Just before placing reinforcing steel, use an air lift or proper size cleanout bucket to remove any material that may have fallen from the sides of the excavation or accumulated on the bottom after the completion of drilling. Use a cleanout bucket if material is too large to be picked up with an air lift.

If concrete placement is not started within 4 hours of the completion of the shaft excavation, reprocess the hole with the auger as directed. Then clean the bottom with an air lift or cleanout bucket, and check the slurry at the bottom of the hole for compliance with the slurry requirements of Article 416.2, “Materials.”

If the slurry forms a gel before concrete placement, agitate the congealed slurry to liquefaction just before concrete placement and whenever directed.

Recover and dispose of all slurry as approved by the Engineer, and in accordance with all federal, state, and local laws. Do not discharge slurry into or in close proximity to streams or other bodies of water.

E. Reinforcing Steel. Completely assemble the cage of reinforcing steel, and place it as a unit immediately before concrete placement. The cage consists of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties, or horizontal bands). If overhead obstacles prevent placement of the cage as a single unit, connect individual segments with couplers or by lapping steel as approved.

If the shaft is lengthened beyond plan length, extend the reinforcing steel cage as follows, unless directed otherwise:

• For shafts supporting structures other than bridges, extend the cage to the bottom.
• For bridge shafts with plan lengths of less than 25 ft., extend the cage to 25 ft. or to the bottom, whichever is shorter.
• For bridge shafts with plan lengths at least 25 ft. that are lengthened less than 33% of plan length, extending the cage is not necessary.
• For bridge shafts with plan lengths at least 25 ft. that are lengthened more than 33% of plan length, extend the cage as directed.

If the cage does not reach the bottom of the shaft, it may be suspended, or a portion of the longitudinal steel may be extended to support the cage on the bottom of the shaft. Bars used to extend or support the cage may be lap spliced or welded by a qualified welder. Place the extension at the bottom of the shaft.

If using spiral reinforcement, tie it to the longitudinal bars at a spacing of at most 24 in., or as required for a stable cage. Do not weld lateral reinforcement to longitudinal bars unless otherwise shown on the plans.
Center the reinforcing steel cage in the excavation using approved centering devices. Use enough devices to hold the cage in position along its entire length. Do not use square concrete spacer blocks in cased shafts.

Support or hold down the cage to control vertical displacement during concrete placement or extraction of the casing. Use support that is concentric with the cage to prevent racking and distortion of the steel.

Check the elevation of the top of the steel cage before and after concrete placement or after casing extraction when casing is used. Downward movement of the steel up to 6 in. per 20 ft. of shaft length and upward movement of the steel up to 6 in. total are acceptable. Maintain the minimum length of steel required for lap with column steel. Use dowel bars if the proper lap length is provided both into the shaft and into the column. Locate and tie all dowel bars into the cage before placing concrete or insert dowel bars into fresh, workable concrete. Locate and tie anchor bolts when required prior to placement of concrete. Use templates or other devices to assure accurate placement of anchor bolts.

**F. Concrete.** Perform all work in accordance with requirements of Item 420, “Concrete Structures.” Mass concrete placement requirements do not apply to drilled shafts. Form portions of drilled shaft that project above natural ground.

Remove loose material and accumulated seep water from the bottom of the excavation before placing concrete. If water cannot be removed, place concrete using underwater placement methods.

Place concrete as soon as possible after all excavation is complete and reinforcing steel is placed. Provide workable concrete that does not require vibrating or rodding. Vibrate formed portions of drilled shafts.

Place concrete continuously for the entire length of the shaft. For dry shafts of 24 in. or smaller diameter, limit free fall of concrete to 25 ft. Use a suitable tube or tremie to prevent segregation of materials. Use a tube or tremie in sections to provide proper discharge and to permit raising as the placement progresses. For dry shafts over 24 in. diameter, concrete can be allowed to free fall an unlimited distance if it does not strike the reinforcing cage or sides of the hole during placement. When free fall is used, provide a hopper with a minimum 3-ft.-long drop tube at the top of the shaft to direct concrete vertically down the center of the shaft. Do not use a shovel or other means to simply deflect the concrete discharge from the truck.

For cased shafts, maintain a sufficient head of concrete at all times above the bottom of the casing to overcome hydrostatic pressure. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Monitor the concrete level in the casing during extraction. Stop the extraction and add concrete to the casing as required to ensure a completely full hole upon casing removal. The elapsed time from the mixing of the first concrete placed into the cased portion of the shaft until the completion of extraction of the casing must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Article 416.2, “Materials.” If the elapsed time is exceeded, modify the concrete mix, the construction procedures, or both for subsequent shafts.

Cure the top surface and treat any construction joint area in accordance with Item 420, “Concrete Structures.”

**G. Additional Requirements for Slurry Displacement or Underwater**
Concrete Placement Methods. Place concrete on the same day that the shaft is excavated and as soon as possible after all excavation is complete and reinforcing steel is placed. Use an air lift or cleanout bucket of the proper size to clean the bottom of the excavation prior to placing the reinforcing steel cage and concrete. Place concrete through a closed tremie or pump it to the bottom of the excavation. Initially seal the tremie or pump line to positively separate the concrete from the slurry or water. Place concrete continuously from the beginning of placement until the shaft is completed. If using a tremie, keep it full of concrete and well submerged in the previously placed concrete at all times. Raise the tremie as necessary to maintain the free flow of concrete and the stability of any casing used. If using a pump, keep the discharge tube submerged in the previously placed concrete at all times. Place additional concrete to ensure the removal of any contaminated concrete at the top of the shaft. At the completion of the pour, allow the top portion of concrete to flush completely from the hole until there is no evidence of slurry or water contamination. Do not attempt to remove this concrete with shovels, pumps or other means. Level the top of shaft with hand tools as necessary.

Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water. For pours over water, provide a collar or other means of capturing slurry and the top portion of concrete flushed from the shaft. If concrete placement is interrupted due to withdrawal of the submerged end of the tremie or pump discharge tube before completion, remove the tube, reseal it at the bottom, penetrate with the tube into the concrete already placed by at least 5 ft., and recharge it before continuing.

The elapsed time from the mixing of the first concrete placed until the completion of concrete placement, including extraction of the casing, must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Article 416.2, “Materials.” If the elapsed time is exceeded, modify the concrete mix, the construction procedures, or both for subsequent shafts.

H. Test Load. If required, test load shafts in accordance with Item 405, “Foundation Test Load.”

416.4. Measurement.

A. Drilled Shaft. Drilled shaft foundations will be measured by the foot to the bottom of the shaft.

1. Interior Bents and Piers. Shafts will be measured from a point approximately 6 in. below the finished earthwork elevation at the center of each shaft, unless specific elevations or dimensions are indicated on the plans or unless the Engineer directs otherwise to meet unusual conditions. The bent height shown on the plans is for estimating purposes only and does not control the top-of-shaft measurement.

2. Abutment Bents and Retaining Walls. Shafts will be measured from the bottom of footing or cap elevation.

3. Other Non-Bridge Structures. Shafts will be measured from the top of the shaft.

B. Bell Footing. Bell footings will be measured by the cubic yard of concrete outside of the plan dimensions of the shaft. Bell footings are a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2,
“Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

C. Core Hole. Core holes will be measured by each core hole drilled.

1.4.7. CONCRETE STRUCTURES

420.1. Description. Construct concrete structures.


A. Concrete. Provide concrete conforming to Item 421, “Hydraulic Cement Concrete.” For each type of structure or unit, provide the class of concrete shown on the plans or in pertinent governing specifications.

B. Grout or Mortar. Provide grout or mortar conforming to Section 421.2.F, “Mortar and Grout.”

C. Latex. Provide an acrylic-polymer latex admixture (acrylic resin emulsion per DMS-4640, “Chemical Admixtures for Concrete”) suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.

D. Reinforcing Steel. Provide reinforcing steel conforming to Item 440, “Reinforcing Steel.”

E. Expansion Joint Material. Provide materials that conform to the requirements of DMS-6310, “Joint Sealants and Fillers”:
- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the plans. Provide preformed bituminous fiber material unless otherwise specified.
- Provide a Class 4, 5, or 7 low-modulus silicone sealant unless otherwise directed.
- Provide asphalt board that conforms to dimensions shown on the plans.
- Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.

F. Waterstop. Provide rubber or polyvinyl chloride (PVC) waterstops that conform to DMS-6160, “Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads,” unless otherwise shown on the plans.

G. Evaporation Retardants. Provide evaporation retardants that conform to the requirements of DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.”

H. Curing Materials. Provide membrane curing compounds that conform to the requirements of DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.” Provide cotton mats that consist of a filling material of cotton “bat” or “bats” (at least 12 oz. per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in. Provide cotton mats that
are free from tears and in good general condition. Provide a flap at least 6 in. wide consisting of 2 thicknesses of the covering and extending along 1 side of the mat.
Provide polyethylene sheeting that is at least 4 mils thick and free from visible defects. Provide only clear or opaque white sheeting when the ambient temperature during curing exceeds 60°F or when applicable to control temperature during mass pours.
Provide burlap-polyethylene mats made from burlap impregnated on 1 side with a film of opaque white pigmented polyethylene, free from visible defects. Provide laminated mats that have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

I. Epoxy. Unless otherwise specified, provide epoxy materials that conform to DMS-6100, “Epoxy and Adhesives.”

420.3. Equipment.

A. Fogging Equipment. Use fogging equipment that can apply water in a fine mist, not a spray. Produce the fog using equipment that pumps water or water and air under high pressure through a suitable atomizing nozzle. Use hand-held mechanical equipment portable enough to use in the direction of any prevailing wind and adaptable for intermittent use to prevent excessive wetting of the concrete.

B. Transporting and Placing Equipment. Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Do not transport or convey concrete through equipment made of aluminum. Use carts with pneumatic tires for carting or wheeling concrete over newly placed slabs.
Use tremies to control the fall of concrete or for underwater placement. Use tremies that are watertight and of large enough diameter to allow the placement of the concrete but less than 14 in. in diameter. For underwater placements, construct the tremie so that the bottom can be sealed and opened once the tremie has been fully charged with concrete.
Use pumps with lines at least 5 in. I.D. where Grade 2 or smaller coarse aggregate is used, and at least 8 in. I.D. for Grade 1 coarse aggregate.

C. Vibrators. Use immersion-type vibrators for consolidation of concrete. Provide at least 1 standby vibrator for emergency use.

D. Screeds and Work Bridges for Bridge Slabs. For bridge slabs use a self-propelled transverse screed or a mechanical longitudinal screed. Use transverse screeds that are able to follow the skew of the bridge for skews greater than 15° unless otherwise approved. Equip transverse screeds with a pan float. Manually operated screeding equipment may be used if approved for top slabs of culverts, small placements, or unusual conditions. Use screeds that are rigid and heavy enough to hold true to shape and have sufficient adjustments to provide for the required camber or section. Equip the screeds, except those of the roller drum type, with metal cutting edges.
For bridge slabs, use sufficient work bridges for finishing operations. Mount a carpet drag to a work bridge or a moveable support system that can vary the area of carpet in contact with the concrete. Use carpet pieces long enough to cover the entire width of the placement. Splice
or overlap the carpet as necessary. Ensure that enough carpet is in contact longitudinally with
the concrete being placed to provide the desired surface finish. Use artificial grass-type
carpeting having a molded polyethylene pile face with a blade length between 5/8 and 1 in.
and with a minimum weight of 70 oz. per square yard. Ensure that the carpet has a strong,
durable backing not subject to rot and that the facing is adequately bonded to the backing to
withstand the intended use. A burlap drag, attached to the pan float on a transverse screed,
may be used instead of the carpet drag.

E. Temperature Recording Equipment. For mass concrete operations or as otherwise
specified, use strip chart temperature recording devices, recording maturity meters in
accordance with Tex-426-A, or other approved devices that are accurate to within ±2°F within
the range of 32 to 212°F.

F. Artificial Heating Equipment. Use artificial heating equipment as necessary for maintaining
the concrete temperatures as specified in Section 420.4.G.11, “Placing Concrete in Cold
Weather.”

G. Sawing Equipment. Use sawing equipment capable of cutting grooves in completed bridge
slabs and top slabs of direct-traffic culverts. Provide grooves that are 1/8 to 3/16 in. deep and
nominally 1/8 in. wide. Groove spacing may range from 5/8 to 1 in. Use sawing equipment
capable of cutting grooves in hardened concrete to within 18 in. of the barrier rail or curb.

H. Spraying Equipment. Use mechanically powered pressure sprayers, either air or airless,
with appropriate atomizing nozzles for the application of membrane curing. Mechanically
driven spraying equipment, adaptable to the rail system used by the screens, may be used for
applying membrane curing to bridge slabs. If approved, use hand-pressurized spray equipment
equipped with 2 or 3 fan-spray nozzles. Ensure that the spray from each nozzle overlaps the
spray from adjacent nozzles by approximately 50%.

I. Concrete Testing Equipment. Provide testing equipment for use by the Engineer in
accordance with Section 421.3.C, “Testing Equipment.”

420.4. Construction. Before starting work, obtain approval for proposed construction
methods. Approval of construction methods and equipment does not relieve the Contractor’s
responsibility for safety or correctness of methods, adequacy of equipment, or completion of
work in full accordance with the Contract.

Unless otherwise shown on the plans, it is the Contractor’s option to perform testing on
structural concrete (structural classes of concrete are identified in Table 5 of Section
421.4.A, “Classification and Mix Design”) to determine the in-situ strength to address the
schedule restrictions in Section 420.4.A, “Schedule Restrictions.” The Engineer may require the
Contractor to perform this testing for concrete placed in cold weather. For Contractor-
performed testing, make enough test specimens to ensure that strength requirements are met
for the operations listed in Section 420.4.A. Make at least 1 set of test specimens for each
element cast each day. Cure these specimens under the same conditions as the portion of the
structure involved for all stages of construction. Ensure safe handling, curing, and storage of
all test specimens. Provide testing personnel, and sample and test the hardened concrete in
accordance with Section 421.4.G, “Sampling and Testing of Concrete.” The maturity method,
Tex-426-A, may be used for insitu strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer’s 7-day lab-cured tests, performed in accordance with Section 421.4.G.5, “Adequacy and Acceptance of Concrete,” will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

A. Schedule Restrictions. Unless otherwise shown on the plans, construct and open completed structures to traffic with the following limitations:

1. Setting Forms. Attain at least 2,500 psi compressive strength before erecting forms on concrete footings supported by piling or drilled shafts, or on individual drilled shafts. Erect forms on spread footings and culvert footings after the footing concrete has aged at least 2 curing days as defined in Section 420.4.J, “Curing Concrete.” Place concrete only after the forms and reinforcing steel have been inspected by the Engineer.

Support tie beam or cap forms by falsework on previously placed tie beams only if the tie beam concrete has attained a compressive strength of 2,500 psi and the member is properly supported to eliminate stresses not provided for in the design. Maintain curing as required until completion of the curing period.

Place superstructure forms or falsework on the substructure only if the substructure concrete has attained a compressive strength of 3,000 psi.

2. Removal of Forms and Falsework. Keep in place weight supporting forms and falsework for bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi in accordance with Section 420.4.K, “Removal of Forms and Falsework.” Keep all forms for mass placements defined in Section 420.4.G.14, “Mass Placements,” in place for 4 days following concrete placement.

3. Placement of Superstructure Members. Do not place superstructure members before the substructure concrete has attained a compressive strength of 3,000 psi.

4. Longitudinal Screeding of Bridge Slabs. Place a longitudinal screed directly on previously placed concrete slabs to check and grade an adjacent slab only after the previously placed slab has aged at least 24 hr. Place and screed the concrete after the previously placed slabs have aged at least 48 hr. Maintain curing of the previously placed slabs during placement.

5. Staged Placement of Bridge Slabs on Continuous Steel Units. When staged placement of a slab is required, ensure that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage placement. Multiple stages may be placed in a single day if approved.

6. Storage of Materials on the Structure. Obtain approval to store materials on completed portions of a structure once a compressive strength of 3,000 psi has been attained. Maintain proper curing if materials will be stored on structures before completion of curing.

7. Placement of Equipment and Machinery. Do not place erection equipment or machinery on the structure until the concrete has attained the design strength specified in Section 421.4.A, “Classification and Mix Design,” unless otherwise approved.

8. Carting of Concrete. Once the concrete has attained a compressive strength of 3,000 psi, it may be carted, wheeled, or pumped over completed slabs. Maintain curing during these operations.
9. **Placing Bridge Rails.** Reinforcing steel and concrete for bridge rails may be placed on bridge slabs once the slab concrete has attained a compressive strength of 3,000 psi. If slipforming methods are used for railing concrete, ensure the slab concrete has attained its design strength specified in Section 421.4.A, “Classification and Mix Design,” before placing railing concrete.

10. **Opening to Construction Traffic.** Bridges and direct-traffic culverts may be opened to all construction traffic when the design strength specified in Section 421.4.A, “Classification and Mix Design,” has been attained if curing is maintained.

11. **Opening to Full Traffic.** Bridges and direct-traffic culverts may be opened to the traveling public when the design strength specified in Section 421.4.A, “Classification and Mix Design,” has been attained for all structural elements including railing subject to impact from traffic, when curing has been completed for all slabs, and when the concrete surface treatment has been applied in accordance with Item 428, “Concrete Surface Treatment.” Obtain approval before opening bridges and direct-traffic culverts to the traveling public. Other noncritical structural and nonstructural concrete may be opened for service upon the completion of curing unless otherwise specified or directed.

12. **Post-Tensioned Construction.** For structural elements designed to be post-tensioned ensure that strength requirements on the plans are met for stressing and staged loading of structural elements.

13. **Backfilling.** Backfill in accordance with Section 400.3.C, “Backfill.”

**B. Plans for Falsework and Forms.** Submit 2 copies of plans for falsework and forms for piers, superstructure spans over 20 ft. long, bracing systems for girders when the overhang exceeds 3 ft. 6 in., and bridge widening details. Submit similar plans for other units of the structure as directed. Show all essential details of proposed forms, falsework, and bracing. Have a licensed professional engineer design, seal, and sign these plans. Department approval is not required, but the Department reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans.

**C. Falsework.** Design and construct falsework to carry the maximum anticipated loads safely, including wind loads, and to provide the necessary rigidity. Submit details in accordance with Section 420.4.B, “Plans for Falsework and Forms.”

Design job-fabricated falsework assuming a weight of 150 pcf for concrete, and include a live load allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the Department for the design of structures.

For commercially produced structural units used in falsework, do not exceed the manufacturer’s maximum allowable working loads for moment and shear or end reaction. Include a live load allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide timber that is sound, in good condition, and free from defects that would impair its strength. Provide timber that meets or exceeds the species, size, and grade requirements in the submitted falsework plans.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to ensure even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.
Use sills or grillages that are large enough to support the superimposed load without settlement. Take precautions to prevent settling of the supporting material unless the sills or grillages are founded on solid rock, shale, or other hard materials.

Place falsework that cannot be founded on a satisfactory spread footing on piling or drilled shafts with enough bearing capacity to support the superimposed load without settlement. Drive falsework piling to the required resistance determined by the applicable formula in Item 404, “Driving Piling.” Design drilled shafts for falsework to carry the superimposed load using both skin friction and point bearing.

Weld in conformance with Item 448, “Structural Field Welding.” Securely brace each falsework bent to provide the stiffness required, and securely fasten the bracing to each pile or column it crosses.

Remove falsework when it is no longer required or as indicated on the submitted falsework plan. Pull or cut off foundations for falsework at least 2 ft. below finished ground level. Completely remove falsework, piling, or drilled shafts in a stream, lake, or bay to the approved limits to prevent obstruction to the waterway.

**D. Forms.** Submit formwork plans in accordance with Section 420.4.B, “Plans for Falsework and Forms.”

1. **General.** Except where otherwise specified or permitted, provide forms of either timber or metal.

Design forms for the pressure exerted by a liquid weighing 150 pcf. Take the rate of concrete placement into consideration in determining the depth of the equivalent liquid. Include a live load allowance of 50 psf of horizontal surface for job-fabricated forms.

Do not exceed 125% of the allowable stresses used by the Department for the design of structures.

For commercially produced structural units used for forms, do not exceed the manufacturer’s maximum allowable working loads for moment and shear or end reaction. Include a live load allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide steel forms for round columns unless otherwise approved. Refer to Item 427, “Surface Finishes for Concrete,” for additional requirements for off-the-form finishes. Provide commercial form liners for imprinting a pattern or texture on the concrete surface as shown on the plans and specified in Section 427.4.B.2.d, “Form Liner Finish.”

Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports, and maintain them to the proper line and grade during concrete placement. Maintain forms in a manner that prevents warping and shrinkage.

Do not allow offsets at form joints to exceed 1/16 in.

For forms to be left in place, use only material that is inert, non-biodegradable, and non-absorptive.

Attachment of forms or screed supports for bridge slabs to steel I-beams or girders may be by welding subject to the following requirements:

- Do not weld to tension flanges or to areas indicated on the plans.
- Weld in accordance with Item 448, “Structural Field Welding.” Take into account:
  - deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram in the setting of slab forms,
  - differential beam or girder deflections due to skew angles and the use of certain stay-in-place slab forming systems, and deflection of the forming system due to the wet concrete.
For bridge approach slabs, securely stake forms to line and grade and maintain in position. Rigidly attach inside forms for curbs to the outside forms. 

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter. Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel. Complete all preparatory work before requesting permission to place concrete. If the forms show signs of bulging or sagging at any stage of the placement, cease placement and remove the portion of the concrete causing this condition immediately if necessary. Reset the forms and securely brace them against further movement before continuing the placement.

2. Timber Forms. Provide properly seasoned good-quality lumber that is free from imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork plans. Maintain forms or form lumber that will be reused so that it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred or that has defects that will produce inferior work, and promptly remove such lumber from the work.

Provide form lining for all formed surfaces except: 
- the inside of culvert barrels, inlets, manholes, and box girders; 
- the bottom of bridge slabs between beams or girders; 
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board or by plywood.

Provide form lining of an approved type such as masonite or plywood. Do not provide thin membrane sheeting such as polyethylene sheets for form lining. Use plywood at least 3/4 in. thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists unless otherwise indicated on the submitted form drawings.

Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so that the facing form material remains in true alignment under the imposed loads.

Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 ft. on each side of joints to provide continuity. Place a row of wales near the bottom of each placement.

Place facing material with parallel and square joints, securely fastened to supporting studs. For surfaces exposed to view and receiving only an ordinary surface finish as defined in Section 420.4.M, “Ordinary Surface Finish,” place forms with the form panels symmetrical (long dimensions set in the same direction). Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and that can be maintained to a true line without warping. Dress wood molding on all faces. Unless otherwise shown on the plans, fill forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 in. on the sides.
To hold forms in place, use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal. Cut back wire ties at least 1/2 in. from the face of the concrete.

Use devices to hold metal ties in place that are able to develop the strength of the tie and adjust to allow for proper alignment.

Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.

Provide adequate clean-out openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

3. Metal Forms. Requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and wetting also apply to metal forms except that metal forms do not require lining unless specifically noted on the plans.

Use form metal thick enough to maintain the true shape without warping or bulging. Countersink all bolt and rivet heads on the facing sides. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete. Use metal forms that present a smooth surface and that line up properly. Keep metal free from rust, grease, and other foreign materials.

4. Form Supports for Overhang Slabs. Form supports that transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam are permitted provided a satisfactory structural analysis has been made of the effect on the girder or beam as indicated in the submitted formwork plans.

When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 ft 6 in., use beam bracing as indicated in the plans. For spans with overhangs exceeding this amount, use additional support for the outside beams regardless of the type of beam used. Submit details of the proposed bracing system in accordance with Section 420.4.B, “Plans for Falsework and Forms.”

Punch or drill holes full size in the webs of steel members for support of overhang brackets, or torch-cut them to 1/4 in. under size and ream them full size. Do not burn the holes full size. Leave the holes open unless otherwise shown on the plans. Never fill the holes by welding.

E. Drains. Install and construct weep holes and roadway drains as shown on the plans.

F. Placing Reinforcement. Place reinforcement as provided in Item 440, “Reinforcing Steel.” Do not weld reinforcing steel supports to I-beams or girders or to reinforcing steel except where shown on the plans.

Place post-tensioning ducts in accordance with the approved prestressing details and in accordance with Item 426, “Prestressing.” Keep ducts free of obstructions until all post-tensioning operations are complete.

G. Placing Concrete. Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Follow the sequence of placing concrete shown on the plans or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for shrinkage cracking, place concrete in early morning or at
night or adjust the placement schedule for more favorable weather. Consult the evaporation rate nomograph in the Portland Cement Association’s *Design and Control of Concrete Mixtures* for shrinkage cracking potential. When mixing, placing, and finishing concrete in non-daylight hours, adequately illuminate the entire placement site as approved. If changes in weather conditions require protective measures after work starts, furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

1. **Placing Temperature.** Place concrete according to the following temperature limits for the classes of concrete defined in Section 421.4.A, “Classification and Mix Design”:
   - Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50 and 95°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.
   - When used in a bridge slab or in the top slab of a direct-traffic culvert, place Class CO, DC, or S concrete only when its temperature at the time of placement is between 50 and 85°F. Increase the minimum placement temperature to 60°F if GGBF slag is used in the concrete. The maximum temperature increases to 95°F if these classes are used for other applications.
   - Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.
   - Place mass concrete, defined by Section 420.4.G.14, “Mass Placements,” only when its temperature at the time of placement is between 50 and 75°F.

2. **Transporting Time.** Place concrete delivered in agitating trucks within 60 min. after batching. Place concrete delivered in nonagitating equipment within 45 min. after batching. Revise the concrete mix design as necessary for hot weather or other conditions that contribute to quick setting of the concrete. Submit for approval a plan to demonstrate that these time limitations can be extended while ensuring the concrete can be properly placed, consolidated, and finished without the use of additional water.

3. **Workability of Concrete.** Place concrete with a slump as specified in Section 421.4.A.5, “Slump.” Concrete that exceeds the maximum slump will be rejected. Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump provided that the maximum mix design water–cement ratio is not exceeded. After introduction of any additional water or chemical admixtures, mix concrete in accordance with Section 421.4.E, “Mixing and Delivering Concrete.” Do not add water or chemical admixtures after any concrete has been discharged.

4. **Transporting Concrete.** Use a method and equipment capable of maintaining the rate of placement shown on the plans or required by this Item to transport concrete to the forms. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods. Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so that the concrete ingredients will not be separated. When necessary to prevent segregation, terminate such equipment in vertical downspouts. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.
Keep all transporting equipment clean and free from hardened concrete coatings. Discharge water used for cleaning clear of the concrete.

5. **Preparation of Surfaces.** Thoroughly wet all forms, prestressed concrete panels, T-beams, and concrete box beams on which concrete is to be placed before placing concrete on them. Remove any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry condition when concrete is placed on them. Ensure that the subgrade or foundation is moist before placing concrete for bridge approach slabs or other concrete placed on grade. Lightly sprinkle the subgrade if dry.

6. **Expansion Joints.** Construct joints and devices to provide for expansion and contraction in accordance with plan details and the requirements of this Section and Item 454, “Bridge Expansion Joints.”

- Prevent bridging of concrete or mortar around expansion joint material in bearings and expansion joints.
- Use forms adaptable to loosening or early removal in construction of all open joints and joints to be filled with expansion joint material. To avoid expansion or contraction damage to the adjacent concrete, loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.
- When the plans show a Type A joint, provide preformed fiber joint material in the vertical joints of the roadway slab, curb, median, or sidewalk, and fill the top 1 in. with the specified joint sealing material unless noted otherwise. Install the sealer in accordance with Item 438, “Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks),” and the manufacturer’s recommendations.
- Use light wire or nails to anchor any preformed fiber joint material to the concrete on 1 side of the joint.
- Ensure that finished joints conform to the plan details with the concrete sections completely separated by the specified opening or joint material.
- Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to ensure full effectiveness of the expansion joint.

7. **Construction Joints.** A construction joint is the joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means that the manner and sequence of concrete placing does not create a construction joint. Make construction joints of the type and at the locations shown on the plans. Do not make joints in bridge slabs not shown on the plans unless approved. Additional joints in other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

- Unless otherwise required, make construction joints square and normal to the forms. Use bulkheads in the forms for all vertical joints.
- Thoroughly roughen the top surface of a concrete placement terminating at a horizontal construction joint as soon as practical after initial set is attained.
- Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it.
- Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.
- Coat the joint surface with bonding mortar, grout, epoxy, or other material as indicated in the plans or other Items. Provide Type V epoxy per DMS-6100, “Epoxies and Adhesives,” for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a
surface that is saturated surface-dry, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer’s recommendations.

8. Handling and Placing. Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform dense compact mass. Do not allow concrete to free-fall more than 5 ft. except in the case of drilled shafts, thin walls such as in culverts, or as allowed by other Items. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities at 1 point and run or work the concrete along the forms.

Deposit concrete in the forms in layers of suitable depth but not more than 36 in. deep unless otherwise permitted.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so that they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. When re-vibration of the concrete is shown on the plans, allow at most 1 hr. to elapse between adjacent or successive placements of concrete except as otherwise allowed by an approved placing procedure. This time limit may be extended by 1/2 hr. if the concrete contains at least a normal dosage of retarding admixture.

Use an approved retarding agent to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

9. Consolidation. Carefully consolidate concrete and flush mortar to the form surfaces with immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to ensure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Insert the vibrator vertically where possible except for slabs where it may be inserted in a sloping or horizontal position. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to ensure flushing of mortar to the surface of all forms.

10. Installation of Dowels and Anchor Bolts. Install dowels and anchor bolts by casting them in-place or by grouting with grout, epoxy, or epoxy mortar unless noted otherwise. Form or drill holes for grouting.

Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 in. deep unless otherwise shown on the plans. When using grout or epoxy mortar, make the diameter of the hole at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1-1/2 in. When using epoxy, make the hole diameter 1/16 to 1/4 in. greater than the dowel or bolt diameter. Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Ensure that holes are in a surface dry condition when epoxy type material is used and in a surface moist condition when hydraulic cement grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void
between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning outlined in the product specifications for prepackaged systems.

For cast-in-place or grouted systems, provide hydraulic cement grout in accordance with Section 421.2.F, “Mortar and Grout,” epoxy, epoxy mortar, or other prepackaged grouts as approved.

Provide a Type III epoxy per DMS-6100, “Epoxies and Adhesives,” when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per DMS-6100 when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise indicated on the plans.

Provide other anchor systems as required in the plans.

11. Placing Concrete in Cold Weather. Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. If concrete placed under poor conditions is unsatisfactory, remove and replace it as directed at Contractor’s expense.

Do not place concrete in contact with any material coated with frost or having a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify that all concrete is effectively protected as follows:

- Maintain the temperature of the top surface of bridge slabs and top slabs of direct-traffic culverts at 50°F or above for 72 hr. from the time of placement and above 40°F for an additional 72 hr.
- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottoms of bridge slab or culvert top slabs, and other similar formed concrete at 40°F or above for 72 hr. from the time of placement.
- Maintain the temperature of all other concrete, including the bottom slabs (footings) of culverts, placed on or in the ground above 32°F for 72 hr. from the time of placement.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Section 420.4.J, “Curing Concrete,” during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possible need for temperature protection, have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement.

12. Placing Concrete in Hot Weather. Use an approved retarding agent in all concrete for superstructures and top slabs of direct traffic culverts, except concrete containing GGBF slag, when the temperature of the air is above 85°F unless otherwise directed.

Keep the concrete at or below the maximum temperature at time of placement as specified in Section 420.4.G.1, “Placing Temperature.” Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

13. Placing Concrete in Water. Deposit concrete in water only when shown on the plans or with approval. Make forms or cofferdams tight enough to prevent any water current passing through the space in which the concrete is being deposited. Do not pump water during the concrete placing or until the concrete has set for at least 36 hr.
Place the concrete with a tremie or pump, or use another approved method, and do not allow it to fall freely through the water or disturb it after it is placed. Keep the concrete surface approximately level during placement.

Support the tremie or operate the pump so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. Submerge the lower end of the tremie or pump hose in the concrete at all times. Use continuous placing operations until the work is complete.

For concrete to be placed under water, design the concrete mix in accordance with Item 421, “Hydraulic Cement Concrete,” with a minimum cement content of 650 lb. per cubic yard. Include an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

14. Mass Placements. Mass placements are defined as placements with a least dimension greater than or equal to 5 ft., or designated on the plans. For monolithic mass placements, develop and obtain approval for a plan to ensure the following during the heat dissipation period:

- the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F and
- the temperature at the central core of the placement does not exceed 160°F.

Base this plan on the equations given in the Portland Cement Association’s Design and Control of Concrete Mixtures. Cease all mass placement operations and revise the plan as necessary if either of the above limitations is exceeded.

Include a combination of the following elements in this plan:

- selection of concrete ingredients including aggregates, gradation, and cement types, to minimize heat of hydration;
- use of ice or other concrete cooling ingredients;
- use of liquid nitrogen dosing systems;
- controlling rate or time of concrete placement;
- use of insulation or supplemental external heat to control heat loss;
- use of supplementary cementing materials; or
- use of a cooling system to control the core temperature.

Furnish and install 2 sets of temperature recording devices, maturity meters, or other approved equivalent devices at designated locations. Use these devices to simultaneously measure the temperature of the concrete at the core and the surface. Maintain temperature control methods for 4 days unless otherwise approved. Maturity meters may not be used to predict strength of mass concrete.

15. Placing Concrete in Foundation and Substructure. Do not place concrete in footings until the depth and character of the foundation has been inspected and permission has been given to proceed.

Placing of concrete footings upon seal concrete is permitted after the cofferdams are free from water and the seal concrete cleaned. Perform any necessary pumping or bailing during the concreting from a suitable sump located outside the forms.

Construct or adjust all temporary wales or braces inside cofferdams as the work proceeds to prevent unauthorized construction joints.

When footings can be placed in a dry excavation without the use of cofferdams, omit forms if approved, and fill the entire excavation with concrete to the elevation of the top of footing. Place concrete in columns monolithically between construction joints unless otherwise directed. Columns and caps or tie beams supported on them may be placed in the same
16. Placing Concrete in Box Culverts. Where the top slab and walls are placed monolithically in culverts more than 4 ft. in clear height, allow between 1 and 2 hr. to elapse before placing the top slab to allow for settlement and shrinkage in the wall concrete. Accurately finish the footing slab at the proper time to provide a smooth uniform surface. Finish top slabs that carry direct-traffic as specified in this Item. Give top slabs of fill type culverts a float finish.

17. Placing Concrete in Superstructure. Unless otherwise shown on the plans, place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed. For small placements or for unusual conditions such as narrow widening, variable cross-slopes, or transitions, use of manually operated screeding equipment may be permitted. Support the screed adequately on a header or rail system stable enough to withstand the longitudinal or lateral thrust of the equipment. Adjust the profile grade line as necessary to account for variations in beam camber and other factors to obtain the required slab thickness and concrete cover over the slab reinforcement. Set beams and verify their surface elevations in a sufficient number of spans so that when adjustment is necessary, the profile grade line can be adjusted over suitable increments to produce a smooth riding surface. Take dead load deflection into account in setting the grades of headers and rail systems. Use construction joints, when required or permitted for slab placements on steel or prestressed concrete beams, as shown on the plans. Before placing concrete on steel girder or truss spans, release falsework under the spans and swing the spans free on their permanent supports. Make 1 or more passes with the screed over the bridge slab segment before placing concrete on it to ensure proper operation and maintenance of grades and clearances. Use an approved system of checking to detect any vertical movement of the forms or falsework. Maintain forms for the bottom surface of concrete slabs, girders, and overhangs to the required vertical alignment during concrete placing. Fog unformed surfaces of slab concrete in bridge slabs and in top slabs of direct-traffic culverts from the time of initial strikeoff of the concrete until finishing is completed and required interim curing is in place. Do not use fogging as a means to add finishing water, and do not work moisture from the fog spray into the fresh concrete. For simple spans, retard the concrete only if necessary to complete finishing operations or as required by this Section. When filling curb forms, bring the top of curb and sidewalk section to the correct camber and alignment, and finish them as described in this Item.

a. Transverse Screeding. Install rails for transverse finishing machines that are supported from the beams or girders so that the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts that remain embedded in the slab to project above the upper mat of reinforcing steel. Rail or screed supports attached to I-beams or girders are subject to the requirements of this Item. Unless otherwise shown on the plans, for transverse screeding the minimum rate of concrete placement is 30 linear feet of bridge slab per hour. Deposit concrete parallel to the skew of the bridge so that all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Furnish personnel and equipment capable of placing, finishing, and curing the slab at an acceptable rate to ensure compliance.
with the specifications. Place concrete in transverse strips. On profile grades greater than 1-1/2%, start placement at the lowest end.

b. **Longitudinal Screeding.** Unless otherwise shown on the plans, use of temporary intermediate headers will be permitted for placements over 50 ft. long if the rate of placement is rapid enough to prevent a cold joint and if these headers are designed for easy removal to permit satisfactory consolidation and finish of the concrete at their locations. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Place concrete in longitudinal strips starting at a point in the center of the segment adjacent to 1 side except as this Section indicates, and complete the strip by placing uniformly in both directions toward the ends. For spans on a profile grade of 1-1/2% or more, start placing at the lowest end. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Where monolithic curb construction is specified, place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.

c. **Placements on Continuous Steel Units.** Unless otherwise shown on the plans, place slabs on continuous steel units in a single continuous operation without transverse construction joints using a self-propelled transverse finishing machine or a mechanical longitudinal screed. Retard the initial set of the concrete sufficiently to ensure that concrete remains plastic in at least 3 spans immediately preceding the slab being placed. Use construction joints, when required for slab placements on steel beams or girders, as shown on the plans. When staged placement of a slab is required in the plans, ensure that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Where plans permit staged placing without specifying a particular order of placement, use an approved placing sequence that will not overstress any of the supporting members.

d. **Slab and Girder Units.** Unless otherwise shown on the plans, place girders, slab, and curbs of slab and girder spans monolithically. Fill concrete girder stems first, and place the slab concrete within the time limits specified in this Item. If using a transverse screed, place concrete in the stems for a short distance and then place the concrete in transverse strips. If using a longitudinal screed, fill the outside girder stem first, beginning at the low end or side, and continue placement in longitudinal strips.

**H. Treatment and Finishing of Horizontal Surfaces Other Than Bridge Slabs.** Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

After the concrete has been struck off, float the surface with a suitable float. Give bridge sidewalks a wood float or broom finish, or stripe them with a brush.

Slightly slope the tops of caps and piers between bearing areas from the center toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge, as directed, so that water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with Section 441.3.K.5, “Bearing and Anchorage Devices.” Give the bearing area under the expansion ends of concrete slabs and slab and girder spans a steel-trowel finish to the exact grades required. Give bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups a textured, wood float finish. Do not allow the bearing area to vary from a level plane more than 1/16 in. in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or with a construction joint. Provide a latex-based mortar, an epoxy mortar, or an approved proprietary
bearing mortar for bearing seat buildups cast with a construction joint. Mix mortars in accordance with the manufacturer’s recommendations. Construct pedestals of Class C concrete, reinforced as shown on the plans or as indicated in Figure 1 and Figure 2.

**Figure 1**
Section through bearing seat buildups.

**Figure 2**
Plan view of bearing seat buildups.
I. Finish of Bridge Slabs. Provide camber for specified vertical curvature and transverse slopes. For concrete flat slab and concrete slab and girder spans cast in place on falsework, provide additional camber to offset the initial and final deflections of the span as indicated in the plans. For concrete slab and girder spans using pan forms, provide camber of approximately 3/8 in. for 30-ft. spans and 1/2 in. for 40-ft. spans to offset initial and final deflections unless otherwise directed. For concrete flat slab and concrete slab and girder spans not using pan forms, when dead load deflection is not shown on the plans, provide a camber of 1/8 in. per 10 ft. of span length but no more than 1/2 in.

Provide a camber of 1/4 in. in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, for the Engineer to check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section wide enough to permit working, level, strike off, and screed the surface, carrying a slight excess of concrete ahead of the screed to fill all low spots.

Move longitudinal screeds across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab. Move transverse screeds longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage.

Screw the surface of the concrete enough times and at intervals to produce a uniform surface true to grade and free of voids.

Work the screeded surface to a smooth finish with a long-handed wood or metal float or hand-float it from work bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Avoid overworking the surface of the concrete. Avoid overuse of finish water.

Perform sufficient checks, witnessed by the Engineer, with a long-handled 16-ft. straightedge on the plastic concrete to ensure that the final surface will be within specified tolerances. Make the check with the straightedge parallel to the centerline. Lap each pass half over the preceding pass. Remove all high spots, and fill and float all depressions over 1/16 in. deep with fresh concrete. Continue checking and floating until the surface is true to grade and free of depressions, high spots, voids, or rough spots. Fill screed-rail support holes with concrete, and finish them to match the top of the slab.

Finish the concrete surface to a uniform texture using a carpet drag, burlap drag, or broom finish. Finish the surface to a smooth sandy texture without blemishes, marks, or scratches deeper than 1/16 in.

Apply the surface texturing using a work bridge or platform immediately after completing the straightedge checks. Draw the carpet or burlap drag longitudinally along the concrete surface, adjusting the surface contact area or pressure to provide a satisfactory coarsely textured surface. A broom finish may be performed using a fine bristle broom transversely. Coat the concrete surface immediately after the carpet or burlap drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. Do not allow more than 10 min. to elapse between the texturing at any location and application of evaporation retardant. The evaporation retardant may be applied using the same work bridge used for surface texturing. Do not work the concrete surface once the evaporation retardant has been applied.

Apply interim and final curing in accordance with Section 420.4.J, “Curing Concrete.”
The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer will use a 10-ft. straightedge (1/8 in. in 10 ft.) to verify ride quality and to determine locations where corrections are needed. If the Engineer determines that the ride quality is unacceptable, submit a plan for approval to produce a ride of acceptable quality. Make all corrections for ride before saw-cutting grooves.

Saw-cut grooves in the hardened concrete of bridge slabs, bridge approach slabs, and direct-traffic culverts to produce the final texturing after completion of the required curing period. Cut grooves perpendicular to the structure centerline. Cut grooves continuously across the slab to within 18 in. of the barrier rail, curb, or median divider. At skewed metal expansion joints in bridge slabs, adjust groove cutting by using narrow-width cutting heads so that all grooves end within 6 in. of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 in. adjacent to either side of the joint. Ensure that the minimum distance to the first groove, measured perpendicular to the edge of the concrete joint or from the junction between the concrete and the metal leg of the joint, is 1 in. Cut grooves continuously across construction joints or other joints in the concrete that are less than 1/2 in. wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18-in. maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

When the plans call for a concrete overlay to be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid. Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 in. with no individual test falling below 0.020 in., unless otherwise shown on the plans, when tested in accordance with Tex-436-A. If the texture depth falls below what is intended, revise finishing procedures to produce the desired texture.

When the plans require an asphalt seal, with or without overlay, on the slab (new construction), on prestressed concrete box beams, or on other precast elements, give all concrete surfaces to be covered a lightly textured broom or carpet drag finish. Provide an average texture depth of approximately 0.025 in. when tested in accordance with Tex-436-A.

**J. Curing Concrete.** Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Engineer may require the same curing methods for like portions of a single structure. Inadequate curing or facilities may delay all concrete placement on the job until remedial action is taken.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hr. or, on colder days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hr. The required curing period begins when all concrete has attained its initial set. Tex-440-A may be used to determine when the concrete has attained its initial set. Cure all concrete for 4 consecutive days except as noted in Table 1.
For upper surfaces of bridge slabs, bridge approach slabs, median and sidewalk slabs, and culvert top slabs constructed using Class S concrete, apply interim curing using a Type 1-D curing compound as soon as possible after application of the evaporation retardant and after the water sheen has disappeared, but no more than 45 min. after application of the evaporation retardant. Apply membrane interim curing using a work bridge or other approved apparatus to ensure a uniform application. Water-cure for final curing in accordance with this Section, starting as soon as possible without damaging the surface finish. Maintain the water curing for the duration noted in Table 1. Place polyethylene sheeting, burlap-polyethylene blankets, laminated mats, or insulating curing mats in direct contact with the slab when the air temperature is expected to drop below 40°F during the first 72 hr. of the curing period. Weigh down these curing materials with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather.

Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, risers, etc.) and other superstructure concrete (curbs, wingwalls, parapet walls, etc.), use only water curing in accordance with this Section.

Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.

1. **Form Curing.** When forms are left in intimate contact with the concrete, other curing methods are not required except for exposed surfaces and for cold weather protection. If forms are removed before the 4-day required curing period, use another approved curing method.

2. **Water Curing.** Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing that meets the requirements for concrete mixing water in Section 421.2.D, “Water.” Do not use seawater or water that stains or leaves an unsightly residue.

a. **Wet Mats.** Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. If needed, place damp burlap blankets made from 9-oz. stock on the damp concrete surface for temporary protection before applying cotton mats. Then place the dry mats and wet them immediately after they are placed. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms.
or ground so that outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.

b. Water Spray. Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.

c. Ponding. Cover the surfaces with at least 2 in. of clean granular material, kept wet at all times, or at least 1 in. deep water. Use a dam to retain the water or saturated granular material.

3. Membrane Curing. Unless otherwise shown on the plans, choose either Type 1-D or Type 2 membrane-curing compound when membrane curing is permitted. Type 1-D (Resin Base Only) is required for interim curing bridge slabs and top slabs of direct traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete provide only 1 type of curing compound on any 1 structure.

Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 sq. ft. per gallon. Do not spray curing compound on projecting reinforcing steel or concrete that will later form a construction joint. Do not apply membrane curing to dry surfaces. Dampen formed surfaces and surfaces that have been given a first rub so that they are moist at the time of application of the membrane.

When membrane is used for complete curing, leave the film unbroken for the minimum curing period specified. Correct damaged membrane immediately by reaplication of membrane. Polyethylene sheeting, burlap-polyethylene mats, or laminated mats in close contact with the concrete surfaces are equivalent to membrane curing.

K. Removal of Forms and Falsework. Unless otherwise directed, forms for vertical surfaces may be removed after the concrete has aged 12 hr. after initial set provided the removal can be done without damage to the concrete. Keep forms for mass placements, defined in Section 420.4.G.14, “Mass Placements,” in place for 4 days following concrete placement. Remove forms for inside curb faces and for bridge rails whenever removal can be done without damage to the curb or railing.

Leave in place weight-supporting forms and falsework spanning more than 1 ft. for all bridge components and culvert slabs except as directed otherwise until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Remove inside forms (walls and top slabs) for box culverts and sewers after concrete has attained a compressive strength of 1,800 psi if an approved overhead support system is used to transfer the weight of the top slab to the walls of the box culvert or sewer before removal of the support provided by the forms.

Forms or parts of forms may be removed only if constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

Remove all metal appliances used inside forms for alignment to a depth of at least 1/2 in. from the concrete surface. Make the appliances so that metal may be removed without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework unless otherwise directed.

L. Defective Work. Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.
M. Ordinary Surface Finish. Apply an ordinary surface finish to all concrete surfaces as follows:

- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.
- Repair spalls by saw-cutting and chipping at least 1/2 in. deep, perpendicular to the surface to eliminate feather edges. Repair shallow cavities using a latex adhesive grout, cement mortar, or epoxy mortar as approved. Repair large areas using concrete as directed or approved.
- Clean and fill holes or spalls caused by the removal of form ties, etc., with latex grout, cement grout, or epoxy grout as approved. Fill only the holes. Do not blend the patch with the surrounding concrete. On surfaces to receive a rub finish in accordance with Item 427, “Surface Finishes for Concrete,” chip out exposed parts of metals chairs to a depth of 1/2 in. and repair the surface.
- Remove all fins, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.
- Ensure that all repairs are dense, well bonded, and properly cured. Finish exposed large repairs to blend with the surrounding concrete where a higher class of finish is not specified. Unless noted otherwise, apply an ordinary surface finish as the final finish to the following exposed surfaces:
  - inside and top of inlets,
  - inside and top of manholes,
  - inside of sewer appurtenances,
  - inside of culvert barrels,
  - bottom of bridge slabs between girders or beams, and
  - vertical and bottom surfaces of interior concrete beams or girders.

Form marks and chamfer edges do not need to be smoothed for the inside of culvert barrels and the bottom of bridge slabs between girders or beams.

420.5. Measurement. This Item will be measured by the cubic yard, square yard, foot, square foot, or by each structure.

A. General. Concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer. In determining quantities, no deductions will be made for chamfers less than 2 in. or for embedded portions of steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, ducts and voids for prestressed tendons, or embedded portions of light fixtures. For slab and girder spans using pan forms, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal. For slabs on steel or prestressed concrete beams, an estimated quantity for the haunch between the slab and beams will be included. No measurement will be made during construction for variation in the amount of haunch concrete due to variations in camber of the beams. For cast-in-place slabs on slab beams, double-T beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.
Additional concrete that may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment. Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be cause for payment adjustment. Mass placements may be either a plans quantity item or measured in place as indicated. Quantities revised by a change in design, measured as specified, will be increased or decreased and included for payment.

B. Plans Quantity. Structure elements designated in Table 2 and measured by the cubic yard are plans quantity measurement items. The quantity to be paid for plans quantity items is the quantity shown in the proposal unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

No adjustment will be made for footings or other in-ground elements where the Contractor has been allowed to place concrete in an excavation without forms.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plans Quantity Payment</td>
</tr>
<tr>
<td>(Cubic Yard Measurement Only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Culverts and culvert wing walls</th>
<th>Abutments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headwalls for pipe</td>
<td>Slab and girder spans (pan form)</td>
</tr>
<tr>
<td>Retaining walls</td>
<td>Footings</td>
</tr>
<tr>
<td>Inlets and manholes</td>
<td>Pile bent caps</td>
</tr>
<tr>
<td>Shear key concrete for box and slab beams</td>
<td>Concrete wearing surface on pre-cast box beams, slab beams or double-T beams</td>
</tr>
<tr>
<td>Bridge approach slabs</td>
<td>Cast-in-place concrete slab spans</td>
</tr>
</tbody>
</table>

Note: Other structure elements, including pier and bent concrete, may be paid for as “plans quantity” when shown on the plans.

C. Measured in Place. Items not paid for as “plans quantity” will be measured in place.

1.4.8. HYDRAULIC CEMENT CONCRETE


421.2. Materials.

A. Cement. Furnish cement conforming to DMS-4600, “Hydraulic Cement.”

B. Supplementary Cementing Materials (SCM).
3. Ground Granulated Blast-Furnace Slag (GGBFS). Furnish GGBFS conforming to DMS-4620, “Ground Granulated Blast- Furnace Slag,” Grade 100 or 120.

C. Chemical Admixtures. Furnish admixtures conforming to DMS-4640, “Chemical Admixtures for Concrete.” Do not use calcium chloride.

D. Water. Furnish mixing and curing water that is free from oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. When using water from other sources, provide test reports showing compliance with Table 1 before use.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements of both Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Test Method</th>
<th>Maximum Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride (Cl)</td>
<td>ASTM D 512</td>
<td>500</td>
</tr>
<tr>
<td>Prestressed concrete</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Bridge decks &amp; superstructure</td>
<td></td>
<td>1,000</td>
</tr>
<tr>
<td>All other concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>ASTM D 516</td>
<td>1,000</td>
</tr>
<tr>
<td>Alkalies (Na₂O + 0.65K₂O)</td>
<td>ASTM D 4191 &amp; ASTMD 4192</td>
<td>600</td>
</tr>
<tr>
<td>Total solids</td>
<td>AASHTO T 26</td>
<td>50,000</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength, min % control at 7 days</td>
<td>ASTM C 109¹</td>
<td>90</td>
</tr>
<tr>
<td>Time of set, deviation from control, Min.</td>
<td>ASTM C 191¹</td>
<td>from 60 early to 90 later</td>
</tr>
</tbody>
</table>

¹ Base comparisons on fixed proportions and the same volume of test water compared to the control mix using city water or distilled water.
Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. When using white hydraulic cement, use mixing and curing water free of iron and other impurities that may cause staining or discoloration.

E. Aggregate. Supply aggregates that meet the definitions in Tex-100-E. Provide coarse and fine aggregates from sources listed in the Department’s Concrete Rated Source Quality Catalog (CRSQC). Provide aggregate from non-listed sources only when tested and approved by the Engineer before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

1. Coarse Aggregate. Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations thereof that are free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate that, when tested in accordance with Tex-413-A, has:

- at most 0.25% by weight of clay lumps,
- at most 1.0% by weight of shale, and
- at most 5.0% by weight of laminated and friable particles.

Wear must not be more than 40% when tested in accordance with Tex-410-A. Unless otherwise shown on the plans, provide coarse aggregate with a 5-cycle magnesium sulfate soundness of not more than 18% when tested in accordance with Tex-411-A. Crushed recycled hydraulic cement concrete is not subject to the 5-cycle soundness test.

The loss by decantation as tested in accordance with Tex-406-A, plus the allowable weight of clay lumps, must not exceed 1.0% or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from crushing stone, if the material finer than the No. 200 sieve is established to be the dust of fracture and essentially free from clay or shale as established by Tex-406-A, Part III, the limit may be increased to 1.5%. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1.0% but not more than 3.0% if the material finer than the No. 200 sieve is determined to be at least 67% calcium carbonate in accordance with Tex-406-A, Part III.

Unless otherwise specified, provide aggregate conforming to the gradation requirements shown in Table 3 when tested in accordance with Tex-401-A.
Table 3
Coarse Aggregate Gradation Chart

<table>
<thead>
<tr>
<th>Aggregate Grade No. 1</th>
<th>Nominal Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>1</td>
<td>2&quot;</td>
</tr>
<tr>
<td>2 (467)</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>3</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>4 (57)</td>
<td>1&quot;</td>
</tr>
<tr>
<td>5 (67)</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>6 (7)</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>7</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>8</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

1. Corresponding ASTM C 33 gradation shown in parentheses.

2. Fine Aggregate. Provide fine aggregate consisting of clean, hard, durable particles of natural or manufactured sand or a combination thereof with or without mineral filler. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, and containing no more than 0.5% clay lumps by weight in accordance with Tex-413-A.

Provide fine aggregate that does not show a color darker than standard when subjected to the color test for organic impurities in accordance with Tex-408-A.

Unless otherwise shown on the plans, use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with Tex-612-J in all concrete subject to direct traffic.

Unless otherwise shown on the plans, when necessary, blend the fine aggregate to meet the acid insoluble residue requirement. When blending, use the following equation: Acid Insoluble (%) = \( \frac{[(A1)(P1)+(A2)(P2)]}{100} \)

where:

\( A1 = \) acid insoluble (%) of aggregate 1
\( A2 = \) acid insoluble (%) of aggregate 2
\( P1 = \) percent by weight of \( A1 \) of the fine aggregate blend
\( P2 = \) percent by weight of \( A2 \) of the fine aggregate blend.

Provide fine aggregate or combinations of aggregates, including mineral filler, conforming to the gradation requirements shown in Table 4 when tested in accordance with Tex-401-A unless otherwise specified.
Except for volumetric mixers (auger/mixer), each plant and truck mixer must be currently certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a licensed professional engineer showing that concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C 94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed engineer’s inspection require reinspection every 2 years. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. When equipment or facilities fail to meet specification requirements, remove them from service until corrected.

1. **Scales.** Check all scales prior to beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 mo. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C 94 requirements. Check batching accuracy of volumetric water batching devices and
admixture dispensing devices at least every 90 days. Perform daily checks as necessary to ensure measuring accuracy.

2. **Volumetric Mixers.** Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C 685. Provide test data showing mixers meet the uniformity test requirements of Tex-472-A.

3. **Agitators and Truck and Stationary Mixers.** Inspect and furnish inspection reports on truck mixers and agitators annually. If an inspection within 12 mo. is not practical, a 2-mo. grace period (for a maximum of 14 mo. between inspections) is permitted. Include in the report the condition of blades and fins and their percent wear from the original manufacturer’s design. Repair mixing equipment exhibiting 10% or more wear before use. Provide truck mixers and agitators equipped with means to readily verify the number of revolutions of the drum, blades, or paddles.

Provide stationary and truck mixers capable of combining the ingredients of the concrete within the specified time or the number of revolutions specified into a thoroughly mixed and uniform mass and capable of discharging the concrete so that at least 5 of the 6 requirements of Tex-472-A are met.

As directed, to resolve issues of mix uniformity and mixer performance, perform concrete uniformity tests on mixers or agitators in accordance with Tex-472-A.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment and within the maximum mixing time or maximum number of revolutions. Remove from service all equipment that fails the uniformity test.

Inspect and maintain mixers and agitators. Keep them reasonably free of concrete buildup, and repair or replace worn or damaged blades or fins.

Ensure all mixers have a plate affixed showing manufacturer’s recommended operating speed and rated capacity for mixing and agitating.

**B. Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

When using non-agitating equipment for transporting concrete, provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete.

**C. Testing Equipment.** Unless otherwise shown on the plans or specified, in accordance with the pertinent test procedure, furnish and maintain:

- test molds,
- curing facilities,
- maturity meters if used, and
- wheelbarrow or other container acceptable for the sampling of the concrete.

Provide strength-testing equipment in accordance with the Contract controlling test unless shown otherwise.

**421.4. Construction.**

**A. Classification and Mix Design.** Furnish mix designs using ACI 211, “Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete,” or other approved
procedures for the classes of concrete required in accordance with Table 5. Do not exceed the maximum water-to-cementitious-material Ratio.

A higher-strength class of concrete with equal or lower water-to-cementitious- material ratio may be substituted for the specified class of concrete.

To account for production variability and ensure minimum compressive strength requirements are met, over-design the mix in accordance with Table 6.

1. Cementitious Materials. Use cementitious materials from prequalified sources; otherwise, request sampling and testing for approval before use. Unless otherwise specified or approved, limit cementitious material content to no more than 700 lb. per cubic yard. When supplementary cementing materials are used, “cement” is defined as “cement plus supplementary cementing material.”

Use Type III cement only in precast concrete or when specified or permitted.

For monolithic placements, use cement of the same type and from the same source. When sulfate-resistant concrete is required, use mix design options 1, 2, 3, or 4 given in Section 421.4.A.6, “Mix Design Options,” using Type I/II, II, V, IP, or IS cement. Do not use Class C fly ash in sulfate-resistant concrete.

Do not use supplementary cementing materials when white hydraulic cement is specified.
### Table 5

**Concrete Classes**

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Design Strength, Min. 28-day ( f'_c ) (psi)</th>
<th>Maximum W/C Ratio</th>
<th>Coarse Aggregate Grades (^{1,3})</th>
<th>General Usage (^{4})</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3,000</td>
<td>0.60</td>
<td>1–4, 8</td>
<td>Inlets, manholes, curb, gutter, curb &amp; gutter, conc. retards, sidewalks, driveways, backup walls, anchors</td>
</tr>
<tr>
<td>B</td>
<td>2,000</td>
<td>0.60</td>
<td>2–7</td>
<td>Riprap, small roadside signs, and anchors</td>
</tr>
<tr>
<td>C(^3)</td>
<td>3,600</td>
<td>0.45</td>
<td>1–6</td>
<td>Drilled shafts, bridge substructure, bridge raling, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, concrete traffic barrier (cast-in-place)</td>
</tr>
<tr>
<td>D</td>
<td>1,500</td>
<td>0.60</td>
<td>2–7</td>
<td>Riprap</td>
</tr>
<tr>
<td>E</td>
<td>3,000</td>
<td>0.50</td>
<td>2–5</td>
<td>Seal concrete</td>
</tr>
<tr>
<td>F(^3)</td>
<td>Note 6</td>
<td>0.45</td>
<td>2–5</td>
<td>Railroad structures; occasionally for bridge piers, columns, or bents</td>
</tr>
<tr>
<td>H(^3)</td>
<td>Note 6</td>
<td>0.45</td>
<td>3–6</td>
<td>Prestressed concrete beams, boxes, piling, and concrete traffic barrier (precast)</td>
</tr>
<tr>
<td>S(^3)</td>
<td>4,000</td>
<td>0.45</td>
<td>2–5</td>
<td>Bridge slabs, top slabs of direct traffic culverts</td>
</tr>
<tr>
<td>P</td>
<td>See Item 360</td>
<td>0.45</td>
<td>2–3</td>
<td>Concrete pavement</td>
</tr>
<tr>
<td>DC(^3)</td>
<td>5,500</td>
<td>0.40</td>
<td>6</td>
<td>Dense conc. overlay</td>
</tr>
<tr>
<td>CO(^3)</td>
<td>4,600</td>
<td>0.40</td>
<td>6</td>
<td>Conc. overlay</td>
</tr>
<tr>
<td>LMC(^3)</td>
<td>4,000</td>
<td>0.40</td>
<td>6–8</td>
<td>Latex-modified concrete overlay</td>
</tr>
<tr>
<td>SS(^3)</td>
<td>Note 7</td>
<td>0.45</td>
<td>4–6</td>
<td>Shurly displacement shafts, underwater drilled shafts</td>
</tr>
<tr>
<td>K(^3)</td>
<td>Note 6</td>
<td>0.45</td>
<td>Note 6</td>
<td>Note 6</td>
</tr>
<tr>
<td>HES</td>
<td>Note 6</td>
<td>0.45</td>
<td>Note 6</td>
<td>Note 6</td>
</tr>
</tbody>
</table>

---

1. Maximum water-cement or water-cementitious ratio by weight.
2. Unless otherwise permitted, do not use Grade 1 coarse aggregate except in massive foundations with 4-in. minimum clear spacing between reinforcing steel bars. Do not use Grade 1 aggregate in drilled shafts.
3. Unless otherwise approved, use Grade 8 aggregate in extruded curbs.
4. For information only.
5. Structural concrete classes.
6. As shown on the plans or specified.
7. Cementitious material content shall be minimum 658 lb/cy of concrete.
Table 6
Over Design to Meet Compressive Strength Requirements

<table>
<thead>
<tr>
<th>No. of Tests&lt;sup&gt;2,3&lt;/sup&gt;</th>
<th>Standard Deviation, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300</td>
</tr>
<tr>
<td>15</td>
<td>470</td>
</tr>
<tr>
<td>20</td>
<td>430</td>
</tr>
<tr>
<td>30 or more</td>
<td>400</td>
</tr>
</tbody>
</table>

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5.
2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi of the specified strength may be used.
3. If less than 15 prior tests are available, the overdesign should be 1,000 psi for specified strength less than 3,000 psi, 1,200 psi for specified strengths from 3,000 to 5,000 psi and 1,400 psi for specified strengths greater than 5,000 psi.

2. Aggregates. Limit the use of recycled crushed hydraulic cement concrete as a coarse or fine aggregate to Class A, B, D, E, and P concrete. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.
When white hydraulic cement is specified, use light-colored aggregates.

3. Chemical Admixtures. Use only preapproved concrete chemical admixtures from the list of prequalified concrete admixtures maintained by the Construction Division. Submit non-preapproved admixtures for testing to the Engineer for approval. Do not use high-range water-reducing admixtures (Type F or G) or accelerating admixtures (Type C or E) in bridge deck concrete.

4. Air Entrainment. Air-entrain all concrete except for Class B in accordance with Table 7 unless otherwise shown on the plans. Use moderate exposure values unless otherwise specified. If the air content is more than 1-1/2 percentage points below or 3 percentage points above the required air, the load of concrete will be rejected.
If the air content is more than 1-1/2 but less than 3 percentage points above the required air, the concrete may be accepted based on strength tests.

Table 7
Air Entrainment

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size, in.</th>
<th>Moderate Exposure</th>
<th>Severe Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 (Grades 7 &amp; 8)</td>
<td>6</td>
<td>7-1/2</td>
</tr>
<tr>
<td>1/2 (Grade 6)</td>
<td>5-1/2</td>
<td>7</td>
</tr>
<tr>
<td>3/4 (Grade 5)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>1 (Grade 4)</td>
<td>4-1/2</td>
<td>6</td>
</tr>
<tr>
<td>1-1/2 (Grades 2 &amp; 3)</td>
<td>4-1/2</td>
<td>5-1/2</td>
</tr>
<tr>
<td>2 (Grade 1)</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

1. For specified concrete strengths above 5,000 psi a reduction of 1 percentage point is permitted.
5. **Slump.** Unless otherwise specified, provide concrete slump in accordance with Table 8 using the lowest slump possible that can be placed and finished efficiently without segregation or honeycombing. Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected.

When approved, the slump of a given concrete mix may be increased above the values shown in Table 8 using chemical admixtures, provided that the admixture-treated concrete has the same or lower water–cement or water–cementitious-material ratio and does not exhibit segregation or excessive bleeding. Request approval for the mix design sufficiently in advance for proper evaluation by the Engineer.

### Table 8

<table>
<thead>
<tr>
<th>Concrete Designation</th>
<th>Recommended Design and Placement Slump, in.</th>
<th>Maximum Acceptable Placement Slump, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled shafts</td>
<td>See Item 416</td>
<td>See Item 416</td>
</tr>
<tr>
<td>Thin walled section (9 in. or less)</td>
<td>4</td>
<td>6-1/2</td>
</tr>
<tr>
<td>Approach slabs, concrete overlays, caps, columns, piers, wall sections (over 9 in.)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Bridge slabs</td>
<td>4</td>
<td>5-1/2</td>
</tr>
<tr>
<td>Prestressed concrete members(^1)</td>
<td>4</td>
<td>6-1/2</td>
</tr>
<tr>
<td>Concrete traffic barrier, concrete bridge railings</td>
<td>4</td>
<td>6-1/2</td>
</tr>
<tr>
<td>Dense concrete overlay</td>
<td>3/4</td>
<td>2</td>
</tr>
<tr>
<td>Latex-modified concrete for bridge deck overlays</td>
<td>3</td>
<td>7-1/2</td>
</tr>
<tr>
<td>Concrete placed underwater</td>
<td>6</td>
<td>8-1/2</td>
</tr>
<tr>
<td>Concrete pavement (slip-formed)</td>
<td>1-1/2</td>
<td>3</td>
</tr>
<tr>
<td>Concrete pavement (formed)</td>
<td>4</td>
<td>6-1/2</td>
</tr>
<tr>
<td>Riprap, curb, gutter, slip-formed, and extruded concrete</td>
<td>As approved</td>
<td>As approved</td>
</tr>
</tbody>
</table>

\(^1\) If a high-range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in.

6. **Mix Design Options.** For structural concrete identified in Table 5 and any other class of concrete designed using more than 520 lb. of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below.

For concrete classes not identified as structural concrete and designed using less than 520 lb. of cementitious material per cubic yard, use one of the mix design Options 1–8 shown in Table 5, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3, and 4 unless sulfate-resistant concrete is required.

**a. Option 1.** Replace 20 to 35% of the cement with Class F fly ash.
b. **Option 2.** Replace 35 to 50% of the cement with GGBFS.

c. **Option 3.** Replace 35 to 50% of the cement with a combination of Class F fly ash, GGBFS, or silica fume. However, no more than 35% may be fly ash, and no more than 10% may be silica fume.

d. **Option 4.** Use Type IP or Type IS cement. (Up to 10% of a Type IP or Type IS cement may be replaced with Class F fly ash, GGBFS, or silica fume.)

e. **Option 5.** Replace 35 to 50% of the cement with a combination of Class C fly ash and at least 6% of silica fume, UFFA, or metakaolin. However, no more than 35% may be Class C fly ash, and no more than 10% may be silica fume.

f. **Option 6.** Use a lithium nitrate admixture at a minimum dosage of 0.55 gal. of 30% lithium nitrate solution per pound of alkalis present in the hydraulic cement.

g. **Option 7.** When using hydraulic cement only, ensure that the total alkali contribution from the cement in the concrete does not exceed 4.00 lb. per cubic yard. of concrete when calculated as follows:

\[
\text{lb. alkali per cu. yd.} = \left( \text{lb. cement per cu. yd.} \times \% \text{ Na}_2\text{O equivalent in cement} \right) \times \frac{1}{100}
\]

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

h. **Option 8.** For any deviations from Options 1–7, perform the following:

- Test both coarse and fine aggregate separately in accordance with ASTM C 1260, using 440 g of the proposed cementitious material in the same proportions of hydraulic cement to supplementary cementing material to be used in the mix.
- Before use of the mix, provide the certified test report signed and sealed by a licensed professional engineer demonstrating that the ASTM C 1260 test result for each aggregate does not exceed 0.10% expansion.

**B. Trial Batches.** Perform all preliminary trial batches and testing necessary to substantiate the proposed mix designs, and provide documentation including mix design, material proportions, and test results substantiating that the mix design conforms to specification requirements. Make all final trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the job. Make the batch size at least 50% of the mixer’s rated capacity. Perform fresh concrete tests for air and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least 3 sets of design strength specimens with 2 specimens per set in accordance with Tex-418-A or Tex-448-A for each test age. Before placing, provide the Engineer the option of witnessing final trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Establish 7-day compressive strength target values using the following formula for each concrete mix to be used:

\[
\text{Target value} = \text{Minimum design strength} \times \frac{7\text{-day avg. trial batch strength}}{28\text{-day avg. trial batch strength}}
\]

When there are changes in aggregates or in type, brand, or source of cement, SCM, or chemical admixtures, reevaluate the mix as a new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of
cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, new trial batches may be waived by the Engineer. When the maturity method is specified or permitted, establish the strength–maturity relationship in accordance with Tex-426-A. When using the maturity method any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

C. Storage of Materials.

1. Cement, Supplementary Cementing Materials, and Mineral Filler. Store all cement, supplementary cementing materials, and mineral filler in weatherproof enclosures that will protect them from dampness or absorption of moisture. When permitted, small quantities of sacked cement may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hours.

2. Aggregates. Handle and store concrete aggregates in a manner that prevents contamination with foreign materials. If the aggregates are stored on the ground, clear the sites for the stockpiles of all vegetation, level the sites, and do not use the bottom 6-in. layer of aggregate without cleaning the aggregate before use. When conditions require the use of 2 or more grades of coarse aggregates, maintain separate stockpiles and prevent intermixing. Where space is limited, separate the stockpiles using physical barriers. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent. Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

3. Admixtures. Store admixtures in accordance with manufacturer’s recommendations and prevent admixtures from freezing.

D. Measurement of Materials. Except for volumetric mixers, measure concrete materials by weight. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and supplementary cementing materials in a weigh hopper and on a separate scale from those used for other materials. Measure the cement first when measuring the cumulative weight. Measure concrete chemical admixtures in powdered form by weight. Measure concrete chemical admixtures in liquid form by weight or volume. Measure batch materials within the tolerances of Table 9.
Table 9
Measurement Tolerances – Non-Volumetric Mixers

<table>
<thead>
<tr>
<th>Material</th>
<th>Tolerance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, wt.</td>
<td>±1</td>
</tr>
<tr>
<td>Mineral admixture, wt.</td>
<td>±1</td>
</tr>
<tr>
<td>Cement + SCM (cumulative weighing), wt.</td>
<td>±1</td>
</tr>
<tr>
<td>Water, wt. or volume</td>
<td>±3</td>
</tr>
<tr>
<td>Fine aggregate, wt.</td>
<td>±2</td>
</tr>
<tr>
<td>Coarse aggregate, wt.</td>
<td>±2</td>
</tr>
<tr>
<td>Fine + coarse aggregate (cumulative weighing), wt.</td>
<td>±1</td>
</tr>
<tr>
<td>Chemical admixtures, wt. or volume</td>
<td>±3</td>
</tr>
</tbody>
</table>

When measuring cementitious materials at less than 30% of scale capacity, ensure that the quantity measured is accurate to not less than the required amount and not more than 4% in excess. When measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, ensure that the cumulative quantity is measured accurate to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

For volumetric mixers, base tolerances on volume–weight relationship established by calibration, and measure the various ingredients within the tolerances of Table 10. Correct batch weight measurements for moisture.

When approved, under special circumstances, measure cement in bags of standard weight. Weighing of sacked cement is not required. Do not use fractional bags except for small hand-mixed batches of approximately 5 cu. ft. or less and when an approved method of volumetric or weight measurement is used.

Table 10
Measurement Tolerances – Volumetric Mixers

<table>
<thead>
<tr>
<th>Material</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, wt. %</td>
<td>0 to +4</td>
</tr>
<tr>
<td>SCM, wt. %</td>
<td>0 to +4</td>
</tr>
<tr>
<td>Fine aggregate, wt. %</td>
<td>±2</td>
</tr>
<tr>
<td>Coarse aggregate, wt. %</td>
<td>±2</td>
</tr>
<tr>
<td>Admixtures, wt. or volume %</td>
<td>±3</td>
</tr>
<tr>
<td>Water, wt. or volume %</td>
<td>±1</td>
</tr>
</tbody>
</table>

E. Mixing and Delivering Concrete. Mix and deliver concrete by means of one of the following operations:
- central-mixed,
- shrink-mixed,
- truck-mixed,
- volumetric mixer-mixed, or
- hand-mixed.

Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment.
For shrink-mixed and truck-mixed concrete, when there is a reason to suspect the uniformity of concrete delivered using a truck mixer or truck agitator, conduct slump tests of 2 individual samples taken after discharging approximately 15% and 85% of the load as a quick check of the probable degree of uniformity. Take the 2 samples within an elapsed time of at most 15 min. If the slumps of the 2 samples differ by more than the values shown in Table 11, investigate the causes and take corrective actions including adjusting the batching sequence at the plant and the mixing time and number of revolutions. Delivery vehicles that fail to meet the mixing uniformity requirements must not be used until the condition is corrected.

<table>
<thead>
<tr>
<th>Average Slump</th>
<th>Slump Tolerance</th>
<th>Slump Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in. or less</td>
<td>1.0 in.</td>
<td>1.5 in.</td>
</tr>
<tr>
<td>4 to 6 in.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Do not apply these tolerances to the required slumps in Table 8.
2. Maximum permissible difference in results of test of samples from 2 locations in the concrete batch.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Do not add water after the introduction of mixing water at the batch plant except on arrival at the job site, with approval, to adjust the slump of the concrete.

When this water is added, do not exceed the mix design water–cementitious-material ratio. Turn the drum or blades at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. Do not add water or chemical admixtures to the batch after any concrete has been discharged.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Before unloading, furnish the delivery ticket for the batch of concrete containing the information required on Department Form 596, “Concrete Batch Ticket.”

When the concrete contains silica fume, adjust mixing times and batching operations as necessary to ensure the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by the Construction Division, Materials and Pavements Section, using cylinders made from trial batches. If uniform dispersion is not achieved, make necessary changes to the batching operations until uniform and complete dispersion of the silica fume is achieved.

1. **Central-Mixed Concrete.** Provide concrete that is mixed completely in a stationary mixer. Mix concrete for a period of 1 min. for 1 cu. yd. and 15 sec. for each additional cu. yd. of rated capacity of the mixer unless mixer performance test data demonstrate that shorter mixing times can be used to obtain a uniform mix in accordance with Tex-472-A. Count the mixing time from the time all the solid materials are in the drum. Charge the mixer so that some water will enter before the cement and aggregate. Ensure that all water is in the drum by the end of the first 1/4 of the specified mixing time. Adjust the mixing time if necessary to achieve a uniform mix. Concrete mixed completely in a stationary mixer must be delivered to the project in a truck mixer, truck agitator, or non-agitating delivery vehicle. When a truck mixer or truck agitator is used for transporting concrete, use the manufacturer’s designated agitating speed for any turning during transportation. Non-agitating delivery vehicles must be clean and
free of built-up concrete with adequate means to control concrete discharge. Deliver the concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity. Resolve questions regarding the uniformity of the concrete by testing when directed by the Engineer in accordance with Tex- 472-A.

2. **Shrink-Mixed Concrete.** Provide concrete that is first partially mixed in a stationary mixer and then mixed completely in a truck mixer. Partially mix for the minimum time required to intermingle the ingredients in the stationary mixer, and then transfer to a truck mixer and mix the concrete at the manufacturer’s designated mixing speed for an adequate amount of time to produce thoroughly mixed concrete. Deliver the concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity.

3. **Truck-Mixed Concrete.** Mix the concrete in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer to produce a uniform concrete mix. Deliver the concrete to the project in a thoroughly mixed and uniform mass and discharge the concrete with a satisfactory degree of uniformity. Additional mixing at the job site at the mixing speed designated by the manufacturer is allowed as long as concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.

4. **Volumetric Mixer-Mixed Concrete.** Unless otherwise specified or permitted, perform all mixing operations in accordance with manufacturer’s recommended procedures. Provide an accurate method of measuring all ingredients by volume, and calibrate equipment to assure correct measurement of materials within the specified tolerances.

5. **Hand-Mixed Concrete.** When permitted, for small placements of less than 2 cu. yd., mix up to a 2-sack batch of concrete by hand methods or in a small motor-driven mixer. For such placements, proportion the mix by volume or weight.

F. **Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in accordance with the pertinent Items.

G. **Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows:

1. **Sampling Fresh Concrete.** Provide all material to be tested. Fresh concrete will be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample will be taken at the time of discharge from the delivery equipment and correlation testing will be performed and documented to ensure specification requirements are met at the discharge end.

2. **Testing of Fresh Concrete.**
   a. **Air Content.** Tex-414-A or Tex-416-A.
   b. **Slump.** Tex-415-A.
   c. **Temperature.** Tex-422-A.
   d. **Making and Curing Strength Specimens.** Tex-447-A.

3. **Testing of Hardened Concrete.** Only compressive strength testing will be used unless otherwise specified or shown on the plans.
   a. **Compressive Strength.** Tex-418-A.
   b. **Flexural Strength.** Tex-448-A.
   c. **Maturity.** Tex-426-a.
4. Certification of Testing Personnel. Contractor personnel performing testing must be either ACI-certified or qualified by a Department-recognized equivalent written and performance testing program for the tests being performed. Personnel performing these tests are subject to Department approval. Use of a commercial laboratory is permitted. All personnel performing testing using the maturity method must be qualified by a training program recognized by the Department before using this method on the job.

5. Adequacy and Acceptance of Concrete. The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. For any concrete that fails to meet the required strengths as outlined below, investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary actions to correct the problem including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions.

a. Structural Concrete. For concrete classes identified as structural concrete in Table 5, the Engineer will make and test 7-day and 28-day specimens. Acceptance will be based on the design strength given in Table 5.

The Engineer will evaluate the adequacy of the concrete by comparing 7-day test results to the target value established in accordance with Section 421.4.B, “Trial Batches.”

b. All Other Concrete. For concrete classes not identified as structural concrete in Table 5, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on the 7-day target value established in accordance with Section 421.4.B, “Trial Batches.”

6. Test Sample Handling. Unless otherwise shown on the plans or directed, remove forms and deliver department test specimens to curing facilities, in accordance with pertinent test procedures. Clean and prepare forms for reuse.

421.5. Measurement and Payment. The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

1.4.9. REINFORCED CONCRETE SLAB

422.1. Description. Form and construct reinforced concrete bridge slab.

422.2. Materials. Furnish materials in accordance with:

- Item 420, “Concrete Structures”
- Item 421, “Hydraulic Cement Concrete”
- Item 426, “Prestressing”
- Item 440, “Reinforcing Steel.”

Use Class S for all cast-in-place concrete unless otherwise shown on the plans.

422.3. Construction.

A. Cast-in-Place Slab. Use conventional forms, permanent metal deck forms, or prestressed concrete panels. Use permanent metal deck forms or conventional forms for thickened slabs,
diaphragms, or other regions as shown on the plans where prestressed concrete panels are not used. Construct the slab as shown on the plans and in accordance with the pertinent requirements of:

- Item 420, “Concrete Structures”
- Item 424, “Precast Concrete Structures (Fabrication)”
- Item 426, “Prestressing”
- Item 440, “Reinforcing Steel.”

B. Extending Existing Slabs. Extend existing slabs in accordance with Item 430, “Extending Concrete Structures.”

C. Prestressed Concrete Panels. Profile each beam to determine the actual camber or sag of the beams before placing panels. Adjust the profile grade line, panel elevation, and bearing seat elevations as needed to obtain the required cover over the slab reinforcement and the required slab thickness. When a profile grade line adjustment is necessary, make adjustments over suitable increments, depending on span lengths, so that the revised grade line will produce a uniform profile and good riding qualities. Obtain approval for the grade adjustments prior to placement. Consider actual beam camber in adjacent spans or slab placements when adjusting the grade line. Place the top portion of abutment backwalls and wings after adjustment to the profile grade line.

422.4. Measurement. Reinforced concrete slab placed under this Item will be measured by the square foot of slab surface area using the nominal dimensions and configuration shown on the plans. Transverse measurement will be made from outer edge of slab to outer edge of slab (including raised median and sidewalk sections). Longitudinal measurement will be made between ends of units or spans. Diaphragms, haunch concrete, reinforcement, and optional steel diaphragms will be considered as a portion of the slab.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustment of quantities is required. The quantities of concrete and reinforcing steel shown on the plans are based on a conventionally formed slab. These quantities include amounts for concrete diaphragms, brackets and other required attachments, and haunch concrete when required, based on the profile grade, theoretical camber, and dead load deflection of the beams. No additional measurement will be made for concrete or reinforcing steel due to a variation in camber of the beams from theoretical camber, or for additional quantities required by optional methods of forming.

1.4.10. PRECAST CONCRETE STRUCTURES (FABRICATION)

424.1. Description. Fabricate precast prestressed and precast non-stressed concrete members. This Item, in conjunction with DMS-7300, “Precast Concrete Fabrication Plants,” applies to both multi-project and project specific fabrication plants. For this Item, the following definitions apply:

- Prestressed Members. Precast concrete members fabricated by the process of pre-tensioning or post-tensioning or a combination of both methods.
• Nonstressed Members. Precast concrete members that have not been pretensioned or post-tensioned.
• Multi-Project Fabrication Plant. A facility at an offsite location that fabricates precast prestressed or precast nonstressed members for more than one Contract.
• Project-Specific Fabrication Plant. A temporary facility at or near the project location that fabricates precast prestressed or precast nonstressed members for only one Contract. This definition may be applied to temporary facilities that fabricate for multiple Contracts, if approved.
• Major Prestressed Members. Includes I-beams, bulb-tee beams, Ubeams, and box beams (voided).
• Minor Prestressed Members. Includes all other prestressed members not listed as major prestressed members.
• Temperature Probe. Thermocouple for measuring concrete temperature or air temperature.
• Temperature Recording Device. Data logger for recording temperatures from the temperature probes.

424.2. Equipment.

A. Field Office and Inspection Laboratory. For multi-project and project-specific fabrication plants, provide a field office and inspection laboratory in accordance with DMS-7300, “Precast Concrete Fabrication Plants.”

B. Furnishings and Laboratory Equipment. For multi-project and project-specific fabrication plants, provide furnishings and laboratory equipment in accordance with DMS-7300, “Precast Concrete Fabrication Plants.”

C. Plant Facilities. For multi-project and project-specific fabrication plants that produce prestressed members, provide plant facilities in accordance with DMS-7300, “Precast Concrete Fabrication Plants.”

424.3. Construction.

A. General Requirements.
1. Shop Drawings.
a. Prestressed Members. When optional designs are permitted by the plans, submit the proposed designs on forms furnished by the Department. Obtain approval of these designs before casting. Approval of optional designs does not relieve the Contractor from the responsibility of furnishing a satisfactory completed structure. Unless otherwise shown on the plans or in other Items, furnish shop drawings for prestressed members. Prepare clear and legible shop drawings on 11 × 17 in. sheets. At the left end, provide a 1-in. margin, with the other margins 1/2-in. wide. Provide a title block on each sheet in the lower right corner with the following information:
• sheet index data shown on lower right corner of the project plans,
• sheet numbering for shop drawings,
• name of structure or stream,
• name of fabricator, and
• name of Contractor.
Submit 7 complete sets of shop drawings to the Engineer. Submit 1 additional copy of each sheet if the owner is a non-Department entity such as a railroad or a municipal or turnpike authority, and another copy if the designer is a private consultant. The Engineer may require additional sets. Provide submittals for precast post-tensioned members in accordance with Section 426.4.A, “Required Submittals.”

b. Nonstressed Members. Furnish shop drawings for nonstressed members when required by the plans or pertinent items.

2. Plant Approval.
   a. Plant Submittals. Provide submittals in accordance with DMS-7300, “Precast Concrete Fabrication Plants,” for each particular plant operation. This requirement does not apply to project-specific nonstressed member fabrication plants.
   b. Plant Audits. Multi-project and project-specific fabrication plants that produce major prestressed members must pass initial and periodic Department-directed plant audits in accordance with DMS-7300, “Precast Concrete Fabrication Plants.”

3. Notice of Beginning Work. Give adequate notice before beginning work as specified in Table 1.

<table>
<thead>
<tr>
<th>Plant Location</th>
<th>Notice Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Texas</td>
<td>7 days</td>
</tr>
<tr>
<td>In the contiguous United States</td>
<td>21 days</td>
</tr>
<tr>
<td>Outside the contiguous United States</td>
<td>60 days</td>
</tr>
</tbody>
</table>

Perform no Department work in the plant before the Engineer authorizes fabrication. When fabrication is performed outside of the contiguous 48 states, the additional cost of inspection will be in accordance with Article 6.4, “Sampling, Testing, and Inspection.”

4. Personnel Qualifications. Provide qualified personnel in accordance with DMS-7300, “Precast Concrete Fabrication Plants,” for each particular plant operation.

5. Quality Responsibilities. The quality responsibilities for the Contractor for each particular plant operation will be in accordance with DMS-7300, “Precast Concrete Fabrication Plants.”

B. Fabrication. Prepare a casting schedule on Department-approved forms per DMS-7300, “Precast Concrete Fabrication Plants,” and submit it daily to the Department before fabrication. This requirement does not apply to project-specific minor prestressed member or projectspecific nonstressed member fabrication plants.

1. Forms. Design forms to prevent damage to the concrete from restraint as the concrete shrinks, from form expansion and contraction from thermal changes, from stripping operations, and from dimensional changes due to pretensioning. Forms, regardless of material, must conform to the profiles, dimensions, and tolerances of the finished product as specified on the plans and in this Item. Maintain forms free from dents, grease, or other foreign materials that may affect the appearance of the member, and clean forms thoroughly before each casting operation and immediately before applying a form-release agent.
   a. External Forms. Construct side and bottom forms of steel unless otherwise approved or noted on the plans. Wood forms, when permitted, must meet the requirements of Section 420.4.D, “Forms.” End headers may be of other material as approved.
Construct forms with sufficient thickness, external bracing and stiffeners, and anchorage to withstand the forces generated during concrete placement and consolidation. Do not stabilize forms with bracing and holding devices that will remain in the finished member. Provide corners with a chamfer or radius where shown on the plans.

Maintain forms sufficiently mortar-tight to prevent damage that requires repair to the finished product. Where sections of forms will be joined, an offset of 1/16 in. for flat surfaces and 1/8 in. for corners and bends is permitted. Do not allow vertical or horizontal gaps or offsets to exceed 1/4 in. between adjacent sections of built-up end headers.

Check the grade and alignment of forms each time they are set, and maintain them during placement of concrete.

Apply a form-release agent, in accordance with the manufacturer’s recommendations, to the facing of forms before placing concrete. Use a form-release agent that facilitates form removal and does not affect any required coating, painting, or color-staining operations. Do not use materials that appreciably stain or react with the concrete. Remove excess form-release agent from the form surface before casting, and ensure that it does not contaminate strands, reinforcing steel, and embedments. Use a clear form-release agent of the same brand throughout the casting of retaining wall panels per structure, unless it can be shown that a different form-release agent does not change the appearance of the concrete. Construct the forms to facilitate removal of members without damage to the concrete. Construct and maintain the soffit (liner) to provide a maximum 1/4-in. variation from the theoretical plane, and do not allow the soffit to vary more than 1/4 in. between any 2 points in any 50-ft. length.

At the Contractor’s option, construct side forms for prestressed bridge deck panels with a 1/8-in. draft for ease of product removal.

**b. Internal Forms.** Use solid expanded polystyrene conforming to ASTM C 578 Type I for forming internal voids. The form material must be inert, non-biodegradable, non-absorptive, and strong enough to maintain sufficient rigidity to withstand the forces generated during concrete placement and consolidation without damage. Other materials for forming internal voids may be used when approved. Provide certification of conformance for void forms. The Engineer may require samples to be submitted when needed.

Anchor internal void forms to prevent movement or misalignment while placing concrete. Provide hold-down devices for all types of void forms at 30-in. maximum spacing unless otherwise approved. Do not use internal hold-down or lateral bracing devices that will remain in the finished member unless approved. Provide enough bearing area on the void form to prevent penetration of hold-down devices into the void form. Splice void form sections to prevent separation or misalignment during concrete placement and consolidation operations. During casting, verify and document void form placement at 10-ft. maximum spacing using an approved method.

Vent void forms without solid cores to eliminate high air pressure caused by heat of hydration. Insert a 3/4-in. diameter plastic tube into the top of the void before placing concrete, and leave it in place until there is no possibility of damage from pressure. Remove the plastic tube afterwards and seal the hole with an approved repair material and procedure.

Drain prestressed concrete box beams and U-beams through the bottom flange by forming holes in each voided area as shown on the plans.

**2. Prestressing.** Perform prestressing in accordance with Item 426, “Prestressing.” Place post-tensioning ducts in accordance with Item 426 and keep ducts free of obstructions.
3. Placing Reinforcing Steel. Place reinforcing steel in accordance with Item 440, “Reinforcing Steel.” Reinforcing steel projection outside of the member must not be more than 1/2 in. or less than 3/4 in. from plan dimension unless otherwise approved. Do not damage sheathing for strand de-bonding. Do not tie reinforcing steel to de-bonded strand regions.

4. Quality of Concrete. Provide concrete in accordance with Item 421, “Hydraulic Cement Concrete,” except that air-entrained concrete will not be required in precast concrete members unless otherwise shown on the plans. For each type of structure or unit, use the class of concrete shown on the plans or in the pertinent Item. When optional designs are permitted, the minimum concrete strength is as shown on the approved shop drawings. Control concrete by compressive strength tests of cylinders or other pertinent performance tests detailed on the plans or pertinent Items. Concrete compressive-strength test cylinders will be made, cured, and tested in accordance with Tex-704-I. Cure release-offension strength cylinders in accordance with Tex-715-I when match-cure technology is used. High-strength concrete (F'c > 9000 psi) is accepted based on 56-day compressive strength testing. Concrete design-strength test cylinders for high-strength concrete will be made, cured, and tested in accordance with Tex-704-I. However, a maximum of 10 design strength cylinders are permitted.

Product with concrete that fails to meet minimum design compressive strength requirements will be reviewed. Concrete that has been determined to be structurally adequate may be accepted at an adjusted price based on the formula in Article 420.6, “Payment.” If the Engineer requires that cores be taken to determine the strength of the in-situ concrete, the coring will be at the Contractor’s expense and will be in accordance with Tex-424-A. For concrete that has been determined to be structurally adequate, coring of the in-situ concrete will not be allowed for the purpose of avoiding the price adjustment. The Department may require reimbursement for testing of cores. Testing by an approved commercial testing laboratory will be at the Contractor’s expense. Test results from a commercial laboratory must be sealed by a licensed professional engineer.

5. Placing Concrete. Place concrete during daylight hours unless the production site has an approved lighting system.

Place concrete only when its temperature at time of placement is between 50°F and 95°F. Under any weather condition, the Contractor is responsible for producing quality concrete and must have adequate weather protection provisions on-site and available for immediate use. If rainfall occurs after concrete placing operations have started, immediately provide protective measures without compromising the quality of the product. Failure to immediately provide adequate weather protection may be cause for rejection of the affected product. Maintain concrete transporting equipment clean and free from hardened concrete coatings. At the time of concrete placement, reinforcing steel, strands, and embedments must be free of dirt, oil, or other bond-breaking substances.

Place and adequately consolidate concrete while it is in a plastic state, which is before the concrete attains initial set as determined in accordance with Tex-440-A. When it is necessary to determine initial set time, including for concrete mix design trial batches per the Department work plan guidelines, perform the test in a manner representative of the concrete temperature at the time of placement. Concrete must not exhibit segregation or excessive bleeding. Minimize concrete flow lines and displacement of the reinforcing steel, strands, embedments, and ducts during concrete placement.
Place concrete as near as possible to its final position in the forms. Do not deposit large quantities of concrete at one location and run or work it along the forms to other locations. Do not allow fresh concrete to free-fall more than 5 ft. unless approved.

Work the coarse aggregate back from the face of the concrete, and force the concrete under and around the reinforcing steel, strands, embedments, and ducts. If prestressed concrete I-beams are cast in multiple lifts, the thickness of the first lift must be slightly above the juncture of the bottom flange and web.

Cast prestressed concrete box beams monolithically in 2 stages, maintaining the concrete in the previously placed bottom slab in a plastic state until the web (side wall) concrete is placed and vibrated into the bottom slab.

The maximum time between the addition of mixing water or cement to the concrete batch and the placing of concrete in the forms is 30 minutes for concrete delivered in non-agitated delivery equipment and 60 minutes for concrete delivered in agitated delivery equipment. If conditions of wind, humidity, and temperature cause quick stiffening of the concrete, the required placement times may be reduced. Submit a plan for approval, if necessary, to demonstrate that the concrete can be properly placed, consolidated, and finished without reducing placement time limits.

Unless otherwise specified, the maximum acceptable placement slump will be in accordance with Section 421.4.A.5, “Slump.”

When the maximum acceptable placement slump is exceeded, the affected concrete will be rejected and re-slumping will not be allowed regardless of the concrete placement times.

Requirements for precast mass placements will be in accordance with Section 420.4.G.14, “Mass Placements.”

a. Placing Concrete in Cold Weather. Maintain concrete temperature between 50°F and 95°F at time of placement as specified in Section 424.3.B.5, “Placing Concrete,” and maintain the concrete temperature of precast members at or above 50°F during the specified curing period as specified in Section 424.3.B.7, “Curing of Concrete.” Do not place concrete when the atmospheric temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the atmospheric temperature in the shade is at least 35°F and rising or above 40°F, provided that adequate cold-weather protection provisions are on-site and available for immediate use before placing concrete when weather conditions indicate a possible need for temperature protection. When required, provide necessary covering material or an approved accelerated curing system in accordance with Section 424.3.B.7.d, “Accelerated Curing,” and do not allow any concrete to remain unprotected for longer than 1 hour after placement. Do not place concrete in contact with any material coated with frost or with material at a temperature of 32°F or lower. If accelerated curing is used, do not apply heat directly to concrete surfaces. Take protective measures to ensure that the difference between air temperature and concrete surface temperature does not cause thermal cracking. Maintain aggregates free from ice, frost, and frozen lumps. When needed to produce the minimum concrete placement temperature of 50°F, heat the aggregate and the water, but:

• do not allow the water temperature to exceed 180°F or the aggregate temperature to exceed 150°F,
• heat the aggregate uniformly to eliminate overheated areas in the stockpile that might cause flash set of the cement, and
• provide an aggregate and water mixture temperature between 50°F and 85°F before introduction of the cement.
b. Placing Concrete in Hot Weather. Keep concrete at or below 95°F at time of placement in accordance with Section 424.3.B.5, “Placing Concrete.” Use any of the following methods, as needed, to control the concrete placement temperature:

- Cool the aggregate by sprinkling or fogging (fine mist) with water, shading, or using an approved liquid nitrogen system and procedure.
- Cool the fresh concrete by using chilled mixing water, partially replacing mixing water with shaved or crushed ice, or using an approved system and procedure to discharge liquid nitrogen into concrete during batching.

When the temperature of steel forms, strand, or reinforcing steel is greater than 120°F, apply a fog spray (fine mist) of water to this steel just before placing concrete. Water droplets left on the form surfaces must not adversely affect surface finishes.

Place concrete without exceeding the design water-cement ratio. When field conditions are such that evaporation of water from the concrete makes the surface finishing operation difficult, a fog spray (fine mist) of water may be applied above the concrete surface. Do not fog directly toward the concrete or in any manner that will wash cement paste from the fresh concrete surface or cause water to puddle. Do not fog as a means to add finishing water and do not work moisture from the fog spray into the fresh concrete. An approved evaporation retardant conforming to DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants,” is also acceptable if used in accordance with the manufacturer’s recommendations. Do not apply the evaporation retardant when floating and troweling concrete. Do not allow it to puddle or be worked into the concrete surface immediately after application. Misuse of fog spray or evaporation retardant will be cause for disallowing its use. If necessary, shade the concrete during casting.

When the air temperature is above 85°F, use an approved retarder, in accordance with the manufacturer’s recommendations, if necessary to control concrete slump loss and lengthen the time for placing, consolidating, and finishing operations.

c. Consolidation of Concrete. Thoroughly consolidate concrete with high-frequency vibration immediately after placement.

For prestressed concrete beams and piling, internal vibration is required and may be supplemented with external vibration.

For emergency use, provide at least 1 on-site standby vibrator of the type being used. Perform concrete vibration using trained personnel and proper timing and spacing to ensure adequate consolidation. Revise the concrete placement and consolidation procedures, and review the concrete mix design and batching procedures, if necessary, when unacceptable defects such as excessive honeycombing, aggregate or mortar pockets or surface air voids (bugholes) are present. Provide supplemental vibrators or modify the vibration system when required to accomplish thorough consolidation of the concrete and complete embedment of the strands, reinforcing steel, embedments, or ducts.

(1) Internal Vibration. Insert vibrators into the concrete immediately after concrete placement at points spaced to ensure uniform vibration of the entire concrete mass. Limit the insertion spacing to within the radius where the vibrators are visibly effective. Allow the vibrators to sink into the concrete by their own weight and to penetrate into previously placed lifts that are still in a plastic state in order to thoroughly consolidate the layers together and prevent cold joints. After the concrete is thoroughly consolidated, withdraw the vibrators slowly to avoid forming holes.

Do not allow prolonged contact of vibrators with forms so that vibrator marks on concrete surfaces are minimal. Do not use vibrators to move concrete to other locations in the forms.

When epoxy-coated reinforcing steel is used, use vibrators with nonmetallic vibrating heads.
to prevent damage to the epoxy coating. Increase the consolidation time and decrease the insertion spacing, if necessary, when using these vibrators.

(2) **External Vibration.**

(a) **Form Vibrators.** Form vibrators may be used to consolidate thin members, supplement internal vibration, or consolidate members with highly congested reinforcing steel. Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

(b) **Surface Vibrators.** Vibratory screeds may be used to consolidate thin sections. Move vibratory screeds at a rate that will bring enough mortar to the surface to embed and cover the coarse aggregate. Do not overvibrate by causing an excessive amount of mortar to be brought to the surface.

(c) **Vibrating Tables.** Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

6. **Finishing of Concrete.** Finished, unfomed surfaces must not have distortions greater than 1/4 in.

a. **Prestressed Members.** Screed or rough-float unfomed surfaces of prestressed members and bridge deck panels by bringing enough mortar to the surface to embed and cover the coarse aggregate.

Provide a uniform rough wood float finish for the top surface of box beams and slab beams with exposed reinforcing steel, I-beams, bulb-tee beams, and U-beams.

Provide tine finish of approximately 1/16-in. amplitude or a stiff broom finish for the top surface of box beams and slab beams without exposed reinforcing steel, bridge deck panels, and double T-beams.

Do not loosen aggregate when roughening the surface with a broom or tine finish.

Provide a smooth metal trowel finish for surfaces at anchor bolt locations.

Strike off the top surface of prestressed concrete piling, and finish it with a wood or magnesium float by bringing enough mortar to the surface to cover the aggregate and providing a reasonably smooth appearance.

b. **Nonstressed Members.** Screed or rough-float unfomed surfaces by bringing enough mortar to the surface to embed and cover the coarse aggregate. Provide a uniform rough wood float finish to the surface unless otherwise shown on the plans.

7. **Curing of Concrete.** To promote early cement hydration, cure concrete by providing adequate moisture on exposed surfaces and by maintaining the concrete temperature or curing enclosure air temperature at the concrete surface within the limits specified in this Section. Provide uniform temperature and moisture on the surfaces to prevent differential shrinkage that may cause warping or cracking. Prevent temperature differentials within the concrete that cause thermal cracking.

Begin curing after the finishing operation, before the formation of plastic shrinkage cracks, and as soon as damage to the surface finish will not occur. If needed to prevent plastic shrinkage cracks, provide fog spray or an evaporation retardant after finishing and before curing. Apply fog spray or evaporation retardant in accordance with Section 424.3.B.5.b, “Placing Concrete in Hot Weather.” Keep exposed concrete surfaces continuously wet for the duration of the specified curing period, unless an approved liquid membrane-forming curing
compound is used. Membrane curing compound is only permitted as noted in this Section or in the pertinent Item.

Approved equipment and materials for curing must be on-site and available for immediate use before placing concrete. Provide temperature probes to monitor the concrete temperature or curing enclosure air temperature as specified in Table 2.

Attach each temperature probe to a separate temperature recording device unless multi-channel temperature recording devices are used, in which case 1 high concrete temperature probe and 1 low concrete temperature probe may be attached to the same recording device. When accelerated curing is used, 1 curing enclosure air temperature probe may also be attached to this multi-channel temperature recording device.

Inadequate curing facilities or lack of attention to the proper curing of concrete will be cause for the Engineer to stop concrete placement until approved curing is provided. Inadequate curing may be cause for rejection of the affected product.

Forms may be removed at the discretion of the Contractor at any time after the concrete has reached sufficient strength to prevent physical damage to the member. Do not interrupt curing for more than 30 minutes during form removal.
### Table 2
#### Temperature Probe Requirements

<table>
<thead>
<tr>
<th>Condition</th>
<th>Major Prestressed Members</th>
<th>Minor Prestressed Members</th>
<th>Nonstressed Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecasted atmospheric temperature $\geq 50^\circ F$ during specified curing period</td>
<td>2 concrete temperature probes per casting line to monitor high concrete temperature regions</td>
<td>2 concrete temperature probes per casting line to monitor high concrete temperature regions $^1$</td>
<td>N/A</td>
</tr>
<tr>
<td>Forecasted atmospheric temperature $&lt; 50^\circ F$ during specified curing period</td>
<td>2 concrete temperature probes per casting line to monitor high concrete temperature regions, and 2 concrete temperature probes per casting line to monitor low concrete temperature regions $^2$</td>
<td>2 concrete temperature probes per casting line to monitor high concrete temperature regions $^1$, and 2 concrete temperature probes per casting line to monitor low concrete temperature regions $^2$</td>
<td>1 concrete temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor low concrete temperature regions $^2$</td>
</tr>
<tr>
<td>Forecasted atmospheric temperature $&lt; 40^\circ F$ during additional 3-day curing period $^3$</td>
<td>N/A</td>
<td>1 concrete temperature probe per similar curing condition for prestressed piling only</td>
<td>N/A</td>
</tr>
<tr>
<td>When accelerated curing is used</td>
<td>2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces $^4$</td>
<td>2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces $^4$</td>
<td>1 temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor curing enclosure air temperature at concrete surfaces $^4$</td>
</tr>
</tbody>
</table>

1. Excluding prestressed bridge deck panels and prestressed retaining wall panels.
2. When accelerated curing is used, concrete temperature probes to monitor low concrete temperature regions are not required.
3. After attaining specified release-of-tension strength.
4. These probes are in addition to the concrete temperature probes required for monitoring high concrete temperature regions.

The following curing requirements apply for prestressed members:
- Cure concrete continuously, except as allowed during form removal, until the compressive strength of the concrete has reached the specified release-of-tension strength and until detensioning has been performed.
• Maintain concrete temperatures between 50°F and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if the Contractor uses one of the concrete mix design options listed in Section 421.4.A.6, “Mix Design Options,” other than options 6, 7, and 8.
• Membrane curing is permitted only for unformed surfaces of prestressed wall panels and for interim curing on unformed surfaces of prestressed piling. Use Type 1-D or Type 2 curing compound conforming to DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants,” for this application.
• Water cure prestressed piling an additional 3 days after attaining the specified release-of-tension strength. Do not interrupt curing for more than 4 hours when moving piling to the storage area. Maintain the concrete temperature of piling at 50°F or above during this additional curing period.

The following curing requirements apply for nonstressed members:
• Cure concrete continuously, except as allowed during form removal, for 4 days or until the compressive strength of the concrete has reached the design strength.
• Maintain concrete temperatures between 50°F and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if the Contractor uses one of the concrete mix design options listed in Section 421.4.A.6, other than options 6, 7, and 8.
• Membrane curing is permitted on nonstressed members, except for surfaces to be painted or color-stained. Cure precast prestressed and precast nonstressed substructure members, excluding piling, in accordance with Section 420.4.J, “Curing Concrete.” Cure members immediately for an additional 24 hours if they are out of cure at any time other than during the allowable 30 minutes for form removal or during the allowable 4 hours for moving piling to storage.

Members failing to meet the concrete temperature requirements or curing enclosure air temperature requirements during curing will be reviewed. Repeated failure to maintain proper concrete temperatures may be cause for rejection of the affected product.

**a. Water Curing.** Water curing provides additional moisture to concrete and prevents moisture loss. Water used for curing must meet the requirements for concrete mixing and curing water specified in Section 421.2.D, “Water.” Do not use seawater or water that stains or leaves an unsightly residue that cannot be removed. Monitor and maintain a temperature differential between curing water and concrete surface temperature that prevents thermal cracking.

1. **Wet Mat Method.** Use water-saturated cotton mats, burlap, burlap-polyethylene sheeting, or other approved moisture-retaining materials. Anchor the wet mats adequately to provide continuous contact with exposed concrete surfaces.
2. **Water Spray Method.** Use overlapping sprays, sprinklers, or soil-soaker hoses so that concrete surfaces are kept continuously wet.
3. **Ponding Method.** Continuously cover the exposed concrete surfaces with standing water.

**b. Moisture Retention Curing.** Moisture retention curing prevents moisture loss from the concrete.

1. **Form Curing Method.** Concrete surfaces in direct contact with forms that are left in place will not require additional curing methods unless cold-weather protection is necessary.
2. **Improper Cover Method.** Cover exposed concrete surfaces with polyethylene sheeting, burlap-polyethylene sheeting, impervious paper, or other approved impermeable materials placed in close contact with concrete surfaces to keep them continuously wet. If this
is not enough to keep exposed concrete surfaces continuously wet, then provide additional moisture inside the enclosure in accordance with Section 424.3.B.7.a, “Water Curing.”

**c. Membrane Curing.** Liquid membrane-forming curing compound is a moisture retention covering that is applied as a liquid. It is only permitted as noted in Section 424.3.B.7, “Curing of Concrete.”

Use Type 1-D or Type 2 membrane curing compound conforming to DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.” Apply membrane curing compound with equipment and in a manner specified in Section 420.3.H, “Spraying Equipment,” and Section 420.4.I.3, “Membrane Curing,” respectively.

When applying membrane curing compound, do not contaminate reinforcing steel, embedments, or concrete surfaces that will later be in direct contact with cast-in-place concrete, unless the curing compound can be completely removed to the satisfaction of the Engineer.

Do not use membrane curing compounds that appreciably stain the concrete.

**d. Accelerated Curing.** Accelerated curing is defined as curing with artificial heat provided to the curing enclosure or forms.

Test accelerated-curing facilities for a minimum of 48 hours to demonstrate that temperature variations do not exceed 20°F between any points in the curing enclosure. Submit accelerated curing facility drawings and test results, and obtain approval before using these facilities for Department work. The test may be performed on the entire casting line with either freshly cast concrete inside the forms or with empty forms. Provide 1 curing enclosure air temperature probe per 100 ft. of casting line when accelerated curing facilities are being tested.

Maintain the air temperature in the curing enclosure between 50°F and 85°F until initial set of the concrete (as determined in accordance with Tex-440-A when establishing mix designs under representative temperature conditions) and for at least 3 hours after concrete placement. The concrete temperature may then be raised uniformly at a maximum rate of 36°F per hour. Provide an unobstructed air space of at least 6 in. between surfaces of the concrete and the curing jacket.

For prestressed and nonstressed concrete members, monitor and maintain the curing enclosure air temperature between 50°F and 160°F during accelerated curing. Do not allow the air temperature to exceed 160°F for more than 1 cumulative hour during the entire curing period. Do not allow the air temperature to exceed 170°F at any time during the specified curing period. Arrange the location of the heat discharge into the curing enclosure so that temperature variations do not exceed 20°F between any points in the curing enclosure.

Provide curing enclosure air temperature probes to monitor the temperature at the concrete surface as specified in Table 2.

Provide enough moisture inside the curing enclosure to keep exposed concrete surfaces continuously wet for the specified curing period.

If accelerated curing is terminated before the specified curing period has elapsed, provide other acceptable curing methods for the remaining curing period.

**(1) Steam Curing.** Steam cure in accordance with the requirements of accelerated curing. Position steam outlets so that live steam is not applied directly on the concrete, forms, or test cylinders.

**(2) Alternate Methods.** Other methods of accelerated curing, such as the use of radiant heaters or portable heater, may be permitted if they meet the requirements of accelerated curing. The use of any alternate method requires written approval.
C. Workmanship. Formed surfaces must not have excessive surface honeycombing, aggregate or mortar pockets, air voids, lift lines, or vibrator marks. Remove form-joint-offset marks in excess of the tolerances specified in Section 424.3.B.1.a, “External Forms,” and fins and rough edges along chamfer lines, in a manner that will not damage the member. Repair fabrication holes, except box beam and U-beam drain holes, with an approved repair material and procedure.

Unless otherwise shown on the plans, recess strands approximately 3/8 in. without overheating or damaging the surrounding concrete. Clean and coat the inside of each 3/8-in. recess and strand end with approximately 10 mils of Type VIII neat epoxy conforming to DMS-6100, “Epoxies and Adhesives,” and fill with epoxy grout while the neat epoxy is still tacky. Furnish epoxy grout with the same type of epoxy and dry, clean sand. Submit for approval any other moisture barrier systems for protecting strands.

Before shipment of members, remove:

• concrete, paste, dirt, oil, or other bond-breaking substances from exposed reinforcing steel, and
• laitance, dirt, oil, or other bond-breaking substances from concrete surfaces to be in contact with cast-in-place concrete.

1. Defects and Breakage.

a. Prestressed and Nonstressed Members. Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review. Submit proposed written repair procedures and obtain approval before performing repairs. Repair work must reestablish the member’s structural integrity, durability, and aesthetics to the satisfaction of the Engineer.

When damage occurs, determine the cause and take corrective action. Failure to take corrective action, leading to similar repetitive damage, could be cause for rejection of the damaged members.

Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive are subject to review.

b. Prestressed Members. Failure of individual wires in a 7-wire strand is acceptable if the total area of wire failure is not more than 2% of the total cross-sectional area of all strands in the member, and if no more than 1 wire fails in any single strand. Any setup with one or more broken wires must be examined by a licensed professional engineer or Quality Control Supervisor (as defined in DMS-7300, “Precast Concrete Fabrication Plants”) to determine the cause before continuing stressing operations on the particular casting line.

Vertical or horizontal cracks 1/16 in. or less in width that tend to close upon transfer of stress to the concrete are acceptable. Cracks that do not tend to close are subject to review. Prestressed bridge deck panels will be rejected for any of the following conditions:

Any crack extending to the reinforcing plane and running parallel and within 1 in. of a strand for at least 1/3 of the embedded strand length; or any transverse or diagonal crack, including corner cracks and breaks, intersecting at least 2 adjacent strands and extending to the reinforcing plane.

Prestressed bridge deck panels that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review.

2. Tolerances.

a. Prestressed Members. Allowable tolerances for the dimensions and configurations shown on the plans or approved shop drawings are shown in Table 3.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>I-Beams and Bulb-Tee Beams</th>
<th>U-Beams</th>
<th>Box and Slab Beams</th>
<th>Double-T Beams</th>
<th>Bridge Deck Panels</th>
<th>Piling</th>
<th>Wall Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (perpendicular to strands for bridge deck panels)</td>
<td>±3/4''</td>
<td>±1''</td>
<td>±1''</td>
<td>±3/4''</td>
<td>±1/2''</td>
<td>1''</td>
<td>±3/16''</td>
</tr>
<tr>
<td>Width (parallel to strands for bridge deck panels)</td>
<td>+3/4'' -1/4''</td>
<td>±1/4''</td>
<td>±1/4''</td>
<td>±1/2''</td>
<td>±1/2''</td>
<td>±1/4''</td>
<td>±3/16''</td>
</tr>
<tr>
<td>Nominal depth (thickness in case of panels)</td>
<td>+1/2'' -1/4''</td>
<td>±1/4''</td>
<td>±1/4''</td>
<td>±1/4''</td>
<td>±1/4''</td>
<td>±1/4''</td>
<td>±3/16''</td>
</tr>
<tr>
<td>Thickness: top slab or flange</td>
<td>+1/2'' -1/4''</td>
<td>±1/2''</td>
<td>±1/2''</td>
<td>±1/4''</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Thickness: bottom slab or flange</td>
<td>+1/2'' -1/4''</td>
<td>±1/2''</td>
<td>±1/2''</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Thickness: web or wall</td>
<td>+3/4'' -1/4''</td>
<td>±1/2''</td>
<td>±1/2''</td>
<td>±1/4''</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Horizontal alignment (deviation from straightness of all panel edges)</td>
<td>±1/8'' per 10'' of length</td>
<td>±1/8'' per 10'' of length, 3/4'' max.</td>
<td>±1/4''</td>
<td>±1/8'' per 10'' of length, 1/2'' max.</td>
<td>±1/8'' per 10'' of length, 1/2'' max.</td>
<td>±1/8'' per 5'' of width, 1/2'' max.</td>
<td></td>
</tr>
<tr>
<td>Deviation of ends (horizontal skew)</td>
<td>±1/4''</td>
<td>±1/8'' per 1'' of width, 1/2'' max.</td>
<td>±1/8'' per 1'' of width, 1/2'' max.</td>
<td>±1/8'' per 1'' of width, 1/2'' max.</td>
<td>±1/2''</td>
<td>±1/8''</td>
<td></td>
</tr>
<tr>
<td>Deviation of ends (vertical batter)</td>
<td>±1/8'' per 1'' of depth, 1/2'' max.</td>
<td>±1/8'' per 1'' of depth, 1/2'' max.</td>
<td>±1/8'' per 1'' of depth, 1/2'' max.</td>
<td>±1/8'' per 1'' of depth, 1/2'' max.</td>
<td>NA</td>
<td>±1/8''</td>
<td>±1/4''</td>
</tr>
<tr>
<td>Dimension</td>
<td>I-Beams and Bulb-Tee Beams</td>
<td>U-Beams</td>
<td>Box and Slab Beams</td>
<td>Double-T-Beams</td>
<td>Bridge Deck Panels</td>
<td>Piling</td>
<td>Wall Panels</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------</td>
<td>---------</td>
<td>-------------------</td>
<td>----------------</td>
<td>-------------------</td>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>Notched end areas (for diaphragms): depth</td>
<td>±1/4&quot;</td>
<td>NA</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Notched end areas (for diaphragms): length</td>
<td>+2&quot;</td>
<td>NA</td>
<td>+2&quot;</td>
<td>+2&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bearing surfaces: perpendicular to vertical axis</td>
<td>±1/8&quot;</td>
<td>NA</td>
<td>±1/8&quot;</td>
<td>±1/8&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bearing surfaces: deviation from plane</td>
<td>±1/16&quot;</td>
<td>±1/8&quot;</td>
<td>±1/8&quot;</td>
<td>±1/16&quot;</td>
<td>NA</td>
<td>NA</td>
<td>±1/16&quot;</td>
</tr>
<tr>
<td>Anchor hole location: from end of member</td>
<td>+3/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±3/4&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Anchor hole location: longitudinal spacing</td>
<td>±3/4&quot;</td>
<td>±1/2&quot;</td>
<td>±1/2&quot;</td>
<td>±3/4&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Anchor hole location: transverse location</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Diaphragm or lateral tie location</td>
<td>±1/2&quot;</td>
<td>NA</td>
<td>±1/2&quot;</td>
<td>±1/2&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Position of internal void form (longitudinal for box beams and U-beams)</td>
<td>NA</td>
<td>±1&quot;</td>
<td>±1&quot;&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NA</td>
<td>NA</td>
<td>±1/2&quot;</td>
<td>NA</td>
</tr>
<tr>
<td>Projection of reinforcing steel outside of member</td>
<td>+1/2&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>+1/2&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>+1/2&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>+1/2&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>NA</td>
<td>+1/2&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-3/4&quot;&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Position of strands: vertical</td>
<td>±1/4&quot;&lt;sup&gt;c&lt;/sup&gt;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/8&quot;&lt;sup&gt;c&lt;/sup&gt;</td>
<td>±1/4&quot;</td>
<td>±1/8&quot;</td>
</tr>
</tbody>
</table>
Table 3 (continued)
Allowable Tolerances for Prestressed Members

<table>
<thead>
<tr>
<th>Dimension</th>
<th>I-Beams and Bulb-Tee Beams</th>
<th>U-Beams</th>
<th>Box and Slab Beams</th>
<th>Double-T Beams</th>
<th>Bridge Deck Panels</th>
<th>Piling</th>
<th>Wall Panels²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of strands: horizontal</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/4&quot;</td>
<td>±1/2&quot;</td>
<td>±1/4&quot;</td>
<td>±1/2&quot;</td>
</tr>
<tr>
<td>Debonded length of strands</td>
<td>±3&quot;</td>
<td>±3&quot;</td>
<td>±3&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Position of strand hold-down points</td>
<td>±5&quot;</td>
<td>±6&quot;</td>
<td>±6&quot;</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Position of handling devices: parallel to length</td>
<td>±5&quot;</td>
<td>±6&quot;</td>
<td>±6&quot;</td>
<td>As shown on plans</td>
<td>±6&quot;</td>
<td>±6&quot;</td>
<td></td>
</tr>
<tr>
<td>Position of handling devices: transverse to length</td>
<td>±1&quot;</td>
<td>±1&quot;</td>
<td>±1&quot;</td>
<td>As shown on plans</td>
<td>±1&quot;</td>
<td>±1&quot;</td>
<td></td>
</tr>
<tr>
<td>Local flatness of formed surfaces (excluding bearing surface)</td>
<td>±1/4&quot; in 10'</td>
<td>±1/4&quot; in 10’</td>
<td>±1/4&quot; in 10’</td>
<td>±1/4&quot; in 10’</td>
<td>±1/4&quot; in 10’</td>
<td>±1/4&quot; in 10’</td>
<td></td>
</tr>
<tr>
<td>Bow (length and width)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>±1/4&quot; per 10'</td>
</tr>
</tbody>
</table>

1. Prestressed and nonstressed wall panels (tie back, C-wall, sound wall, etc.) except MSE wall panels.
2. Maximum length as approved.
3. Measured along the panel depth at the top and bottom panel sides.
4. Voided box beams only.
5. Length of box beam internal void form ±1", ±6".
6. For draped strands, the tolerance for vertical position of strands at the end of the beam may be increased to ±1/2" provided the tested concrete compressive strength, before release of tension into the member, is at least 5% greater than the release-of-tension strength shown on the plans.
7. Measured from bottom of panel.

Variations greater than those specified in Table 3 are subject to review. However, these tolerances do not relieve the Contractor from the responsibility of furnishing a completed structure that is in reasonably close conformity with the lines, grades, cross-sections, dimensions, and details specified. Correct members not meeting these tolerances at no additional expense to the Department, to achieve a satisfactory completed structure. This also
includes costs for correction due to variations in vertical beam camber. Correction may require replacement of the member.

Horizontal misalignment (sweep) in beams, which may increase at a later time and exceed the tolerance shown in Table 3, may be acceptable if the members can be hauled, erected, and aligned to within the allowable tolerance without being damaged. Store these members in a manner that will minimize the sweep.

Embedments must be firmly held in proper position to avoid movement during concrete placement. Place embedments in accordance with the manufacturer’s recommendations. Place weld clip inserts for permanent metal deck forming no more than 1/16 in. from the beam edge.

b. **Nonstressed Members.** Unless otherwise shown on the plans, the allowable tolerances for nonstressed members are as specified in Table 4. The allowable tolerances for nonstressed wall panels, except MSE wall panels, are as specified in Table 3.

**Table 4**  
Allowable Tolerances for Nonstressed Members

<table>
<thead>
<tr>
<th>Member</th>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE wall panels and wall components¹ (coping, posts, etc.)</td>
<td>All dimensions (including deviation from edge straightness)</td>
<td>±3/16 in.</td>
</tr>
<tr>
<td></td>
<td>Deviation of ends (horizontal skew)</td>
<td>±1/4 in. in 5 ft.,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1/2 in. max.</td>
</tr>
<tr>
<td></td>
<td>Local flatness of formed surfaces</td>
<td>±1/8 in. in 5 ft.</td>
</tr>
<tr>
<td></td>
<td>Connection hardware</td>
<td>±1/2 in.</td>
</tr>
</tbody>
</table>

¹. Includes wall components for tie-back walls, C-walls, sound walls, etc.

**D. Storage and Handling.** Immediately after form removal, mark members for identification as shown on approved shop drawings in accordance with the requirements of the pertinent Items or as required. Inspect members immediately before shipping to the job site for damage that may have occurred in storage.

1. **Prestressed Members.** Store and handle prestressed members in accordance with Item 425, “Precast Prestressed Concrete Structural Members.”

2. **Nonstressed Members.** Store and handle nonstressed members in a manner to avoid excessive bending stresses and damage. The storage area must be clean and well drained. Prevent excessive or differential settlement of members by storing them on stable ground and on dunnage of sufficient size, shape, and strength, to prevent crushing.

When members are stacked, separate them with blocking, arranged in vertical planes, that does not crush under load. Stack members so that lifting devices are accessible and undamaged.

Rearrange improperly stored members and inspect them for damage. Members that are improperly stored and become cracked, warped, or otherwise damaged in storage may be cause for rejection.
Dunnage and blocking material must not cause damage or stains that are unacceptable for the required finish.

424.4. Measurement and Payment. The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to bid items of the Contract.

1.4.11. PRECAST PRESTRESSED CONCRETE STRUCTURAL MEMBERS

425.1. Description. Furnish and erect precast prestressed concrete members fabricated by pretensioning, post-tensioning, or a combination of the two.

425.2. Materials. Use materials that meet requirements of the following Items:
- Item 421, “Hydraulic Cement Concrete”
- Item 426, “Prestressing”
- Item 434, “Elastomeric Bridge Bearings”
- Item 440, “Reinforcing Steel”
- Item 442, “Metal For Structures”
- DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants”
- DMS-6100, “Epoxies and Adhesives.”

The bedding strip for precast prestressed concrete bridge deck panels must be extruded polystyrene conforming to ASTM C 578, Type VI, with:
- maximum water absorption of 0.1% by volume tested in accordance with ASTM C 272 and minimum compressive strength of 40 psi tested in accordance with ASTM D 1621 by loading the bedding strip sample perpendicular to the skin (bearing) face.

Provide a manufacturer’s certification stating that the bedding strip meets the requirements of this Item. Use adhesive or bonding agents for polystyrene as recommended by the polystyrene manufacturer.

Use other materials as panel bedding strips only after submitting suitable data for structural review and approval.

The dimensions for panel bedding strips must conform to those shown on the plans.

425.3. Construction. Fabricate precast prestressed concrete members in accordance with Item 424, “Precast Concrete Structures (Fabrication).”

A. Handling, Storing, Hauling, and Erection. Properly handle, store, haul, and erect all members so that they are placed in the structure without damage.

Unless approved on shop or erection drawings, maintain members in an upright position at all times, and raise and support them near the ends to prevent torsion. Lift members with approved lifting devices as shown on the shop drawings or as approved.

Do not move members from the casting yard until all requirements of the pertinent items have been met. Do not haul beams to the project site until at least 7 days have elapsed since casting unless otherwise approved.
The storage area must be clean and well drained. Prevent excessive or differential settlement of members by storing them on:
• stable ground and
• dunnage of sufficient size, shape, and strength to prevent crushing.
Place dunnage a distance not greater than 3% of the beam length from the beam ends. When approved, cantilever beams may be supported at locations other than near the ends. Support concrete box beams and U-beams under the solid end block area during handling, storage, hauling, and erection.
When members are stacked, separate them with blocking arranged in vertical planes that will not crush under load. Stack members so that lifting devices are not damaged. Rearrange improperly stored members and inspect them for damage. Members that are improperly stored and become cracked, warped, or otherwise damaged in storage may be rejected. Securely tie or brace all beams during erection in accordance with minimum erection and bracing standards. When railroad or roadway traffic must be maintained beneath beams already placed, protect traffic against falling objects during the erection of diaphragms and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms. Protect traffic with nets or flooring with openings not larger than 1 in., or as approved.
When erecting precast prestressed concrete bridge deck panels, fit mating surfaces to prevent excessive grout leakage. If such fit is not provided, fill the joint with grout or seal it with an acceptable caulking compound before placing the cast-in-place portion of the slab. After slab placement, finish surfaces of beams or other members in accordance with Section 420.4.M, “Ordinary Surface Finish,” and Item 427, “Surface Finishes for Concrete.” Correct beam discrepancies including but not limited to horizontal misalignment or variations in vertical camber, to achieve a satisfactory completed structure, at no additional expense to the Department. Correction may require replacement of the member.

425.4. Measurement. This Item will be measured by the foot, square foot, square yard, cubic yard, or each member.
This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurement or calculations will be made if adjustments of quantities are required.

1.4.12. SURFACE FINISHES FOR CONCRETE

427.1. Description. Finish concrete surface as specified.

427.2. Materials. Furnish materials in accordance with this Article for the type of surface finish specified.

A. Coatings.
1. Adhesive Grout and Concrete Paint. Provide coatings in accordance with DMS-8110, “Coatings for Concrete.” Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
2. Opaque Sealer. Provide penetrating-type sealer in accordance with DMS-8110, “Coatings for Concrete.” Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
3. **742 Appearance Coating.** Provide #742 gray appearance coating (Federal Standard 595B color 35630) in accordance with DMS-8100, “Structural Steel Paints-Formula.”

4. **Epoxy Paint.** Provide Type X epoxy coating in accordance with DMS-6100, “Epoxy Paints and Adhesives.”

B. **Exposed Aggregate Finish.** Provide approved aggregates meeting the grading requirements shown on the plans. Unless otherwise shown on the plans, provide gravel consisting of predominantly rounded particles. When a bush-hammered finish is desired, use crushed stone. Provide a concrete surface retardant. Provide clear acrylic resin sealer in accordance with DMS-8110, “Coatings for Concrete,” or clear Type II permanent anti-graffiti coating in accordance with DMS-8111, “Anti-Graffiti Coatings.”

427.3. **Equipment.** The Engineer may require demonstration of the equipment’s capabilities.

A. **Low-Pressure Water Blasting.** Use equipment capable of supplying a minimum pressure at the nozzle end of 3,000 psi at a minimum flow rate of 3 gpm. Use a 0° rotary, vibratory, or wobble-type nozzle. Use equipment capable of including abrasives in the water stream when specified on the plans.

B. **Abrasive Blasting.** Use equipment equipped with filters to produce oilfree air and also water-free air when dry air is required.

C. **Slurry Blasting.** Use equipment capable of combining air and abrasives with water to form a wet blast media capable of cleaning and preparing surface without creating dust.

D. **Spraying.** For spray applications, use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern.

E. **Off-the-Form Finish Forms.** Use nonstaining, nonporous, high-quality forming materials (e.g., steel or medium-density and high-density overlaid plywood forms). Use steel or high-density overlaid plywood forms when the same form will be used more than twice.

F. **Form Liners.** Provide form liners capable of producing a patterned finish as shown on the plans. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

427.4. **Construction.** Provide the finish specified on the plans for the specific surface areas.

A. **Surface Areas of Finish.** “Surface area of finish” designates the areas where the specified surface is to be applied.

1. **Surface Area I.** Surface Area I includes:
   - surfaces of railing;
   - exterior vertical faces of fascia beams, slabs, slab spans, arches, and box girders;
   - the outside bottom surface of fascia beams and girders;
   - the underside of overhanging slabs to the point of juncture of the supporting beam;
   - the entire underside of slab spans when shown on the plans;
   - vertical and underside surfaces of bents and piers;
   - all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and embankment is placed; and
   - all other exposed surfaces shown in the plans to require surface treatment.

2. **Surface Area II.** Surface Area II includes surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.
3. **Surface Area III.** Surface Area III includes only the top and roadway faces of all concrete railing and bridge wingwalls.

4. **Surface Area IV.** Surface Area IV includes areas designated on the plans.

**B. Surface Finishes.** Apply the coating or special finish from Table 1 as specified on the plans.

<table>
<thead>
<tr>
<th>Coatings</th>
<th>Special Surface Finishes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesive grout</td>
<td>Blast</td>
</tr>
<tr>
<td>Concrete paint</td>
<td>Rub</td>
</tr>
<tr>
<td>Opaque sealer</td>
<td>Off-the-form</td>
</tr>
<tr>
<td>742 appearance coating</td>
<td>Form liner</td>
</tr>
<tr>
<td>Epoxy paint</td>
<td>Exposed aggregate</td>
</tr>
</tbody>
</table>

1. **Application of Coatings.**
   a. **Preparation.** Before applying a coating, thoroughly clean the surface by chemical cleaning, if required, and by blast cleaning.

   **(1) Chemical Cleaning.** Clean surfaces contaminated with oil, grease, or other contaminants by scrubbing the area with an approved detergent or other concrete cleaning material before blast cleaning. Do not use a solvent that will stain the surface or inhibit coating adhesion. Perform the following test to check for surface contamination of oil type materials:
   - Spray the surface with a fine mist of potable water.
   - Examine the area to see if water beads up.
   - If beading is found, clean the surface.

   **(2) Blast Cleaning.** Before applying a specified coating, blast-clean the designated surface to remove weak surface material, curing compound, and other contaminants, leaving a lightly etched uniformly textured surface. Use an approved abrasive propelled by oil-free air with or without the addition of potable water, or blast with potable water with or without the addition of an approved abrasive at sufficient pressure to effectively clean and prepare the surface. When water-blasting, maintain the stand-off-distance of the nozzle to a maximum of 12 in. from the surface being cleaned.

   Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

   Immediately before application of any coating, blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles. Perform the following test to check for surface cleanliness as directed:
   - Press a 10 in. long strip of 2 in. wide clear packing tape on the surface by rubbing with moderate pressure times.
   - Grasp the free end of the tape, and remove the tape from the surface with a sharp jerk.
   - Examine the surface of the tape for clinging particles.
Continue cleaning the concrete surface until there are no particles clinging to the tape surface for subsequent tests. An additional test that can be used to check the surface for dust is to wipe the surface with a dark cloth and then examine the cloth for discoloration.

b. Application. Mix coating materials thoroughly with a mechanical mixer at a speed that causes the mixture to rotate entirely in the container. Ensure complete mixing by probing the container with a stirring device searching for nondispersed or settled material. Do not apply coatings before the new concrete aging a minimum of 28 days unless approved otherwise. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by the Engineer. Do not apply coatings when surface temperature of the concrete exceeds 110°F.

Apply coatings to obtain a consistent color and texture.

1. Adhesive Grout. Apply coating on a moistened surface to a uniform minimum thickness of 1/16 in. Do not apply when ambient temperature is less than 50°F.

2. Concrete Paint. Apply the coating on a dry surface in 2 coats for a total maximum application rate of 150 sq. ft. per gallon. Match the color of the applied coating with the color standard shown on the plans. Do not thin material unless approved. Apply when ambient temperature is between 50°F and 100°F.

3. Opaque Sealer. Apply the coating to a dry surface in 2 coats for a total maximum application rate of 200 sq. ft. per gallon. Match the color of the applied coating with the approved color standard shown on the plans. Do not thin the material unless approved. Apply when ambient temperature is between 40°F and 95°F.

4. 742 Appearance Coating. Apply the coating on a dry surface at a rate of at most 400 sq. ft. per gallon. Apply when ambient temperature is above 40°F.

5. Epoxy Paint. Apply the coating on a dry surface at a maximum application rate of 100 sq. ft. per gallon. Apply when ambient temperature is above 50°F.

Repair surface finish where coating has been applied that exhibits peeling, flaking, or discoloration or that has been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with the requirements of this Item.

2. Special Surface Finishes. Submit a work plan to the Engineer for any special finish shown on the plans. Include in the work plan the type of aggregates, materials, variation of panel or pattern arrangement, dimensions, construction methods, and other features affecting the work as is necessary for the “Special Surface Finish” specified.

a. Blast Finish. Provide surface profile as shown in the plans, or meet the minimum requirements of Section 427.4.B.1.a. “Preparation.” Construct a 4-ft. by 4-ft. sample panel using the same concrete used in construction of the member to receive the blast finish. Prepare the surface of the sample panel to meet the specified finish, and obtain approval of the sample finish. Use the approved sample panel finish as the standard for surfaces requiring a blast finish.

b. Rub Finish. Provide a finish to the surface by rubbing the surface with a carborundum stone or other approved material. Begin rubbing the surface immediately after forms have been removed. If rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish, provide blast finish or other finish as directed at no additional cost to the Department. Perform the requirements to obtain the ordinary surface finish specified in Section 420.4.M, “Ordinary Surface Finish,” concurrently with rubbing the surface. Where concrete patching is performed, rub these areas after the patch material has thoroughly set and blend the patch in with the surrounding area to produce a surface with uniform color and texture.
After form removal, keep the surface continuously wet until the rubbing is complete. Rub the surface sufficiently to bring the wetted concrete surface to a paste producing a smooth dense surface without pits, form marks, or other irregularities. Do not use cement grout to form the paste on the surface. Stripe the surface with a brush to conceal the rubbing pattern and allow the paste to reset. Wash the concrete with potable water after the paste has sufficiently set to leave it with a neat and uniform appearance and texture. If required, apply membrane curing in accordance with Item 420, “Concrete Structures,” after rubbing is complete.

c. Off-the-Form Finish. Provide a finish with minimal surface defects and uniform color and texture by using non-staining, non-porous, high-quality forming materials. Use the same type of forming materials for like elements for the entire structure. Use mortar-tight forms to prevent leakage and discoloration. If necessary, seal joints with compressible gasket material, caulk, tape or by other suitable means that are not detrimental to the concrete finish. Use one brand and type of form release agents for all surfaces unless another product produces a similar concrete surface appearance. Do not use barrier-type (wax, fuel oil, carrier oil, etc.) release agents. Use form release agents containing a rust inhibitor on steel forms. Clean rust off steel forms before use. Do not use plywood that will cause discoloration of the concrete surface. Direct special attention to consolidation and vibration of the concrete around the form surfaces to minimize bug holes. Modify concrete placement and vibration techniques if surface contains an excessive amount of bug holes. Remove all forms without interruption once form removal begins to prevent discoloration due to differing form curing times. Do not use membrane curing on surfaces with off-the-form finish. Repair honeycombed and spall areas with least dimension larger than 2 in. in accordance with the concrete surface repair procedures outlined in Item 420, “Concrete Structures,” to obtain an ordinary surface finish as defined in Section 420.4.M, “Ordinary Surface Finish.” For honeycombed and spall areas with least dimension greater than 3/4 in. but smaller than 2 in., patch by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than 3/4 in. Perform required repairs as soon as forms are removed. Match repair material color and texture with surrounding concrete surfaces. Minimize the area of repair by not smearing the repair material over acceptable concrete surfaces in an attempt to blend the repair with the surrounding concrete. Cut out form ties at least 1/2 in. below the surface, and patch accordingly. Perform repair work as soon as possible after removing forms so that concrete and repair material have similar ages. Replace or refurbish the forms when the Engineer determines that defective formwork is causing an excessive amount of repair work.

d. Form Liner Finish. Provide patterned finish as shown on the plans. Do not splice form liner panels in a way that causes a noticeable transition or line between pieces. Wash and clean form liners after each use when the forms can be re-used. Replace form liners that have become damaged or worn. Construct a sample panel for each form liner finish. Approval is required to verify that the sample panel meets the requirements of the plans and specifications before beginning work. Upon approval, the sample panel becomes the model panel that all other work will be compared against. Deviation in color, grade, or depth from the model panel is grounds for rejection of the form liner finish. Removal of defective work may be necessary as determined by the Engineer and in accordance with the surface finish requirements outlined in Item 420, “Concrete Structures,” to obtain an ordinary surface finish as defined in Section 420.4.M, “Ordinary Surface Finish.”
Seal all form liner joints in a manner acceptable to the Engineer to prevent leakage at the surface.

**e. Exposed Aggregate Finish.** Provide exposed aggregate finish as indicated on the plans. Provide a depth of finish between 3/8 in. and 1/2 in. unless directed otherwise. Apply a concrete surface retarder that penetrates approximately 1/4 in. into the forms or concrete surface to help achieve the desired finish. Apply 2 or 3 coats to wood forms to account for absorption if necessary. Tape or caulk form joints to prevent escape of the retarder during the placing operations. Protect the form surfaces from sun and rain while exposed to the atmosphere. Re-treat form surfaces with retarder if disturbed. Protect adjacent areas of concrete not requiring exposed aggregate finish from the retarder. Remove forms 12 to 15 hr. after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member unless directed otherwise.

Expose the aggregate for the finish immediately after form removal. Remove the grout paste covering the aggregate to be exposed by an approved method. Do not loosen the aggregate by the grout removal operation. Maintain required curing on all surfaces except for the time while the aggregate is being exposed. Cure using wet mats or membrane after the aggregate is exposed.

Repair defective areas as determined by the Engineer.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of acrylic resin sealer or clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply a single coat or multiple coats for a total maximum application rate of 250 sq. ft. per gallon.

**427.5. Measurement.** When surface finishes for concrete is shown on the plans to be a pay item, measurement will be by the square foot of the type of surface finish specified. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurement or calculations will be made if adjustments of quantities are required.

**1.4.13. CONCRETE SURFACE TREATMENT**

**428.1. Description.** Prepare surface and apply a linseed oil treatment or a penetrating-type sealant treatment to concrete surfaces.

**428.2. Materials.** Furnish materials required by the class of surface treatment shown on the plans.

**A. Surface Treatment Class I.** Provide mixture containing a minimum of 50% and a maximum of 70% boiled linseed oil by volume. Use mineral spirits as the complement component for any ambient temperature range above 40°F, or kerosene for ambient temperature range above 70°F. Provide material in accordance with the following specifications:

- Boiled linseed oil: ASTM D 260
- Mineral spirits: ASTM D 235
- Kerosene: ASTM D 3699.

Provide combined mixture in clean, leakproof, labeled containers. Clearly state the contents on all the containers.
B. Surface Treatment Class II. Provide penetrating surface treatment in accordance with DMS-8140, “Concrete Surface Treatment (Penetrating).”

428.3. Construction Methods. Treat the upper surfaces of the roadway slab (including direct traffic culverts), bridge sidewalks and medians, the inside faces of curbs and concrete rails, and all other areas shown in the plans. Do not treat surfaces given a higher finish as defined in Item 427, “Surface Finishes for Concrete,” unless otherwise shown on the plans.

A. Surface Treatment Class I. Clean concrete surfaces to remove contaminants that retard or prevent absorption of the mixture before treatment application. Do not apply the treatment before required concrete curing is complete, while the surface is damp, or when the ambient temperature is below 40°F. Do not heat the mixture. Use a spray applicator equipped with a spray bar to apply the treatment material unless directed otherwise. Apply the material in 2 stages. Apply at an approximate rate of 40 sq. yd. per gallon for the first stage and 67 sq. yd. per gallon for the second stage for a total coverage of 25 sq. yd. per gallon. Wait a minimum of 4 hr. after the first application before applying the second application. Apply so that a uniform coverage is obtained. Remove any excess mixture remaining on the surface 4 hr. after the second application or cover with an application of fine sand. Do not allow traffic on the treated surface for 24 hr. after the final application.

B. Surface Treatment Class II. Refer to the manufacturer’s specifications for instruction on the use of the treatment material in addition to the requirements of this Item. Clean the concrete surfaces to remove all visible curing compound and any other contaminants that retard or prevent penetration of the mixture before treatment application. Demonstrate the method of cleaning to the Engineer by preparing a 100-sq. ft. area before proceeding with complete cleaning. Do not damage the concrete surface to the point that the coarse aggregate is exposed. Acceptance of the entire cleaned surface by the Engineer is required before the application of the treatment material. Apply the treatment material no sooner than 14 days after casting the concrete and a minimum of 1 day after curing blankets have been removed. Apply treatment material to a dry surface no sooner than 24 hours after any water has reached the concrete surface. Apply treatment material when surface temperature is between 40°F and 100°F. Do not dilute or alter the treatment material. Apply the treatment material at a rate of 125 sq. ft. of surface area per gallon. Treat the upper side of horizontal and near-horizontal surfaces in 1 pass or coat. Treat the vertical and overhead surfaces in 2 passes or coats. Apply the first coat at a rate of 165 sq. ft. of surface area per gallon, and apply the second coat at a rate of 500 sq. ft. of surface area per gallon. Apply the second coat within 1 hr. of application of the first coat. Use a spray applicator equipped with a spray bar to apply the treatment material to deck surfaces. Apply the treatment material at a uniform rate, covering the entire surface being treated. Follow the treatment material manufacturer’s specifications regarding the post-wetting of the treated surface and required lapse time before traffic is permitted on the treated surface.
428.4. Measurement. This Item will be measured by the square yard of concrete surface treated. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

1.4.14. CONCRETE STRUCTURE REPAIR

429.1. Description. Remove unsound concrete, repair spalled or delaminated concrete, and replace concrete with repair materials.

429.2. Materials. Provide materials in accordance with the requirements of the following Items:
- Item 420, “Concrete Structures”
- Item 421, “Hydraulic Cement Concrete”
- Item 431, “Pneumatically Placed Concrete”
- Item 440, “Reinforcing Steel”
- DMS-6100, “Epoxies and Adhesives”
- DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair.”

For all repairs, provide repair materials suitable for the appropriate horizontal, vertical, or overhead application. Obtain approval for any proposed repair material unless a repair material type is indicated in the plans.

A. Repairs Less Than 1 in. Thick. Use cement mortar; epoxy mortar using a Type VIII epoxy per DMS-6100, “Epoxies and Adhesives”; or a prepackaged repair material meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair.”

B. Repairs Between 1 and 6 in. Thick. Use concrete or a prepackaged repair material meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair,” containing a coarse aggregate whose maximum size is less than 1/3 the thickness of the thinnest portion of the repair.

C. Repairs Thicker Than 6 in. Use concrete of the same class as the original construction unless otherwise approved.

For concrete, submit a mix design for approval in accordance with Item 421, “Hydraulic Cement Concrete,” with a water-cement ratio less than 0.45. Include all pertinent information on admixtures. Prepackaged repair materials not meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair,” may be used only for with approval. Unless noted otherwise, provide repair materials capable of achieving a 7-day compressive strength of 4,000 psi for repair of reinforced concrete and 5,000 psi for prestressed or post-tensioned concrete members. Pneumatically applied concrete or mortar placed in accordance with Item 431, “Pneumatically Placed Concrete,” may also be used with approval. Prepare trial batches of any proposed repair material or application method as directed.

Provide steel pins, studs, or expansion bolts with a minimum diameter of 1/8 in. and a minimum length of 2 in. to attach reinforcement at the described location as shown on the
plans or as directed. Provide reinforcing steel, either welded wire fabric or reinforcing bars, as required by this Item or as shown on the plans.

429.3. Equipment. Provide equipment as outlined below.

A. Concrete Removal Equipment. Provide sawing equipment capable of sawing the concrete to the specified depth. Provide power-driven chipping tools not heavier than the nominal 30-lb. class or hydrodemolition equipment for the bulk removal of concrete. Provide chipping hammers not heavier than the nominal 15-lb. class or hydrodemolition equipment for the removal of concrete beneath reinforcing steel or along the edges of the repair area.

B. Surface Preparation Equipment. Provide abrasive blasting or hydrodemolition equipment capable of preparing the concrete surface and exposed reinforcing steel for the repair material. Provide air compressors with air lines equipped with filters designed to remove all oil from the air for air-blast cleaning. Provide high-pressure water blasting equipment as necessary to prepare surfaces for repair.


D. Placing and Finishing Equipment. Provide sufficient and appropriate hand tools for placing and finishing stiff plastic concrete or prepackaged repair materials, and for working them to the correct level for strike-off. Provide small, immersion-type vibrators for all repairs deeper than 6 in. Provide external form vibrators where immersion-type vibrators cannot be used.

429.4. Construction. Obtain approval for all materials and methods of application at least 2 weeks before beginning any repair work. Repair locations will be indicated on the plans or by the Engineer. Saw-cut the entire perimeter of all repair areas to a minimum depth of 1/2 in. Avoid reentrant corners for areas to be repaired. Adjust the depth of the saw-cut as necessary to avoid cutting reinforcing steel near the surface of the concrete.

A. Removal of Concrete. Use power-driven chipping tools or hydrodemolition equipment to remove all loose or defective concrete. Avoid damage to sound concrete to remain in place. Avoid hitting reinforcing steel with the chipping tools. Once the initial concrete is removed, use small power-driven chipping or hydrodemolition equipment to undercut all exposed reinforcing steel. Expose the entire perimeter of the steel bars for the full area of the repair. Provide a minimum clearance of 1/2 in. between the exposed steel and the surrounding concrete or 2 times the maximum aggregate size, whichever is greater. Remove additional concrete as necessary to keep the repair area to a reasonably uniform depth. Damage to sound concrete or to the bond of reinforcing steel outside the repair area will be repaired at the Contractor’s expense. Obtain approval of the completed concrete removal before proceeding to surface preparation.

B. Surface Cleaning. Clean the area to be repaired by abrasive blasting, high-pressure water blasting, or other approved methods. Remove all loose particles, dirt, deteriorated concrete, or other substances that would impair the bond of the repair material. Clean exposed reinforcing steel of concrete, rust, oil, and other contaminants. Follow this with a high-pressure air blast for final cleaning.
C. Anchors. When reinforcing steel is required, support it using anchor studs, expansion hook bolts, grouted rebar, or steel pins capable of resisting a pullout force of 2,500 lb. Space anchors no more than 12 in. center-to-center on overhead surfaces, 18 in. center-to-center on vertical surfaces, and 36 in. center-to-center on top horizontal surfaces. Use at least 3 anchors in each individual patch area. Secure steel pins or studs into the concrete with epoxy or other approved methods. Do not use explosive force to shoot pins, studs, or other anchors into the concrete. Check the resistance to pullout of the reinforcing anchors as directed. Notify the Engineer before installation of the anchors. Locate anchors to prevent damage to prestressing tendons or conduits embedded in the concrete. Maintain a minimum clear cover of 3/4 in. between the reinforcing steel and anchors and the finished surface of the repair area.

D. Reinforcing Steel. Replace or supplement any reinforcing steel that has more than 25% section loss due to corrosion. Place supplemental reinforcing steel as indicated on the plans or as directed. Provide additional reinforcement for all areas where the thickness of the repair material will exceed 4 in. Use a single layer of $2 \times 2 - W1.2 \times W1.2$ or $3 \times 3 - W1.5 \times W1.5$ welded wire fabric or No. 3 bars spaced at 6 in., unless noted otherwise on the plans. Place the reinforcing steel parallel to the finished surface, and support it so that it will be roughly in the middle of the repair area and a minimum of 3/4 in. out from the surface to be covered. Lap adjacent sheets or bars at least 6 in. and tie them together securely at a spacing of at most 18 in. Pre-bend reinforcing steel fabric to fit around corners and into re-entrant angles before installing it. Place and secure reinforcement to prevent displacement due to repair material application.

E. Formwork. Where forms are necessary or desired, erect them in accordance with Item 420, “Concrete Structures.” Ensure forms are securely attached and mortar-tight if pressure-type application methods are used.

F. Substrate Preparation. Use a bonding agent if cement mortar or concrete is used for the repair material unless directed otherwise. Use either a cement scrub coat or a Type V or Type VII epoxy conforming to DMS-6100, “Epoxies and Adhesives,” as the bonding agent. Follow the manufacturer’s recommendations for bonding agents if prepackaged repair materials are used. Do not use an epoxy bonding agent with rapid setting repair materials. Apply a cement scrub coat bonding agent to the saturated surface-dry substrate by scrubbing, brushing, or other approved methods immediately before placing the repair material. Apply an epoxy bonding agent in accordance with the manufacturer’s recommendations. Ensure that any bonding agent used does not set or cure prematurely, creating a bond breaker.

Where saturated surface-dry (SSD) conditions are needed, prewet the substrate by ponding water on the surface for 24 hr. before placing the repair materials. If ponding is not possible, achieve SSD conditions by high-pressure water blasting 15 to 30 min. before placing the repair material. A saturated surface-dry condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

G. Repair Material Application. Place the repair material in an approved manner ensuring that the repair material is in intimate contact with the substrate and free of voids. Follow the manufacturer’s recommendations for prepackaged repair materials. Place repair materials so that the original lines and surfaces of the structure are restored. Follow the requirements of Item 420, “Concrete Structures,” for temperature limitations at time of placement.
H. Curing. Cure all cement mortar and concrete repairs for 4 days in accordance with Item 420, “Concrete Structures.” Cure prepackaged repair materials in conformance with the manufacturer’s recommendations. Cure pneumatically placed concrete in accordance with Item 431, “Pneumatically Placed Concrete.” Remove forms when approved or at the end of the curing period.

I. Epoxy Injection. Perform epoxy injection as indicated in the plans or as directed, in accordance with Item 780, “Epoxy Injection.”

J. Repair of Defective Work. As directed, after completion of curing, repair or replace defective areas and patched areas that have debonded, at the Contractor’s expense.

429.5. Measurement. This Item will be measured by the square foot, in place, as measured on the surface of the completed repair. When a repair involves multiple surfaces, such as a corner, measurement will be made of all surfaces repaired.

1.4.15. EXTENDING CONCRETE STRUCTURES

430.1. Description. Prepare and construct extensions and widenings of existing structures.

430.2. Materials. Furnish materials in accordance with the following:
- Item 420, “Concrete Structures”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- DMS-6310, “Joint Sealants and Fillers.”

430.3. Construction.
A. General. Perform work in accordance with Item 420, “Concrete Structures,” and the requirements of this Item. Verify pertinent dimensions and elevations of the existing structure before ordering any required materials.

B. Removal. Remove portions of the existing structure to the lines and dimensions shown on the plans or as directed. Dispose of these materials as shown on the plans or as directed. Remove any metal railing without damaging it, and stack it neatly on the right of way at locations that do not interfere with traffic or construction or at locations shown on the plans. All removed metal railing remains the property of the Department unless otherwise shown on the plans. Repair any portion of the remaining structure damaged as a result of the construction. Do not use explosives to remove portions of the existing structure unless approved in writing. Do not use a demolition ball, other swinging weight, or impact equipment unless shown on the plans. Use pneumatic or hydraulic tools for final removal of concrete at the “break” line. Use removal equipment, as approved, that will not damage the remaining concrete.

C. Reuse of Removed Portions of Structure. Detach and remove all portions of the old structure that are to be incorporated into the extended structure to the lines and details as specified on the plans or as directed. Move the unit to be reused to the new location specified using approved methods. Place the reinforcement and extension concrete according to the plan details.

D. Breaking Back Bridge Slabs. For bridge slabs and direct traffic slabs of box culverts, saw the top surface of the slab along the “break” line to a depth of 1/2 in. before breaking back. Do not cut the reinforcement at the “break” line. Sever the concrete at the “break” line. Do not
damage the remaining reinforcement within 1 lap length of the “break” line during removal of the designated portion of the existing structure.

E. Splicing Reinforcing Steel. Splice new reinforcing bars to exposed bars in the existing structure using lap splices in accordance with Item 440, “Reinforcing Steel,” unless otherwise shown on the plans. The new reinforcing steel does not need to be tied to the existing steel where spacing or elevation does not match that of the existing steel provided the lap length is attained. Weld in accordance with Item 448, “Structural Field Welding,” when welded splices are permitted. Install any required dowels in accordance with Item 420, “Concrete Structures.”

F. Concrete Preparation. Roughen and clean concrete surfaces that are in contact with new construction before the placing of forms. Prepare these construction joint surfaces in accordance with Item 420, “Concrete Structures.” Finish and cure roadway slabs in accordance with Item 420, “Concrete Structures.”

430.4. Measurement. This Item will be measured by the quantity of concrete as provided under “Measurement” in Item 420, “Concrete Structures.”

1.4.16. REINFORCING STEEL

440.1. Description. Furnish and place reinforcing steel of the sizes and details shown on the plans.


A. Approved Mills. Before furnishing steel, producing mills of reinforcing steel for the Department must be pre-approved in accordance with DMS-7320, “Qualification Procedure for Reinforcing Steel Mills,” by the Construction Division, which maintains a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

B. Deformed Bar and Wire Reinforcement. Unless otherwise shown on the plans, reinforcing steel must be Grade 60, and bar reinforcement must be deformed. Reinforcing steel must conform to one of the following:

- ASTM A 615, Grades 40 or 60;
- ASTM A 996, Type A, Grades 40 or 60;
- ASTM A 996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A 996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A 706.

The provisions of this Item take precedence over ASTM provisions. The nominal size, area, and weight of reinforcing steel bars covered by this Item are shown in Table 1. Designate smooth bars up to No. 4 by size number and above No. 4 by diameter in inches.
Table 1
Size, Area, and Weight of Reinforcing Steel Bars

<table>
<thead>
<tr>
<th>Bar Size Number (in.)</th>
<th>Bar Size Number (mm)</th>
<th>Diameter (in.)</th>
<th>Area (Sq. in.)</th>
<th>Weight per Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10</td>
<td>0.375</td>
<td>0.11</td>
<td>0.376</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>0.500</td>
<td>0.20</td>
<td>0.668</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>0.625</td>
<td>0.31</td>
<td>1.043</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>0.750</td>
<td>0.44</td>
<td>1.502</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
<td>0.875</td>
<td>0.60</td>
<td>2.044</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>1.000</td>
<td>0.79</td>
<td>2.670</td>
</tr>
<tr>
<td>9</td>
<td>29</td>
<td>1.128</td>
<td>1.00</td>
<td>3.400</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
<td>1.270</td>
<td>1.27</td>
<td>4.303</td>
</tr>
<tr>
<td>11</td>
<td>36</td>
<td>1.410</td>
<td>1.56</td>
<td>5.313</td>
</tr>
<tr>
<td>14</td>
<td>43</td>
<td>1.693</td>
<td>2.25</td>
<td>7.650</td>
</tr>
<tr>
<td>18</td>
<td>57</td>
<td>2.257</td>
<td>4.00</td>
<td>13.60</td>
</tr>
</tbody>
</table>

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

C. Smooth Bar and Spiral Reinforcement. Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi and meet ASTM A 615. For smooth bars that are larger than No. 3, provide steel conforming to ASTM A 615 or meet the physical requirements of ASTM A 36.

Spiral reinforcement may be smooth or deformed bars or wire of the minimum size or gauge shown on the plans. Bars for spiral reinforcement must comply with ASTM A 615, Grade 40; ASTM A 996, Type A, Grade 40; or ASTM A 675, Grade 80, meeting dimensional requirements of ASTM A 615. Smooth wire must comply with ASTM A 82, and deformed wire must comply with ASTM A 496.

D. Weldable Reinforcing Steel. Reinforcing steel to be welded must comply with ASTM A 706 or have a carbon equivalent (C.E.) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish C.E. is required for reinforcing steel that does not meet ASTM A 706 to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Section 448.4.B.1.a, “Miscellaneous Welding Applications.”

Calculate C.E. using the following formula:

\[
C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}
\]

E. Welded Wire Fabric. For fabric reinforcement, use wire that conforms to ASTM A 82 or A
496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with “D” and for smooth wire with “W.” Designate welded wire fabric as shown in the following example: 6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

<table>
<thead>
<tr>
<th>Size Number (in.)</th>
<th>Size Number (mm)</th>
<th>Diameter (in.)</th>
<th>Area (sq. in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>200</td>
<td>0.628</td>
<td>0.310</td>
</tr>
<tr>
<td>30</td>
<td>194</td>
<td>0.618</td>
<td>0.300</td>
</tr>
<tr>
<td>28</td>
<td>181</td>
<td>0.597</td>
<td>0.280</td>
</tr>
<tr>
<td>26</td>
<td>168</td>
<td>0.575</td>
<td>0.260</td>
</tr>
<tr>
<td>24</td>
<td>155</td>
<td>0.553</td>
<td>0.240</td>
</tr>
<tr>
<td>22</td>
<td>142</td>
<td>0.529</td>
<td>0.220</td>
</tr>
<tr>
<td>20</td>
<td>129</td>
<td>0.505</td>
<td>0.200</td>
</tr>
<tr>
<td>18</td>
<td>116</td>
<td>0.479</td>
<td>0.180</td>
</tr>
<tr>
<td>16</td>
<td>103</td>
<td>0.451</td>
<td>0.160</td>
</tr>
<tr>
<td>14</td>
<td>90</td>
<td>0.422</td>
<td>0.140</td>
</tr>
<tr>
<td>12</td>
<td>77</td>
<td>0.391</td>
<td>0.120</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
<td>0.357</td>
<td>0.100</td>
</tr>
<tr>
<td>8</td>
<td>52</td>
<td>0.319</td>
<td>0.080</td>
</tr>
<tr>
<td>7</td>
<td>45</td>
<td>0.299</td>
<td>0.070</td>
</tr>
<tr>
<td>6</td>
<td>39</td>
<td>0.276</td>
<td>0.060</td>
</tr>
<tr>
<td>5.5</td>
<td>35</td>
<td>0.265</td>
<td>0.055</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td>0.252</td>
<td>0.050</td>
</tr>
<tr>
<td>4.5</td>
<td>29</td>
<td>0.239</td>
<td>0.045</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>0.226</td>
<td>0.040</td>
</tr>
<tr>
<td>3.5</td>
<td>23</td>
<td>0.211</td>
<td>0.035</td>
</tr>
<tr>
<td>2.9</td>
<td>19</td>
<td>0.192</td>
<td>0.035</td>
</tr>
<tr>
<td>2.5</td>
<td>16</td>
<td>0.178</td>
<td>0.025</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>0.160</td>
<td>0.020</td>
</tr>
<tr>
<td>1.4</td>
<td>9</td>
<td>0.134</td>
<td>0.014</td>
</tr>
<tr>
<td>1.2</td>
<td>8</td>
<td>0.124</td>
<td>0.012</td>
</tr>
<tr>
<td>0.5</td>
<td>3</td>
<td>0.080</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.
F. Epoxy Coating. Epoxy coating will be required as shown on the plans. Before furnishing epoxy-coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with DMS-7330, “Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators.” The Construction Division maintains a list of approved applicators. Coat reinforcing steel in accordance with Table 3.

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar</td>
<td>ASTM A 775 or A 934</td>
</tr>
<tr>
<td>Wire or fabric</td>
<td>ASTM A 884 Class A or B</td>
</tr>
<tr>
<td>Mechanical couplers</td>
<td>As shown on the plans</td>
</tr>
<tr>
<td>Hardware</td>
<td>As shown on the plans</td>
</tr>
</tbody>
</table>

Use epoxy coating material and coating repair material that complies with DMS-8130, “Epoxy Powder Coating for Reinforcing Steel.” Do not patch more than 1/4 in. total length in any foot at the applicator’s plant. Epoxy-coated reinforcement will be sampled and tested in accordance with Tex-739-I. Maintain identification of all reinforcing throughout the coating and fabrication and until delivery to the project site. Furnish 1 copy of a written certification that the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer’s control tests.

G. Mechanical Couplers. When mechanical splices in reinforcing steel bars are shown on the plans, use the following types of coupler:
- sleeve-filler,
- sleeve-threaded,
- sleeve-swaged, or
- sleeve-wedge.
Furnish only couplers that have been produced by a manufacturer that has been prequalified in accordance with DMS-4510, “Mechanical Couplers.” Sleeve-wedge type couplers will not be permitted on coated reinforcing. Couplers for use on individual projects must be sampled and tested in accordance with DMS-4510. Furnish couplers only at locations shown on the plans.

440.3. Construction.

A. Bending. Cold-bend the reinforcement accurately to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the Department. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer. Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter \( d \), must be as shown in Table 4.
Where bending No. 14 or No. 18 Grade 60 bars is required, bend-test representative specimens as described for smaller bars in the applicable ASTM specification. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

B. Tolerances. Fabrication tolerances for bars are shown in Figure 1.
C. Storage. Store steel reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure that reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-
sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

D. Splices. Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs 15 in. or less in thickness, columns, walls, and parapets.

- Unless otherwise approved, splices will not be permitted in bars 30 ft. or less in plan length. For bars exceeding 30 ft. in plan length, the distance center-to-center of splices must be at least 30 ft. minus 1 splice length, with no more than 1 individual bar length less than 10 ft. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 5. Maintain the specified concrete cover and spacing at splices, and place the lapspliced bars in contact, securely tied together.

Table 5

<table>
<thead>
<tr>
<th>Bar Size Number (in.)</th>
<th>Bar Size Number (mm)</th>
<th>Uncoated Lap Length</th>
<th>Coated Lap Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10</td>
<td>1 ft. 4 in.</td>
<td>2 ft. 0 in.</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>1 ft. 9 in.</td>
<td>2 ft. 8 in.</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>2 ft. 2 in.</td>
<td>3 ft. 3 in.</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>2 ft. 7 in.</td>
<td>3 ft. 11 in.</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
<td>3 ft. 5 in.</td>
<td>5 ft. 2 in.</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>4 ft. 6 in.</td>
<td>6 ft. 9 in.</td>
</tr>
<tr>
<td>9</td>
<td>29</td>
<td>5 ft. 8 in.</td>
<td>8 ft. 6 in.</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
<td>7 ft. 3 in.</td>
<td>10 ft. 11 in.</td>
</tr>
<tr>
<td>11</td>
<td>36</td>
<td>8 ft. 11 in.</td>
<td>13 ft. 5 in.</td>
</tr>
</tbody>
</table>

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 5 are permitted.
- For box culvert extensions with less than 1 ft. of fill, lap the existing longitudinal bars with the new bars as shown in Table 3. For extensions with more than 1 ft. of fill, lap at least 1 ft. 0 in.
- Ensure that welded splices conform to the requirements of the plans and of Item 448, “Structural Field Welding.” Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.
- Install mechanical coupling devices in accordance with the manufacturer’s recommendations at locations shown on the plans. Protect threaded male or female connections, and make sure the threaded connections are clean when making the connection. Do not repair damaged threads.
• Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

E. Placing. Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Place reinforcement as near as possible to the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars must not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars must not vary from plan placement by more than 1/4 in. Cover of concrete to the nearest surface of steel must be at least 1 in. unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is −0, +1/2 in. Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and to keep the steel at the proper distance from the forms. Support bars by standard bar supports with plastic tips, approved plastic bar supports, or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Use bright basic bar supports to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32 in. thick and extend upward on the wire to a point at least 1/2 in. above the formwork.

All accessories such as tie wires, bar chairs, supports, or clips used with epoxy-coated reinforcement must be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy-coated reinforcement.

Cast mortar or concrete blocks to uniform dimensions with adequate bearing area. Provide a suitable tie wire in each block for anchoring to the steel. Cast the blocks to the thickness required in approved molds. The surface placed adjacent to the form must be a true plane, free of surface imperfections. Cure the blocks by covering them with wet burlap or mats for a period of 72 hr. Mortar for blocks should contain approximately 1 part hydraulic cement to 3 parts sand. Concrete for blocks should contain 850 lb. of hydraulic cement per cubic yard of concrete.

Place individual bar supports in rows at 4-ft. maximum spacing in each direction. Place continuous type bar supports at 4-ft. maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains is not cause for rejection.

Tie reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 ft. in each direction. For reinforcing steel cages for other structural members, tie the steel at enough intersections to provide a rigid cage of steel. Fasten mats of wire fabric securely at the ends and edges.

Before concrete placement, clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement. Do not place concrete until authorized.
If reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement, stop placement until corrective measures are taken.

F. Handling, Placement, and Repair of Epoxy-Coated Reinforcing Steel.

1. Handling. Provide systems for handling coated reinforcement with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.

2. Construction Methods. Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 440.3.F.3, “Repair of Coating.” Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6 in. beyond the weld limits before welding and 2 in. beyond the limits of the coupler before assembly. After welding or coupling, clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a nearwhite finish. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating. After cleaning, coat the splice area with epoxy repair material to a thickness of 7 to 17 mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3. Repair of Coating. For repair of the coating, use material that complies with the requirements of this Item and ASTM D 3963. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, apply at least the same coating thickness as required for the original coating. Repair all visible damage to the coating. Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure that they are free from surface contaminants. Make repairs in the shop or in the field as required.

440.4. Measurement and Payment. The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

1.4.17. MANHOLEs AND INLETS

465.1. Description. Construct manholes and inlets, complete in place or to the stage detailed, including furnishing and installing frames, grates, rings and covers. Drainage junction boxes are classified as manholes.

465.2. Materials. Furnish materials in accordance with the following:
- Item 420, “Concrete Structures”
- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- Item 471, “Frames, Grates, Rings, and Covers.”
Precast manholes, inlets, risers, and appurtenances are acceptable unless otherwise shown. Alternate designs for precast items must be acceptable to the Engineer and not deviate from the functional dimensions given. Alternate designs are to be designed and sealed by a licensed professional engineer.

A. Concrete. Furnish Class A concrete for cast-in-place manholes and inlets unless otherwise shown on the plans. Furnish Class A concrete or concrete meeting ASTM C 478 for precast manholes and inlets. Airentrained concrete will not be required in precast concrete members.

B. Mortar. Furnish mortar composed of 1 part hydraulic cement and 2 parts clean sand. Hydrated lime or lime putty may be added to the mix to a maximum of 10% by weight of the total dry mix.

C. Bricks. Furnish first-quality, sound, perfectly shaped bricks. Provide clay or shale bricks that are homogeneous and thoroughly and uniformly hard-burned and that meet ASTM C 32, Grade MS or MM. Provide concrete bricks meeting ASTM C 55, Type I (Grade S-I). The maximum allowable water absorption of completely dry bricks is 16% by weight when submerged in water for 24 hr.

D. Concrete Blocks. Provide concrete blocks that meet ASTM C 139.

E. Cast Iron or Aluminum. Provide supports and steps conforming to the shape and dimensions shown on the plans that meet the requirements of ASTM A 48, Class 35B, for gray iron castings or ASTM A 536, Grade 65-45-12, for ductile iron castings. Steps may also be aluminum meeting ASTM B 221, Alloy 6005-T5. Provide steps in accordance with ASTM C 478, Section 16, “Steps and Ladders.”

F. Timber. Provide sound timber for temporary covers when used with Stage I construction (see Section 465.3, “Construction”) that is a minimum of 3 in. nominal thickness and reasonably free of knots and warps.

G. Other Materials. Commercial-type hardware of other materials may be used with prior approval.

465.3. Construction.

A. General. All types of manholes and inlets may be built either in 1 stage or in 2 stages, described as Stage I and Stage II. Build manholes and inlets designed to match the final roadway surface in stages. Construct Stage II after the pavement structure is substantially complete unless otherwise approved by the Engineer. Construct the Stage I portion of manholes and inlets as shown on the plans or as specified in this Item. Furnish and install a temporary cover as approved by the Engineer. For Stage I construction of cast iron or steel inlet units, furnish and install the sewer pipe and a temporary plug for the exposed end of the sewer pipe from the storm sewer to a point below the top of curb indicated on the plans.
For Stage II, construct the remaining wall height and top of manhole or inlet and furnish and install any frames, grates, rings and covers, manhole steps, curb beams, or collecting basins required. Construct precast manholes and inlets in accordance with Item 420, “Concrete Structures,” or ASTM C 478. Construct cast-in-place manholes and inlets in accordance with Item 420. Forms will be required for all concrete walls. Multi-project fabrication plants (as defined in Item 424, “Precast Concrete Structures (Fabrication)” ) that produce manholes and inlets will be approved by the Construction Division in accordance with DMS-7340, “Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Manholes and Inlets.” The Construction Division maintains a list of approved multiproject plants. Outside wall forms for cast-in-place concrete may be omitted with the approval of the Engineer if the surrounding material can be trimmed to a smooth vertical face. The outside form for concrete bases supporting brick walls may be omitted. Cast steps into the concrete walls when the concrete is placed, or drill and grout steps in place after concrete placement. Mortar steps into joints for brick walls. Use a full bed of mortar for brick work so the brick will thoroughly bond to the mortar. Construct full mortar joints no more than 1/2 in. wide for brick walls. Furnish a header course or bond course (laid perpendicular to the preceding courses) every fifth course of brick.

B. Manholes and Inlets for Precast Concrete Pipe Sewers. Construct manholes and inlets for precast concrete pipe sewers as soon as is practicable after sewer lines into or through the manhole or inlet locations are completed. Neatly cut all sewers at the inside face of the walls of the manhole or inlet and point up with mortar.

C. Manholes and Inlets for Monolithic Pipe Sewers. Construct bases for manholes and inlets on monolithic pipe sewers either monolithically with the sewer or after the sewer is constructed.

D. Manholes for Box Sewers. Cast bases for manholes for box sewers as an integral part of the sewer. Construct manholes before backfilling, or cover the manhole opening temporarily and backfill the sewer as a whole.

E. Inverts. Shape and route floor inverts passing out or through the manhole or inlet as shown on the plans. Shape by adding and shaping mortar or concrete after the base is cast or by placing the required additional material with the base.
F. Finishing Complete Manholes and Inlets. Complete manholes and inlets in accordance with the plans. Backfill to original ground elevation in accordance with Item 400, “Excavation and Backfill for Structures.”

G. Finishing Stage I Construction. Complete Stage I construction by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with Item 400, “Excavation and Backfill for Structures.”

H. Stage II Construction. Construct subgrade and base course or concrete pavement construction over Stage I manhole or inlet construction, unless otherwise approved by the Engineer. Excavate to expose the top of Stage I construction and complete the manhole or inlet in accordance with the plans and these Specifications, including backfill and cleaning of all debris from the bottom of the manhole or inlet.

I. Inlet Units. Install cast iron or steel inlet units in conjunction with the construction of concrete curb and gutter. Set the inlet units securely in position before placing concrete for curb and gutter. Form openings for the inlets and recesses in curb and gutter as shown on the plans. Place and thoroughly consolidate concrete for curb and gutter adjacent to inlets and around the inlet castings and formed openings and recesses without displacing the inlet units.

465.4. Measurement. All manholes and inlets satisfactorily completed in accordance with the plans and specifications will be measured by each manhole or inlet, complete, or by each manhole or inlet completed to the stage of construction required by the plans. Extension to inlets will be measured by each extension separately from the inlet.

C.1.4.27 REMOVING STRUCTURES

496.1. Description. Remove and either dispose of or salvage structures.

496.2. Construction.

A. Removal.
1. Pipes. Avoid damaging appurtenances determined by the Engineer to be salvageable.
2. Concrete, Brick, or Stone Structures. Portions of structures that will not interfere with the proposed construction may remain in place 2 ft. or more below the permanent ground line. Square off remaining structures and cut reinforcement flush with the surface of the concrete.
3. Steel Structures. Dismantle steel to be retained by the Department or re-erected by cold-cutting fastener heads and punching or drilling the remaining portion of the fastener, air-arc gouging welded connections, and flame-cutting beams along a straight line. The Engineer may approve other methods of cutting. Cut beams at the locations shown in the plans. Match-mark steel to be re-erected with paint in accordance with the erection drawings. Remove steel piles or cut off 2 ft. or more below the permanent ground line.
4. Timber Structures. Remove all fasteners from timber determined by the engineer to be salvageable. Remove timber piles or cut off 2 ft. or more below the permanent ground line.

B. Salvage. Avoid damage to materials shown in the plans to be salvaged. Deliver materials to be retained by the Department to the location shown in the plans. Block up salvaged steel materials off the ground.
C. Disposal. Material removed that is not deemed to be salvageable is the property of the Contractor. Dispose of removed material off the right of way in accordance with federal, state, and local regulations.

D. Backfill. Backfill excavation and voids to the original ground line if resulting from the removal of structures. Place backfill that will support any portion of the roadbed or embankment to the same requirements for placing embankment. Backfill other areas in 10-in. layers, loose measurement, and compact to the density of adjacent undisturbed material.

496.3. Measurement. This Item will be measured by each structure or by the foot.
1.5. MISCELLANEOUS CONSTRUCTION

1.5.1. BARRICADES, SIGNS, AND TRAFFIC HANDLING

502.1. Description. Provide, install, move, replace, maintain, clean, and remove upon completion of work all barricades, signs, cones, lights, and other traffic control devices used for traffic handling as indicated on the plans and as directed.

502.2. Construction. Provide traffic control devices that conform to details shown on the plans, the TMUTCD, and the Compliant Work Zone Traffic Control Device List (CWZTCDL) maintained by the Traffic Operations Division.

A. Implementation. Before beginning work, designate in writing a Contractor’s Responsible Person (CRP) to be the representative of the Contractor who is responsible for taking or directing corrective measures of installation and maintenance deficiencies as soon as possible. The CRP must be accessible by phone and able to respond to emergencies 24 hours per day.

Follow the traffic control plan (TCP) and install traffic control devices as shown on the plans and as directed. Install traffic control devices straight and plumb. Do not make changes to the location of any device or implement any other changes to the TCP without the approval of the Engineer. Minor adjustments to meet field constructability and visibility are allowed.

Submit Contractor-proposed TCP changes, signed and sealed by a licensed professional engineer, to the Engineer for approval. The Engineer may develop, sign, and seal Contractor-proposed changes. Changes must conform to guidelines established in the TMUTCD using approved products from the CWZTCDL.

Maintain traffic control devices by taking corrective action as soon as possible. Corrective action includes but is not limited to cleaning, replacing, straightening, covering, or removing devices. Maintain the devices such that they are properly positioned, spaced, and legible, and that retroreflective characteristics meet requirements during darkness and rain.

B. Flaggers. Provide a Contractor representative who has been certified as a flagging instructor through courses offered by the Texas Engineering Extension Service, the American Traffic Safety Services Association, the National Safety Council, or other approved organizations. Provide the certificate indicating course completion when requested. This representative is responsible for training and assuring that all flaggers are qualified to perform flagging duties. A qualified flagger must be independently certified by one of the organizations listed above or trained by the Contractor’s certified flagging instructor. Provide the Engineer with a current list of qualified flaggers before beginning flagging activities. Use only flaggers on the qualified list.

Flaggers must be courteous and able to effectively communicate with the public. When directing traffic, flaggers must use standard attire, flags, signs, and signals and follow the flagging procedures set forth in the TMUTCD.

C. Removal. Upon completion of work, remove all barricades, signs, cones, lights, and other traffic control devices used for work-zone traffic handling, unless otherwise shown on the plans.

502.3. Measurement. This Item will be measured by the month.
1.5.2. **CONSTRUCTING DETOURS**

508.1. **Description.** Construct and maintain detours. Remove detours when required.

508.2. **Materials.**  
A. **Embarkment.** Use roadway excavation for embankment material or use material from other approved sources.

B. **Temporary Drainage Pipe.** Furnish pipe required for temporary drainage in accordance with details shown on the plans or as directed. Pipe will become the property of the Contractor upon removal. Temporary use of permanent pipe for use on the project is allowable if the sequence of work permits. If pipe used temporarily is damaged so that it is not acceptable in accordance with applicable Items, it will not be acceptable for incorporation in the final project. The damaged pipe remains the property of the Contractor.

C. **Base and Surfacing.** Furnish base and surfacing materials in accordance with Items as shown on the plans.

508.3. **Construction.** Construct the detour at the locations and to the lines, grades, and typical sections shown on the plans or as directed, in accordance with pertinent Items. Maintain detours for public travel in a safe and passable condition. The safety of the public and convenience of traffic is of prime importance. Maintain detours in accordance with Article 4.5, “Maintenance of Traffic”; Article 7.7, “Public Safety and Convenience”; Article 7.14, “Contractor’s Responsibility for Work”; and this Item. Remove detours after they are no longer needed for traffic. Removed materials will become the property of the Contractor unless otherwise shown on the plans or directed. Dispose of the materials off the right of way, unless otherwise directed, in accordance with federal, state, and local requirements. If allowed, materials may be disposed of by spreading along the adjacent roadway slopes. If embankment, base, or surfacing is to be reused within the roadway construction or stockpiled for future use, salvage or stockpile in accordance with pertinent Items.

508.4. **Measurement.** This Item will be measured by the 100-ft. station, the square yard of pavement area, or each detour constructed.

1.5.3. **CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER**

529.1. **Description.** Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.

529.2. **Materials.** Furnish materials conforming to:  
- Item 360, “Concrete Pavement”  
- Item 420, “Concrete Structures”  
- Item 421, “Hydraulic Cement Concrete”
• Item 440, “Reinforcing Steel.”
  Use Class A concrete or material specified in the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.

529.3. Construction. Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 420, “Concrete Structures.” Construct joints at locations shown on the plans. Cure for at least 72 hr.
Furnish and place reinforcing steel in accordance with Item 440, “Reinforcing Steel.”
Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans.

A. Conventionally Formed Concrete. Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.
Pour concrete into forms, and strike off with a template 1/4 to 3/8 in. less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.
Place curbs, gutters, and combined curb and gutters in 50-ft. maximum sections unless otherwise approved.

B. Extruded or Slipformed Concrete. Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. If required, coat cleaned surfaces with approved adhesive or coating at the rate of application shown on the plans or as directed. Place concrete with approved self-propelled equipment. The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.
Attach a pointer or gauge to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved.
Finish surfaces immediately after extrusion or slipforming.

529.4. Measurement. This Item will be measured by the foot.

1.5.4. SIDEWALKS


531.2. Materials. Furnish materials conforming to the following:
• Item 360, “Concrete Pavement”
• Item 420, “Concrete Structures”
• Item 421, “Hydraulic Cement Concrete”
• Item 440, “Reinforcing Steel.”
Use Class A concrete or other concrete as specified. Use Grade 8 course aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.

531.3. Construction. Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Hand-tamp and sprinkle foundation when placement is directly on subgrade or foundation materials. Remove and dispose of existing concrete in accordance with Item 104, “Removing Concrete.” Provide a clean surface for concrete placement directly on the surface material or pavement. Mix and place concrete in accordance with the pertinent Items. Handfinishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Install joints as shown on the plans. Brush all exposed surfaces to a smooth and uniform surface. Ensure that abrupt changes in sidewalk elevation do not exceed 1/4 inch, sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope. Where a sidewalk crosses a concrete driveway, ensure that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans.

Provide finished work with a well-compacted mass, a surface free from voids and honeycomb, and the required true-to-line shape and grade. Cure for at least 72 hr. in accordance with Item 420, “Concrete Structures.”

A. Conventionally Formed Concrete. Provide sidewalk sections separated by premold or board joint of the thickness shown on the plans in lengths greater than 8 ft. but less than 40 ft., unless otherwise directed. Terminate workday production at an expansion joint.

B. Extruded or Slipformed Concrete. Provide any additional surface finishing immediately after extrusion or slipforming as required on the plans. Construct joints at locations as shown on the plans or as directed.

531.4. Measurement. Sidewalks will be measured by the foot or by the square yard of surface area. Curb ramps will be measured by each unit. The unit will consist of the curb ramp, landing, adjacent flares or side curb, and detectable warning surface as shown on the plans.
1.6. LIGHTING, SIGNING, MARKINGS, AND SIGNALS

1.6.1. ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS

677.1. Description. Eliminate existing pavement markings and raised pavement markers.


677.3. Equipment. Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

677.4. Construction. Eliminate existing pavement markings and markers on both concrete and asphaltic surfaces in such a manner that color and texture contrast of the pavement surface will be held to a minimum. Repair damage to asphaltic surfaces, such as spalling, shelling, etc., greater than 1/4 in. in depth resulting from the removal of pavement markings and markers. Dispose of markers in accordance with federal, state, and local regulations. Use any of the following methods unless otherwise shown on the plans.

A. Surface Treatment Method. Apply surface treatment material at rates shown on the plans or as directed. Place a surface treatment a minimum of 2 ft. wide to cover the existing marking. Place a surface treatment, thin overlay, or microsurfacing a minimum of 1 lane in width in areas where directional changes of traffic are involved or in other areas as directed by the Engineer.

B. Burn Method. Use an approved burning method. For thermoplastic pavement markings or prefabricated pavement markings, heat may be applied to remove the bulk of the marking material prior to blast cleaning. When using heat, avoid spalling pavement surfaces. Sweeping or light blast cleaning may be used to remove minor residue.

C. Blasting Method. Use a blasting method such as water blasting, abrasive blasting, water abrasive blasting, shot blasting, slurry blasting, water-injected abrasive blasting, or brush blasting as approved. Remove pavement markings on concrete surfaces by a blasting method only.

D. Mechanical Method. Use any mechanical method except grinding. Flail milling is acceptable in the removal of markings on asphalt and concrete surfaces.

677.5. Measurement. This Item will be measured by each word, symbol, or shape eliminated; by the foot of marking eliminated; or by any other unit shown on the plans. This is a plans quantity measurement item. The quantity to be paid is the quantity shown in
the proposal unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

1.6.2. PAVEMENT SURFACE PREPARATION FOR MARKINGS

678.1. Description. Prepare pavement surface areas before placement of pavement markings and raised pavement markers. Item 677, “Eliminating Existing Pavement Markings or Markers,” governs complete removal of existing markings.

678.2. Materials. Use a commercial abrasive-blasting medium capable of producing the specified surface cleanliness. Use potable water, when water is required.

678.3. Equipment. Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

678.4. Construction. Prepare pavement surface of sufficient area for the pavement markings or raised pavement markers shown on the plans. Remove all contamination and loose material. Avoid damaging the pavement surface. When existing pavement markings are present, remove loose and flaking material. Approved pavement surface preparation methods are sweeping, air blasting, flail milling, and blast cleaning unless otherwise specified on the plans.

For concrete pavement surfaces, in addition to the above, air blast after the removal of contamination or existing material and just prior to placing the stripe. Perform the air blasting with a compressor that is capable of generating compressed air at a minimum of 150 cfm and 100 psi using 5/16-in. or larger hosing for the air blast.

Contaminants up to 0.5 sq. in. may remain if they are not removed by the following test, performed just before application of markings:

**Step 1.** Air-blast the surface to be tested, to simulate blasting during application of markings.

**Step 2.** Firmly press a 10-in.-long, 2-in.-wide strip of monofilament tape onto the surface, leaving approximately 2 in. free.

**Step 3.** Grasp the free end and remove the tape with a sharp pull.

678.5. Measurement. This Item will be measured by the foot for each width specified; by each word, shape, or symbol; or by any other unit except lump sum.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2, “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.
1.6.3. INSTALLATION OF HIGHWAY TRAFFIC SIGNALS

680.1. Description. Install highway traffic signals.

680.2. Materials. Ensure electrical materials and construction methods conform to the current NEC and additional local utility requirements.
Furnish new materials. Ensure all materials and construction methods conform to the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following items:

- Item 610, “Roadway Illumination Assemblies”
- Item 625, “Zinc-Coated Steel Wire Strand”
- Item 627, “Treated Timber Poles”
- Item 634, “Plywood Signs”
- Item 636, “Aluminum Signs”
- Item 656, “Foundations for Traffic Control Devices.”

Provide controller assemblies that meet the requirements of DMS-11170, “Traffic Signal Controller Assembly,” and the details shown on the plans.
Provide controller assemblies from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified controller assembly manufacturers.
Provide flasher assemblies that meet the requirements of DMS-11160, “Flasher Controller Assembly,” and the details shown on the plans.
Provide flasher assemblies from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified flasher assembly manufacturers. Sampling and testing of traffic signal controller assemblies will be done in accordance with Tex-1170-T.

680.3. Construction. Install traffic signal controller foundations in accordance with Item 656, “Foundations for Traffic Control Devices.”

A. Electrical Requirements.
1. Electrical Services. Make arrangements for electrical services and install and supply materials not provided by the utility company as shown on the plans. Unless otherwise shown on the plans, install 120-volt, single-phase, 60-Hz AC electrical service.

2. Conduit. Install conduit and fittings of the sizes and types shown on the plans. Conduit of larger size than that shown on the plans may be used with no additional compensation, providing that the same size is used for the entire length of the conduit run. Extend conduit in concrete foundations 2 to 3 in. above the concrete. Seal the ends of each conduit with silicone caulking or other approved sealant after all cables and conductors are installed.

3. Wiring. Unless otherwise shown on the plans, furnish stranded No. 12 AWG XHHW conductors. Install above-ground cables and conductors in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles. Make power entrances to ground-mounted controllers through underground conduit. Wire each signal installation to operate as shown on the plans.
Attach ends of wires to properly sized self-insulated solderless terminals. Attach terminals to
the wires with a ratchet-type compression crimping tool properly sized to the wire. Place
prenumbered identification tags of plastic or tape around each wire adjacent to wire ends in
the controller and signal pole terminal blocks.
Splices will not be permitted except as shown on the plans, unless the Engineer approves each
individual splice in writing. Make all allowed splices watertight.
4. Grounding and Bonding. Ground and bond conductors in accordance with the NEC. Ensure
the resistance from the grounded point of any equipment to the nearest ground rod is less
than 1 ohm.
Install a continuous bare or green insulated copper wire (equipment ground) throughout the
electrical system that is the same size as the neutral conductor, but a minimum No. 8 AWG.
Connect the equipment ground to all metal conduit, signal poles, controller housing, electrical
service ground, ground rods, and all other metal enclosures and raceways.
Provide copper wire bonding jumpers that are a minimum No. 8 AWG.

B. Controller Assemblies. Construct controller foundations in accordance with Item 656,
“Foundations for Traffic Control Devices.” Immediately before mounting the controller
assembly on the foundation, apply a bead of silicone caulk to seal the cabinet base. Seal any
space between conduit entering the controller and the foundation with silicone caulk. Deliver
the keys for the controller cabinets to the Engineer when the contract is complete.
Place the instruction manual and wiring diagrams for all equipment in the controller cabinet,
inside the controller cabinet.

C. Timber Poles. Furnish ANSI Class 2 timber poles other than for electrical services in
accordance with details shown on the plans.

D. Preservation of Sod, Shrubbery, and Trees. Replace sod, shrubbery, and trees damaged
during the Contract.

E. Removal and Replacement of Curbs and Walks. Obtain approval before cutting into or
removing walks or curbs not shown on the plans to be removed or replaced. Restore any curbs
or walks removed equivalent to original condition after work is completed, to the satisfaction
of the Engineer.

F. Sign Lighting. Attach sign lighting to traffic signal equipment as shown on the plans.

G. Intersection Illumination. Construct luminaires on signal poles as shown on the plans.

H. Test Period. Operate completed traffic signal installations continuously for at least 30- days
in a satisfactory manner. If any Contractor-furnished equipment fails during the 30-day test
period, repair or replace that equipment. This repair or replacement, except lamp
replacement, will start a new 30-day test period.
Replace materials that are damaged or have failed prior to acceptance. Replace failed or
damaged existing signal system components when caused by the Contractor. The Department
will relieve the Contractor of maintenance responsibilities upon passing a 30- day performance
test of the signal system and acceptance of the contract.
680.4. Measurement. This Item will be measured as each signalized intersection controlled by a single traffic signal controller.

1.6.4. TEMPORARY TRAFFIC SIGNALS

681.1. Description. Furnish, install, operate, maintain, reconfigure, and remove temporary traffic signals.

681.2. Work Methods. Install materials in accordance with Item 680, “Installation of Highway Traffic Signals.” If signal equipment is furnished by the Department, obtain the equipment at locations shown on the plans. Provide electrical services in accordance with Item 628, “Electrical Services” (except for measurement and payment).

A. Operation and Maintenance. Maintain and operate the temporary traffic signals for the duration of the contract. Set signal timing as shown on the plans or as directed.
1. Designate in writing a sufficiently skilled individual responsible for maintenance and operation of the temporary traffic signals who is available to respond within a reasonable time, 24 hr. each day, unless otherwise shown on the plans.
2. Provide backup power, when shown on the plans, for each location at all times.

B. Reconfiguration. Reconfigure temporary traffic signals in accordance with the plans, as directed, and within the requirements of this Item. Reconfiguration is any change made to an installed intersection, including relocation of poles, controller, or signal heads.

C. Removal. Remove all equipment installed for temporary traffic signals, as shown on the plans or as directed in writing.
1. Completely remove poles or other supports used for temporary traffic signals. When approved, a concrete foundation may remain 2 ft. or more below finish grade. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.
2. Retain all removed temporary signal components, except for those furnished by the Department, unless otherwise shown on the plans.

681.3. Measurement. This Item will be measured by each temporary signalized intersection. A signalized intersection is a group of signals operated by a single controller.

1.6.5. VEHICLE AND PEDESTRIAN SIGNAL HEADS

682.1. Description. Furnish and install vehicle and pedestrian signal heads.


A. Definitions.
1. Back Plate. A thin strip of material extending outward from all sides of a signal head.
2. Incandescent Optical Unit. The lens, reflector, lamp, lamp receptacle, and associated supporting parts in a signal section.
3. LED Optical Unit. The LED lens and associated supporting parts in a signal section.
4. Louver. A device mounted to the visor restricting signal face visibility.
5. Signal Section. One housing case, housing door, visor, and optical unit.
6. Signal Face. One section or an assembly of 2 or more sections facing one direction.
7. Signal Head. A unidirectional face or a multidirectional assembly of faces, including back plates and loupers when required, attached at a common location on a support.

B. General. Provide vehicle signal heads in accordance with DMS-11120, “Vehicle Signal Heads.” Provide vehicle signal heads from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified vehicle signal head manufacturers.
Provide pedestrian signal heads in accordance with DMS-11130, “Pedestrian Signal Heads.” Provide pedestrian signal heads from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified pedestrian signal head manufacturers.
Supply either aluminum or polycarbonate signal head components that are of the same material and manufacturer for any one project.
Use galvanized steel, stainless steel, or dichromate sealed aluminum bolts, nuts, washers, lock washers, screws, and other assembly hardware. When dissimilar metals are used, ensure the metals are selected or insulated to prevent corrosion.
Use closed-cell silicone or closed-cell neoprene gaskets.

682.3. Construction.
A. Assembly. Assemble individual signal sections in multi-section faces in accordance with the manufacturer’s recommendations to form a rigid signal face. Assemble and mount signal heads as shown on the plans. Install loupers and back plates in accordance with the manufacturer’s recommendations. Close any openings in an assembled signal head with a plug of the same material and color as the head.
When installing a retrofit replacement LED traffic signal or pedestrian signal lamp unit into an existing signal housing, only remove the existing lens, reflector, and incandescent lamp; fit the new unit securely in the housing door; and connect the new housing unit to the existing electrical wiring or terminal block by means of simple connectors.
B. Wiring. Wire each optical unit to the terminal block located in that signal section by means of solderless wire connectors or binding screws and spade lugs. Wire all sections of a multi-section signal face to the section terminal blocks in which the traffic signal cable is terminated.
Maintain the color coding on leads from the individual optical units throughout the signal head, except for the traffic signal cable. Use solderless wire connectors or binding screws and spade lugs for connections to terminal blocks. Use binding screws and spade lugs for field wiring.

682.4. Measurement. This Item will be measured by each vehicle signal section, pedestrian signal section, back plate, or louver.
C1.6.6 MAINTENANCE OF TRAFFIC SIGNALS

690.1. Description. Furnish, install, modify, repair, replace, or remove components of a traffic signal.

690.2. Materials. Unless otherwise noted on the plans, the Department will only furnish traffic signal poles, mast arms, and controllers that become part of the final installation. Submit a material list to the Engineer for all poles, mast arms, and controllers needed. Pick up materials at the locations and times shown on the plans. Designate in writing the persons authorized to pick up the material.
Assume responsibility for all materials furnished by the Department. Use material furnished by the Department for this Contract only. Return unused or removed material deemed salvageable by the Engineer to the Department upon completion of the work and prior to final payment at location shown on the plans or as directed. Dispose of any material deemed not salvageable by the Engineer in accordance with federal, state, and local regulations. When materials are required to be furnished by the Contractor, meet the material requirements of the pertinent Item for the material requirements.

690.3. Equipment. Required equipment includes but is not limited to an aerial device capable of reaching overhead work, trenching machine, boring machine, concrete saw, and digger-boom truck. Use only equipment, tools, and machinery in good repair and operating condition. Repair or replace any equipment that, in the opinion of the Engineer, may affect the quality of work or safety.

690.4. Work Methods. Conform to the NEC, local utility requirements, the requirements of this Item, and the pertinent requirements of the following Items:
• Item 416, “Drilled Shaft Foundations”
• Item 421, “Hydraulic Cement Concrete”
• Item 476, “Jacking, Boring or Tunneling Pipe or Box”
• Item 610, “Roadway Illumination Assemblies”
• Item 618, “Conduit”
• Item 620, “Electrical Conductors”
• Item 622, “Duct Cable”
• Item 624, “Ground Boxes”
• Item 625, “Zinc-Coated Steel Wire Strand”
• Item 627, “Treated Timber Poles”
• Item 628, “Electrical Services”
• Item 634, “Plywood Signs”
• Item 636, “Aluminum Signs”
• Item 656, “Foundations for Traffic Control Devices”
• Item 680, “Installation of Highway Traffic Signals”
• Item 682, “Vehicle and Pedestrian Signal Heads”
• Item 684, “Traffic Signal Cables”
• Item 685, “Roadside Flashing Beacon Assemblies”
• Item 686, “Traffic Signal Pole Assemblies (Steel)”
• Item 687, “Pedestrian Pole Assemblies”
• Item 688, “Pedestrian Detectors and Vehicle Loop Detectors.” Perform the following work as directed:

A. **Conduit.** Install, replace, remove, or modify conduits in accordance with Item 618, “Conduit”; as shown on the plans; or as directed. Use 90° “sweep” type elbow on conduits entering a ground box.

B. **Foundations.** Install, replace, or remove foundations for traffic signal pole and ground mount controller cabinets in accordance with Item 416, “Drilled Shaft Foundations”; in accordance with Item 656, “Foundations for Traffic Control Devices”; as shown on the plans; or as directed.

C. **Concrete.** Install concrete in accordance with Item 421, “Hydraulic Cement Concrete.”

D. **Ground Boxes.** Install, repair, replace, remove, or modify ground boxes in accordance with Item 624, “Ground Boxes”; as shown on the plans; or as directed.

E. **Vehicle and Pedestrian Detectors.** Install, repair, replace, remove, or modify pedestrian push buttons and vehicle loop detectors in accordance with Item 688, “Pedestrian Detectors and Vehicle Loop Detectors”; as shown on the plans; or as directed.

F. **Electrical Service.** Install, repair, replace, remove, or modify an electrical service assembly in accordance with Item 628, “Electrical Services”; as shown on the plans; or as directed. Mount any or all of the following on an electrical service support assembly: conduit, weather head, load center, meter base, lightning protection, wiring, and associated hardware.

G. **Signal Pole.** Install, repair, replace, remove, or modify signal poles in accordance with pertinent Items, as shown on the plans, or as directed. Comply with Item 627, “Treated Timber Poles,” for timber signal poles with guy wires and anchors and with Item 686, “Traffic Signal Pole Assemblies (Steel),” for steel poles with concrete foundations. Remove timber poles and anchors completely, to 24 in. below ground level, or as directed. Remove concrete foundations to 24 in. below ground level or as directed. Install, repair, replace, remove, or modify pedestrian signal pole assemblies in accordance with Item 687, “Pedestrian Pole Assemblies”; as shown on the plans; or as directed. Install, repair, replace, remove, or modify roadside flashing beacons in accordance with Item 685, “Roadside Flashing Beacon Assemblies”; as shown on the plans; or as directed.

H. **Down Guy.** Install, replace, remove, or modify down guy with guard or down guy with guard and anchor.

I. **Steel Wire Strand.** Install, replace, or remove steel wire strand in accordance with Item 625, “Zinc-Coated Steel Wire Strand”; as shown on the plans; or as directed. Attach span wire on timber poles using a 5/8-in. straight thimble-eye bolt. Attach span wire on metal poles using at least 2 turns of wire around the pole. Place and properly tighten the 3-bolt clamp as near as possible to the pole.

J. **Luminaire Head and Mast Arm.** Install, replace, remove, or modify luminaire heads, arms, bulbs, photocells, and hardware on timber or steel signal poles. Install material using
manufacturer’s specifications. Fuse luminaires individually in the signal pole hand hole. Install a separate cable from the breaker load panel to each luminaire.

**K. Signal Head Assembly.** Install, repair, replace, remove, or modify pedestrian signal heads or vehicle signal head assemblies in accordance with Item 682, “Vehicle and Pedestrian Signal Heads”; as shown on the plans; or as directed. Mount signal heads by a span wire hanger clamp, bracket arm assembly, or mast arm bracket assembly. Signal head assemblies consist of 1 to 12 signal sections. Install signal heads as shown on the plans or as directed. Assemble the signal heads with backplates, louvers, and brackets as needed. Mount all signal heads at the same elevation. Install signal head perpendicular to the travel lane it controls. Plumb all signal heads vertically and horizontally.

**L. Traffic Signal Controller Cabinet, Ground Mount.** Install, repair, replace, remove, or modify ground-mounted cabinet. Plumb and tighten the cabinet. Apply silicone sealant around the base of the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans or as directed.

**M. Traffic Signal Controller Cabinet, Pole Mount.** Install, repair, replace, remove, or modify pole-mounted cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans or as directed.

**N. Flashing Beacon Controller Cabinet.** Install, repair, replace, remove, or modify flasher cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans or as directed.

**O. Cables.** Install, repair, replace, remove, or modify signal, loop lead-in, electrical, communication, or illumination cables in conduits or along messenger cables in accordance with Item 620, “Electrical Conductors”; in accordance with Item 684, “Traffic Signal Cables”; as shown on the plans; or as directed. Attach aerial cable at 1-ft. intervals using approved cable ties along a messenger span cable. Install a drip loop of at least 2 turns at each pole, signal head, and weather head. Label each cable brought into the controller cabinet. Coil 5 ft. of cable neatly on the traffic signal controller cabinet floor for each cable. Install solderless pressure connectors that meet the requirements of the NEC for all wires attached to terminal posts. Use a ratchet-type fullcircle crimper for insulated terminals to provide a solderless pressure connector.

**P. Sealing.** Install, repair, replace, remove, or modify sealant in detector saw slots, at the open end of all conduits terminated at the roadway edge, and in ground boxes. Apply sealant as shown on the plans or as directed.

**Q. Salvage Operations.** Remove traffic signal when no replacement is required. Return unused or removed material deemed salvageable by the Engineer to the Department. Dispose of all other material.

**R. Signal-Related Signs.** Install, repair, replace, remove, or modify small post-mounted or
overhead signs.

S. Curbs, Ramps, and Sidewalks. Install, repair, replace, remove, or modify curbs, ramps, and sidewalks. Secure permission to install traffic signal items before cutting into or removing curbs, ramps, and sidewalks. Replace all curbs, ramps, and sidewalks as shown on the plans. Install pedestrian access ramps as shown on the plans.

T. Protection of Utilities. Locate and protect all public lines and utility customer service lines in the work area. Notify the utility company and locate and mark, uncover, or otherwise protect all such lines in the construction area. Obtain information on the location and grade of water, sewer, gas, telephone, electric lines, and other utilities in the work area from the utility company. This information does not relieve the Contractor of responsibility for protecting utilities. Reimburse the utility line owner for expenses or costs (including fines that may be levied against the utility company) that may result from unauthorized or accidental damage to any utility lines in work area.

U. Preservation of Sod, Shrubbery, and Trees. Preserve all sod, shrubbery, and trees at the site during the Contract. Obtain permission to remove any sod, shrubbery, or tree branches. Preserve and restore sod and shrubbery into their original position. Replace damaged sod or shrubbery at the Contractor’s expense.

690.5. Measurement. Measurement will be as follows:

A. Removal of Conduit. By the foot of conduit.

B. Installation of Conduit by Trenching. By the foot of the trench containing conduit, regardless of the size of conduit.

C. Installation of Conduit by Jacking or Boring. By the foot of road bore made. Pits for jacking or boring are subsidiary to this Item.

D. Installation of Vehicle Detectors. By the foot of saw cut containing detector wire.

E. Removal, Replacement, or Installation of Ground Boxes. By each box removed, replaced, or installed, regardless of the type of box. A concrete apron around the box will be considered subsidiary to this Item.

F. Removal, Replacement, or Installation of Cables. By the foot of traffic signal cables removed, replaced, or installed, except that measurement will not be made for cable inside signal heads and controllers or for cable coiled in ground boxes, in pole bases, and on span wires.

G. Installation of Duct Cables. By the foot of trench containing duct cable.

H. Removal, Replacement, or Installation of Cables by Messenger Cable. By the foot removed, replaced, or installed.
I. Removal, Replacement, or Installation of Span Cable Assembly. By the foot of span removed, replaced, or installed. A span is defined as the distance from one pole to the next pole.

J. Replacement or Installation of Electrical Service. By each electrical service replaced or installed. The removal of the existing assembly will be considered subsidiary to this Item.

K. Removal, Replacement, or Installation of Timber Poles. By each timber pole removed, replaced, or installed. Attachment of required hardware is subsidiary to this Item.

L. Removal, Replacement, or Installation of Signal Head Assemblies. By each head removed, replaced, or installed. Assembly and wiring are subsidiary to this Item.

M. Removal, Replacement, or Installation of Signal Related Signs. By each sign assembly removed, replaced, or installed.

N. Removal, Replacement, or Installation of Pedestrian Push Buttons. By each push button removed, replaced, or installed.

O. Removal, Replacement, or Installation of Traffic Signal Pole Foundations. By the foot, of the type of foundation removed, replaced, or installed.

P. Installation of Foundations for Ground Mount or Pole Mount Cabinets. By each foundation installed.

Q. Removal, Replacement, or Installation of Controller Cabinet, Ground Mount. By each cabinet removed, replaced, or installed.

R. Removal, Replacement, or Installation of Controller Cabinet, Pole Mount. By each cabinet removed, replaced, or installed.

S. Removal, Replacement, or Installation of Flasher Cabinet. By each cabinet removed, replaced, or installed.


U. Removal, Replacement, or Installation of Roadside Flashing Beacon Assemblies. By each assembly removed, replaced, or installed.

V. Removal, Replacement, or Installation of Signal Pole Assemblies. By each assembly, according to the type of pole assembly removed, replaced, or installed. Wiring in the pole and hardware is subsidiary to this Item.

W. Removal, Replacement, or Installation of Curbs. By the foot removed, replaced, or installed.
X. Removal, Replacement, or Installation of Pedestrian Ramps. By each ramp removed, replaced, or installed.

Y. Removal, Replacement, or Installation of Sidewalks. By the square foot removed, replaced, or installed.

Z. Removal of Concrete Foundations. By each foundation removed.

AA. Removal, Replacement, or Installation of Luminaire Heads. By each luminaire head removed, replaced, or installed.

BB. Removal, Replacement, or Installation of Luminaire Mast Arms. By each mast arm removed, replaced, or installed.
1.7. MAINTENANCE

1.7.1. CLEANING AND SEALING JOINTS AND CRACKS (ASPHALT CONCRETE)

712.1. Description. Clean and seal joints and cracks in asphalt concrete roadway surfaces.

712.2. Materials. Furnish materials unless otherwise shown on the plans. Furnish sealant materials as shown on the plans in accordance with Item 300, “Asphalts, Oils, and Emulsions.” Furnish an approved fine aggregate.

712.3. Equipment. Furnish equipment, tools, and machinery for proper prosecution of the work.

A. Hot Applied Sealants. Heat in a double-jacketed heater using a heat transfer oil so that no direct flame comes in contact with the shell of the vessel containing the sealing compound. Provide a heater capable of circulating and agitating the sealant during the heating process to achieve a uniform temperature rise and to maintain the desired temperature. Provide gauges to monitor the temperature of the vessel contents and to avoid overheating the material. Provide a heater equipped with a gear-driven asphalt pump with adequate pressure to dispense the sealant.

B. Cold Applied Sealants. Provide equipment with adequate pressure to dispense the sealant in a continuous flow.

712.4. Work Methods. Clean and seal joints and cracks that are 1/16 in. or greater in width. When required, rout joints and cracks to the configuration shown on the plans. Clean joints and cracks with air blast cleaning or other acceptable methods to a depth of at least twice the joint or crack width. Joints and cracks must be free of moisture before sealing. Dispose of materials removed as directed or approved. Apply sealing material with a pressure nozzle. Completely fill cracks and joints. Squeegee material to no more than 3 in. wide and 1/8 in. above the pavement surface. Prevent tracking with an application of fine aggregate as directed.

712.5. Measurement. This Item will be measured by the foot, gallon, pound, or lane mile. Shoulders wider than 6 ft. are considered additional lanes.

1.7.2. REPAIR OF SPALLING IN CONCRETE PAVEMENT

720.1. Description. Repair spalling and partial-depth failures in concrete pavement.

720.2. Materials. Furnish either rapid-set concrete or polymeric patching material unless otherwise shown on the plans.

A. Rapid-Set Concrete. Provide concrete that meets DMS-4655, “Rapid- Hardening Cementing Materials for Concrete Repair.”
Use a packaged blend of hydraulic cement, sand, and gravel (maximum size 3/8 in.) which requires the addition of water and has a maximum shrinkage of 0.15% in accordance with ASTM C 928. Do not use chlorides, magnesium or gypsum to accelerate setting time. Before spall repair operations, demonstrate that the mixture achieves flexural strength of at least 425 psi in 5 hr., a minimum compressive strength of 5,100 psi in 7 days, and 6,300 psi in 28 days. Test in accordance with Tex-418-A and Tex-448-A.

B. Polymeric Patching Material. Provide polymeric patching material that meets DMS-6170, “Polymeric Materials for Patching Spalls in Concrete Pavement,” and matches the color of the pavement.

720.3. Equipment. Furnish equipment in accordance with Item 429, “Concrete Structure Repair,” or as approved.

720.4. Work Methods. Repair areas as shown on the plans or as directed. Dispose of debris off the right of way in accordance with federal, state, and local regulations.

A. Hydraulic Cement Concrete Material. Saw at least 1 1/2 in. deep around repair area before concrete removal, unless otherwise directed, providing a vertical face around the perimeter of the repair area. Provide a uniform rough surface free of loose particles and suitable for bonding. Remove concrete to a depth of 1 1/2 in. or the depth of deteriorated concrete, whichever is greater. Use chipping hammers not heavier than the nominal 15-lb. class or hydrodemolition equipment for the removal of concrete below 1 1/2 -in. depth. Mix, place, and cure in accordance with manufacturer’s recommendations. Do not place concrete if the air temperature is below 40°F. Screed concrete to conform to roadway surface. Provide a rough broom finish.

B. Polymeric Patching Material. Submit for approval a statement from the manufacturer identifying the recommended equipment and installation procedures. Remove the deteriorated concrete to the dimensions shown on the plans or as directed. Dry and abrasive-blast the repair area to ensure it is free from moisture, dirt, grease, oil, or other foreign material that may reduce the bond. Remove dust from the abrasive blasting operation. Apply primer to the repair area. Reapply primer if conditions change before placing patching material. Mix, place, and cure in accordance with manufacturer’s recommendations. Begin placement of material at the lower end of sloped areas. Screed polymeric patching material to conform to the roadway surface. Provide a non-skid finish with a notched trowel.

720.5. Measurement. This Item will be measured as follows:

A. Hydraulic Cement Concrete Material. By the cubic foot of concrete repair material placed.

B. Polymeric Patching Material. By the gallon of polymeric patching material placed.
1.7.3. **LITTER REMOVAL**

**734.1. Description.** Remove and dispose of litter. Litter includes matter not part of the highway facility, such as trash, garbage, scrap metals, paper, wood, plastic, glass products, animal remains, rubber products, tires, auto parts, furniture, mattresses, household appliances, and large bulky items.

**734.2. Materials.** Furnish bags and containers.

**734.3. Equipment.** Provide equipment and tools. Provide highly visible omni-directional amber flashing warning lights on work vehicles. Provide equipment that prevents the accumulated debris from being strewn along the roadway during transport.

**734.4. Work Methods.** Remove bagged litter on the same day it is collected. Do not remove dead animals larger than 150 lb. or hazardous materials; instead notify the Department for removal. Dispose of litter off the right of way in accordance with federal, state, and local regulations. Perform litter removal and disposal according to the following types.

A. **Litter.** Remove and dispose of litter from the right of way, including shoulders but excluding the traveled lanes and shoulders next to barriers, to the limits shown on the plans.

B. **Spot Litter.** Work requests are made on a callout basis. Begin removing litter within 3 hr. of notification, unless otherwise shown on the plans.

**734.5. Measurement.** This Item will be measured as follows.

A. **Litter.** By the cycle or acre.

B. **Spot Litter.** By the acre. The minimum quantity per callout is 3 acres, unless otherwise shown on the plans.

1.7.4. **DEBRIS REMOVAL**

**735.1. Description.** Remove and dispose of debris discarded or deposited on or adjacent to the pavement. Debris includes objects not part of the highway facility, such as dead animals, tires, tire fragments, wood, furniture, mattresses, household appliances, and scrap metal.

**735.2. Equipment.** Provide highly visible omnidirectional flashing warning lights on work vehicles. Provide equipment that prevents the accumulated debris from being strewn along the roadway during transport.
735.3. **Work Methods.** Remove debris at locations shown on the plans. Dispose of debris off the right of way in accordance with applicable federal, state, and local regulations.

**A. Center Medians and Mainlanes.** Remove and dispose of debris from the main travel lanes, paved medians, paved shoulders, and an additional 5 ft. adjacent to the pavement, unless otherwise shown on the plans.

**B. Frontage Roads.** Remove and dispose of debris from frontage roads, shoulders, U-turn lanes, and intersecting streets to the right-of-way line, including turn lanes, underpasses and overpasses, and an additional 5 ft. adjacent to the pavement, unless otherwise shown on the plans.

**C. Entrance and Exit Ramps.** Remove and dispose of debris from ramps, shoulders, and an additional 5 ft. adjacent to the pavement, unless otherwise shown on the plans.

**D. Spot Debris Removal.** Work requests are made on a callout basis. Remove and dispose of debris as directed. Begin removing debris within 3 hr. of notification, unless otherwise shown on the plans.

735.4. **Measurement.** This Item will be measured as follows:

**A. Center Medians and Mainlanes, Frontage Roads, and Entrance and Exit Ramps.** By the cycle or right-of-way centerline mile. A right-of-way centerline mile is defined as the distance from beginning reference marker location to ending reference marker location, regardless of the number of roadbeds.

**B. Spot Debris Removal.** By the roadbed mile. The minimum quantity per callout is 1 roadbed mile, unless otherwise shown on the plans.
2. Texas Commission on Environmental Quality (TCEQ)

2.1. Subchapter C: Conventional Collection Systems

2.1.1. Applicability.

This subchapter applies to the design, construction, operation, and testing standards for conventional gravity wastewater collection systems, conventional wastewater lift stations, force mains for wastewater transport, and reclaimed water conveyance systems.

2.1.2. Edwards Aquifer.

An owner who plans to install a wastewater collection system located over the Edwards Aquifer recharge zone must design and install the system in accordance with Chapter 213 of this title (relating to Edwards Aquifer), in addition to these rules.

2.1.3. Pipe Design.

(a) Flow Design Basis. An owner must use the requirements of this section to design a gravity collection system.

(1) An owner must design a wastewater collection system to handle the transport of the peak dry weather flow from the service area, plus infiltration and inflow.

(2) The flow calculations must include the details of the average dry weather flow, the dry weather flow peaking factor, and the infiltration and inflow.

(3) The flow calculations must include the flow expected in the facility immediately upon completion of construction and at the end of its 50-year life.

(b) Gravity Pipe Materials.

(1) An owner must identify in the report the proposed gravity collection system pipe with its appropriate American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), or American Water Works Association (AWWA) standard numbers for both quality control (dimensions, tolerances, etc.) and installation (bedding, backfill, etc.).

(2) The selection of gravity collection system pipe must be based on:

(A) the characteristics of the wastewater conveyed;
(B) the character of industrial wastes;
(C) the possibility of septic conditions;
(D) the exclusion of inflow and infiltration;
(E) any external forces;
(c) Joints for Gravity Pipe.

(1) The technical specifications for joints for gravity pipe must include the materials and methods used in making joints.

(2) Materials used for gravity pipe joints must prevent infiltration and root entrance. A joint must:

(A) include rubber gaskets;
(B) include polyvinyl chloride (PVC) compression joints;
(C) include high density polyethylene compression joints;
(D) be welded;
(E) be heat fused; or
(F) include other types of factory-made joints.

(3) The technical specifications must include ASTM, AWWA, ANSI, or other appropriate national reference standards for the joints.

d) Separation distances between public water supply pipes and wastewater collection system pipes or manholes.

(1) Collection system pipes must be installed in trenches separate from public water supply trenches.

(2) Collection system pipes must be no closer than nine feet in any direction to a public water supply line.

(3) If a nine-foot separation distance cannot be achieved, the following guidelines will apply.

(A) If a collection system parallels a public water supply pipe the following requirements apply.

(i) A collection system pipe must be constructed of cast iron, ductile iron, or PVC meeting ASTM specifications with at least a 150 pounds per square inch (psi) pressure rating for both the pipe and joints.
(ii) A vertical separation must be at least two feet between the outside diameters of the pipes.
(iii) A horizontal separation must be at least four feet between outside diameters of the pipes.
(iv) A collection system pipe must be below a public water supply pipe.

(B) If a collection system pipe crosses a public water supply pipe, the following requirements apply:
(i) If a collection system is constructed of cast iron, ductile iron, or PVC with a minimum pressure rating of 150 psi, the following requirements apply:

(I) A minimum separation distance is six inches between outside diameters of the pipes.
(II) A collection system pipe must be below a public water supply pipe.
(III) Collection system pipe joints must be located as far as possible from an intersection with a public water supply line.

(ii) If a collection system pipe crosses under a public water supply pipe and the collection system pipe is constructed of acrylonitrile butadiene styrene (ABS) truss pipe, similar semi-rigid plastic composite pipe, clay pipe, or concrete pipe with gasketed joints, the following requirements apply:

(I) A minimum separation distance is two feet.
(II) If a collection system pipe is within nine feet of a public water supply pipe, the initial backfill around the collection system pipe must be:
   - (a) sand stabilized with two or more 80 pound bags of cement per cubic yard of sand for any section of collection system pipe within nine feet of a public water supply pipe.
   - (b) installed from one quarter of the diameter of the collection system pipe below the centerline of the collection system pipe to one pipe diameter (but not less than 12 inches) above the top of the collection system pipe.

(iii) If a collection system crosses over a public water supply pipe, one of the following procedures must be followed:

(I) Each portion of a collection system pipe within nine feet of a public water supply pipe must be constructed of cast iron, ductile iron, or PVC pipe with at least a 150 psi pressure rating using appropriate adapters.
(II) A collection system pipe must be encased in a joint of at least 150 psi pressure class pipe that is:
   - (a) centered on the crossing;
   - (b) sealed at both ends with cement grout or manufactured seal;
   - (c) at least 18 feet long;
   - (d) at least two nominal sizes larger than the wastewater collection pipe;
   and
   - (e) supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

(4) Public water supply pipe and collection system manhole separation.

(A) Unless collection system manholes and the connecting collection system pipe are watertight, as supported by leakage tests showing no leakage, they must be installed a minimum of nine feet of horizontal clearance from an existing or proposed public water supply pipe.
(B) If a nine-foot separation distance cannot be achieved, the requirements in paragraph (3) of this subsection apply.

(e) **Building laterals and taps.** Building laterals and taps on an installation must:

1. include a manufactured fitting that limits infiltration;
2. prevent protruding service lines; and
3. protect the mechanical and structural integrity of a wastewater collection system.

(f) **Bore or tunnel for crossings.** The spacing of supports for carrier pipe through casings must maintain the grade, slope, and structural integrity of a pipe as required by subsection (k) of this section.

(g) **Corrosion potential.**

1. If a pipe or an integral structural component of a pipe will deteriorate when subjected to corrosive internal conditions or if a pipe or component does not have a corrosive resistant liner installed by the pipe manufacturer, the report must demonstrate the structural integrity of a pipe during the minimum 50-year design life cycle.
2. A pipe must have an appropriate lining if the corrosion analysis indicates that corrosion will reduce the functional life of the pipe to less than 50 years.

(h) **Odor Control.**

1. An owner shall determine if odor control measures are necessary to prevent a wastewater collection system from becoming a nuisance, based upon the potential of the wastewater collection system to generate hydrogen sulfide.
2. A potential odor determination must include the estimated flows immediately following construction and throughout a system’s 50-year expected life cycle.

(i) **Active Geologic Faults.**

1. An owner shall identify any active faults within the area of a collection system and minimize the number of collection system lines crossing faults.

   (A) Where an active fault crossing is unavoidable, the report must specify design features that protect the integrity of a wastewater collection system in the event of movement of the fault.

   (B) If a collection system line cross an active fault line, the design must specify:

   1. joints that provide maximum deflection, as required in subsection (m) of this section; and
(ii) manholes on each side of the fault so that a portable pump may be used in the event of a wastewater collection system failure.

active fault.

(2) An owner shall not install a collection system service connection within 50 feet of an

(j) Capacity Analysis.

(1) An owner must ensure that a wastewater collection system’s capacity is sufficient to serve the estimated future population, including institutional, industrial, and commercial flows.

(2) An owner must include in the report the calculations that demonstrate that the hydraulic capacity of a collection system includes the peak flow of domestic sewage, peak flow of waste from industrial sites, and maximum infiltration rates.

(3) A collection system must be designed to prevent a surcharge in any pipe at the expected peak flow.

(4) The minimum diameter allowed for a gravity pipe is 6.0 inches.

(5) Connecting storm water drains to a collection system is prohibited.

(6) An owner may use the data from an existing collection system. In the absence of existing data, a design must use data from a similar system or as described in paragraph (7) of this subsection.

(7) New collection systems.

(A) The sizing of pipe for a new collection system must be based on an engineering analysis of initial and future flows.

(B) A new collection system design must be sized for the peak flow, which is based on the estimated daily sewage flow contribution as shown in Figure: 30 TAC §217.32(a)(3), Table B.1 of this title (relating to Organic Loadings and Flows).

(k) Structural Analysis.

(1) An owner must ensure that a collection system is designed to have a minimum structural life of 50 years.

(2) For flexible pipe, which is pipe that will deflect at least 2% without structural distress, used in a collection system, the report must include:
(A) live load calculations;
(B) allowable buckling pressure determinations;
(C) prism load calculations;
(D) wall crushing determinations;
(E) strain prediction calculations;
(F) calculations that quantify long term pipe deflection; and
(G) all information pertinent to a determination of an adequate design including, but not limited to:

(i) the method of determining the modulus of soil reaction for bedding material and
   in-situ material;
(ii) pipe diameter and material with reference to appropriate standards;
(iii) modulus of elasticity,
(iv) tensile strength,
(v) pipe stiffness or ring stiffness constant converted to pipe stiffness;
(vi) Leonhardt's zeta factor;
(vii) trench width;
(viii) depth of cover;
(ix) water table elevation; and
(x) unit weight of soil.

(3) The design procedure dictates a minimum pipe stiffness. For trench installations, the
design must specify a minimum stiffness requirement to ensure ease of handling, transportation, and
construction. Pipe stiffness must be related to ring stiffness constant by the following equation:

\[
PS = C \times RCS \times \left( \frac{8.337}{D} \right)
\]

Where:
PS = Pipe stiffness in pounds per square inch (psi)
C = Conversion factor, (0.80)
RCS = Ring stiffness constant
D = Mean pipe diameter in inches

(4) Pipe that meet all the requirements in this paragraph are not required to perform the
structural calculations in paragraph (3) of this subsection, provided that a pipe is installed and tested in
accordance with all other requirements of this subchapter:

(A) open trench design;
(B) flexible pipe with a pipe stiffness of 46 psi or greater;
(C) buried 17 feet or less;
(D) diameter of 12 inches or less;
(E) modulus of soil reaction for the in-situ soil of 200 psi or greater;
(F) no effects on a pipe due to live loads;
(G) a unit weight of soil of 120 pounds per cubic foot or less; or
(H) a pipe trench width of 36 inches or greater.

(5) A design analysis for rigid pipe installations must be included in the report, including a structural analysis and any details necessary to verify that the structural strength is sufficient to withstand the expected stresses. For rigid conduits, the minimum strength for each class of pipe material and the appropriate standard must be included.

(I) Minimum and Maximum Slopes.

(1) All wastewater collection systems must contain slopes sufficient to allow a velocity when flowing full of not less than 2.0 feet per second.

(2) Absent site-specific data, a collection system must be designed in accordance with the minimum and maximum slopes specified in this paragraph.

(A) The grades shown in the following table are based on Manning's formula with an assumed "n factor" of 0.013 and are the minimum acceptable slopes.

<table>
<thead>
<tr>
<th>Size of Pipe (inches)</th>
<th>Minimum Slope (%)</th>
<th>Maximum Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.50</td>
<td>12.35</td>
</tr>
<tr>
<td>8</td>
<td>0.33</td>
<td>8.40</td>
</tr>
<tr>
<td>10</td>
<td>0.25</td>
<td>6.23</td>
</tr>
<tr>
<td>12</td>
<td>0.20</td>
<td>4.88</td>
</tr>
<tr>
<td>15</td>
<td>0.15</td>
<td>3.62</td>
</tr>
<tr>
<td>18</td>
<td>0.11</td>
<td>2.83</td>
</tr>
<tr>
<td>21</td>
<td>0.09</td>
<td>2.30</td>
</tr>
<tr>
<td>24</td>
<td>0.08</td>
<td>1.93</td>
</tr>
<tr>
<td>27</td>
<td>0.06</td>
<td>1.65</td>
</tr>
<tr>
<td>30</td>
<td>0.055</td>
<td>1.43</td>
</tr>
<tr>
<td>33</td>
<td>0.05</td>
<td>1.26</td>
</tr>
<tr>
<td>36</td>
<td>0.045</td>
<td>1.12</td>
</tr>
<tr>
<td>39</td>
<td>0.04</td>
<td>1.01</td>
</tr>
<tr>
<td>&gt;39</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

* For pipes larger than 39 inches in diameter, the slope is determined by Manning's formula to maintain a velocity greater than 2.0 feet per second and less than 10.0 feet per second when flowing full.

(i) The minimum acceptable "n" value for design and construction is

(ii) The "n" value must take into consideration the slime, grit, and grease layers that will affect hydraulics or hinder flow as a pipe ages.
If a velocity greater than 10 feet per second will occur when a pipe flows full, based on Manning's formula, shown in the following figure, and an "n" value of 0.013, special provisions must protect against pipe and bedding displacement.

**Equation C.2. Manning’s Formula**

\[
v = \frac{1.49}{n} x R_h^{0.67} x \sqrt{S}
\]

Where:
- \( V \) = velocity (ft/sec)
- \( n \) = Manning’s roughness coefficient (0.013)
- \( R_h \) = hydraulic radius (ft)
- \( S \) = slope (ft/ft)

**Alignment.**

1. A gravity collection system must be laid with a uniform grade between manholes.
2. The report must justify any deviation from straight alignment by complying with the requirements of this section.
3. Deviation from uniform grade (e.g., grade breaks or vertical curves) without manholes and with open cut construction is prohibited.
4. The calculations for horizontal pipe curvature and the detail of the proposed curvature on the plans must be included in the report.
5. A construction method that flexes a pipe joint is prohibited, unless a joint deflection meets the least of the following:
   
   A. equal to 5 degrees;
   B. less than or equal to 80% of the manufacturer’s recommended maximum deflection; or
   C. 80% of the appropriate ASTM, AWWA, ANSI, or other nationally established standard for joint deflection.
6. The maximum allowable manhole spacing for collection systems with horizontal curvature is 300 feet. A manhole must be at the point of curvature and the point of termination of a curve.

**Inverted Siphons and Sag Pipes.**

1. A sag pipe must include:

   A. two or more barrels;
(B) a minimum pipe diameter of 6.0 inches; and
(C) the necessary appurtenances for convenient flushing and maintenance.

(2) A manhole must include adequate clearance for rodding and cleaning.

(3) Sag pipes must be sized and designed with sufficient head to achieve a velocity of at least 3.0 feet per second at initial and design flows.

(4) The arrangement of inlet and outlet details must divert the normal flow to one barrel.

(5) A system must allow any barrel to be taken out of service for cleaning.

(6) Provisions must be made to allow cleaning across each bend with equipment available to the entity operating the collection system.

(7) Sag pipe must be designed to minimize nuisance odors.

(8) Inverted siphons and sag pipes must be pressure tested according to the requirement of 2.1.7 of this title (relating to Testing Requirements for Installation of Gravity Collection System Pipes).

(o) Bridged Sections.

(1) Pipe with restrained joints or monolithic pipe across a bridged section requires a manhole on each end.

(2) A bridged section must withstand the hydraulic forces applied by the occurrence of a 100-year flood event for a collection system site, including buoyancy.

(3) A bridged section must be capable of withstanding impacts from debris.

(4) Bank sections must be stabilized to prevent erosion.

(5) Bridge supports must be designed to ensure that a pipe has adequate grade, slope, and structural integrity.

2.1.4. Criteria for Laying Pipe.

(a) Pipe Embedment.

(1) A rigid pipe must be laid with the adequate bedding, haunching, and initial backfill to support the anticipated load. The bedding classes that are allowed are A, B, or C, as described in American Society for Testing and Materials (ASTM) C 12, American National Standards Institute (ANSI) A 106.2, Water Environment Federation Manual of Practice No. 9 or American Society of Civil Engineers (ASCE) MOP 37.
(2) A flexible pipe must be laid with the adequate bedding, haunching, and initial backfill to support the anticipated load. The bedding classes that are allowed are IA, IB, II, or III, as described in ASTM D-2321 or ANSI K65.171.

(3) Debris, large clods, or stones that are greater than six inches in diameter, organic matter, or other unstable materials are prohibited as bedding, haunching, or initial backfill.

(4) Backfill must not disturb the alignment of a collection system pipe.

(5) If trenching encounters significant fracture, fault zones, caves, or solutional modification to the rock strata, an owner must halt construction until an engineer prepares a written report detailing how construction will accommodate these site conditions.

(b) Compaction.

(1) Compaction of an embedment envelope must meet the manufacturer's recommendations for the collection system pipe used in a project.

(2) Compaction of an embedment envelope must provide the modulus of soil reaction for the bedding material necessary to ensure a wastewater collection system pipe's structural integrity as required by §217.53 of this title (relating to Pipe Design).

(3) The placement of the backfill above a pipe must not affect the structural integrity of a pipe.

(c) Envelope Size.

(1) A minimum clearance of 6.0 inches below and on each side of the bell of all pipes to the trench walls and floor is required.

(2) The embedment material used for haunching and initial backfill must be installed to a minimum depth of 12 inches above the crown of a pipe.

(d) Trench Width.

(1) The width of a trench must allow a pipe to be laid and jointed properly and must allow the backfill to be placed and compacted as needed.

(2) The maximum and minimum trench width needed for safety and a pipe's structural integrity must be included in the report.

(3) The width of a trench must be sufficient to properly and safely place and compact haunching materials.
(4) The space between a pipe and a trench wall must be wider than the compaction equipment used in the pipe zone.

### TRENCH CROSS-SECTION SHOWING TERMINOLOGY

2.1.5. **Manholes and Related Structures.**

(a) An owner must include manholes in a wastewater collection system at:

1. all points of change in alignment, grade, or size;
2. at the intersection of all pipes; and
3. at the end of all pipes that may be extended at a future date.

(b) Manholes placed at the end of a wastewater collection system pipe that may be extended in the future must include pipe stub outs with plugs.

(c) A clean-out with watertight plugs may be installed in lieu of a manhole at the end of a wastewater collection system pipe if no extensions are anticipated.
(d) Cleanout installations must pass all applicable testing requirements outlined for gravity collection pipes in 2.1.7. of this title (relating to Testing Requirements for Installation of Gravity Collection System Pipes).

(e) A manhole must be made of monolithic, cast-in-place concrete, fiberglass, pre-cast concrete, high-density polyethylene, or equivalent material that provides adequate structural integrity.

(f) The use of bricks to adjust a manhole cover to grade or construct a manhole is prohibited.

(g) Manholes may be spaced no further apart than the distances specified in the following table for a wastewater collection system with straight alignment and uniform grades, unless a variance based on the availability of cleaning equipment that is capable of servicing greater distances is granted by the executive director.

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Maximum Manhole Spacing (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-15</td>
<td>500</td>
</tr>
<tr>
<td>18-30</td>
<td>800</td>
</tr>
<tr>
<td>36-48</td>
<td>1000</td>
</tr>
<tr>
<td>54 or larger</td>
<td>2000</td>
</tr>
</tbody>
</table>

(h) Tunnels are exempt from manhole spacing requirements because of construction constraints.

(i) An intersection of three or more collection pipes must have a manhole.

(j) A manhole must not be located in the flow path of a watercourse, or in an area where ponding of surface water is probable.

(k) The inside diameter of a manhole must be no less than 48 inches. A manhole diameter must be sufficient to allow personnel and equipment to enter, exit, and work in the manhole and to allow proper joining of the collection system pipes in the manhole wall.

(l) Manholes must meet the following requirements for covers, inlets, and bases.

   (1) Manhole Covers.

       (A) A manhole where personnel entry is anticipated requires at least a 30 inch diameter clear opening.
       (B) A manhole located within a 100-year flood plain must have a means of preventing inflow.
       (C) A manhole cover construction must be constructed of impervious material.
(D) A manhole cover that is located in a roadway must meet or exceed the American Association of State Highways and Transportation Officials standard M-306 for load bearing.

(2) Manhole Inverts.

(A) The bottom of a manhole must contain a U-shaped channel that is a smooth continuation of the inlet and outlet pipes.
(B) A manhole connected to a pipe less than 15 inches in diameter must have a channel depth equal to at least half the largest pipe’s diameter.
(C) A manhole connected to a pipe at least 15 inches in diameter but not more than 24 inches in diameter must have a channel depth equal to at least three-fourths of the largest pipe’s diameter.
(D) A manhole connected to a pipe greater than 24 inches in diameter must have a channel depth equal to at least the largest pipe’s diameter.
(E) A manhole with pipes of different sizes must have the tops of the pipes at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe.
(F) A bench provided above a channel must slope at a minimum of 0.5 inch per foot.
(G) An invert must be filleted to prevent solids from being deposited if a wastewater collection system pipe enters a manhole higher than 24 inches above a manhole invert.
(H) A wastewater collection system pipe entering a manhole more than 24 inches above an invert must have a drop pipe.

(m) The inclusion of steps in a manhole is prohibited.

(n) Connections. A manhole-pipe connection must use watertight, size-on-size resilient connectors that allow for differential settlement and must conform to American Society for Testing and Materials C-923.

(o) Venting. An owner must use an alternate means of venting if manholes are at more than 1,500 foot intervals and gasketed manhole covers are required for more than three manholes in sequence. Vents must meet the following requirements:

(1) Vent design must minimize inflow;
(2) Vents must be located above a 100-year flood event elevation; and
(3) Tunnels must be vented in compliance with this subsection.

(p) Cleanouts. The size of a cleanout must be equal to the size of the wastewater collection system main.

2.1.6. Trenchless Pipe Installation.
(a) The following trenchless technologies may be used for installation of new wastewater collection system pipe:

1. Impact moling, which is a technique that launches a percussive soil displacement hammer (mole) from an excavation to displace soil and form a bore. The new pipe is drawn behind the mole or pulled into the bore using the hammer's reverse action. A pneumatically driven mole displaces the soil by the action of a percussive piston;

2. Pipe ramming, which is a simple technique using a pneumatic hammer to drive steel casings through the ground from one pit to another; or

3. Microtunneling, which is a remotely controlled mechanical tunneling system where the spoil is removed from the cutting head within the new pipeline, which is advanced by pipe jacking. The cutting head must have the appropriate cutting tools and crushing devices for the range of gravels, sands, silts, and clays that may be found at the collection system site.

(b) The following trenchless technologies may be used for replacement of wastewater collection system pipe:

1. Pipe bursting, which is a method of on-line replacement of fracturable pipe. An expanding device, either pneumatic or hydraulic, is introduced into the defective pipeline, shattering the pipe and drawing in the new pipe behind it. Insertion of short lengths may be made from pits but this involves jointing of the pipeline within the pit;

2. Pipe splitting, which is similar in technique to pipe bursting but is used on non-fragmental pipes such as steel, ductile iron or polyethylene. The system uses specialized splitting heads designed to cut through the pipe wall and joints and expand the existing pipe into the surrounding ground; or

3. Pipe eating, which is an on-line microtunnelled replacement technique. The existing defective pipeline is crushed (or eaten), by the tunneling machine and removed through the new pipeline. It is used predominantly on concrete sewer installations. This system allows for size replacement and upsizing.

(c) The following trenchless technologies may be used for lining of existing wastewater collection system pipe, which reduces the inside diameter of the pipe:

1. Cement mortar lining, which is the application of a cement mortar (typically about four millimeters thick) to the inside of a pipe to protect against corrosion;

2. Epoxy spray lining, which is a method of lining pipes with a thin lining of resin (typically about one millimeter thick) that is sprayed onto the interior surface of a cleaned collection system pipe to isolate the pipe from the wastewater and possibly reinforce the structural capabilities of the pipe;
(3) cure in place pipe, which is method of lining existing pipe with a flexible tube impregnated with a resin that produces a pipe after the resin cures. The resin may be set by the use of heat or ultraviolet light; or

(4) sliplining, by which continuous or discreet pipes are inserted within existing pipes.

(d) Any other trenchless method of installing, replacing, or repairing collection system pipe is nonconforming technology and subject to the requirements of §217.7(b) of this title (relating to Types of Plans and Specifications Approvals).

(e) A wastewater collection system using a trenchless technology must be designed, installed, and constructed in accordance with American Society for Testing and Materials (ASTM) or American Water Works Association (AWWA) standards with reference to materials used and construction procedures. In the absence of ASTM or AWWA standards, executive director review may be based upon other recognized standards utilized by industry engineers.

(f) The report must include the following:

(1) the trenchless method;
(2) the type of pipe;
(3) the type(s) of soil;
(4) the pipe length and diameter;
(5) pipe slope;
(6) the method for disconnecting and reconnecting lateral and service connections;
(7) the provisions for flow bypass for existing system; and
(8) the pipe standard.

(g) The method for disconnecting and reconnecting lateral and service connections must be included in the report.

(h) Pipe installed by a trenchless technology is subject to the testing requirements in 2.1.7 of this title (relating to Testing Requirements for Installation of Gravity Collection System Pipes) and 2.1.18 of this title (relating to Force Main Testing).

2.1.7. Testing Requirements for Installation of Gravity Collection System Pipes.
For a collection system pipe that will transport wastewater by gravity flow, the design must specify an infiltration and exfiltration test or a low-pressure air test. A test must conform to the following requirements:

1. **Low Pressure Air Test.**

   (A) A low pressure air test must follow the procedures described in American Society For Testing And Materials (ASTM) C-828, ASTM C-924, or ASTM F-1417 or other procedure approved by the executive director, except as to testing times as required in Table C.3 in subparagraph (B)(ii) of this paragraph or Equation 3.c in subparagraph (C) of this paragraph.

   (B) For sections of collection system pipe less than 36 inch average inside diameter, the following procedure must apply, unless a pipe is to be tested as required by paragraph (2) of this subsection.

   (i) A pipe must be pressurized to 3.5 pounds per square inch (psi) greater than the pressure exerted by groundwater above the pipe.

   (ii) Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge is computed from the following equation:

   **Equation C.3.**

   \[
   T = \frac{(0.085xDxK)}{Q}
   \]

   Where:
   
   \( T \) = time for pressure to drop 1.0 pound per square inch gauge in seconds
   \( K \) = 0.000419xLxL, but not less than 1.0
   \( D \) = average inside pipe diameter in inches
   \( L \) = length of same pipe size being tested, in feet
   \( Q \) = rate of loss, 0.0015 cubic feet per minute per square foot internal surface

   (C) Since a K value of less than 1.0 may not be used, the minimum testing time for each pipe diameter is shown in the following table:
Table C.3. - Minimum Testing Times for Low-Pressure Air Test

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Minimum Time (seconds)</th>
<th>Maximum Length for Minimum Time (feet)</th>
<th>Time for Longer Length (seconds/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>340</td>
<td>398</td>
<td>0.855</td>
</tr>
<tr>
<td>8</td>
<td>454</td>
<td>298</td>
<td>1.520</td>
</tr>
<tr>
<td>10</td>
<td>567</td>
<td>239</td>
<td>2.374</td>
</tr>
<tr>
<td>12</td>
<td>680</td>
<td>199</td>
<td>3.419</td>
</tr>
<tr>
<td>15</td>
<td>850</td>
<td>159</td>
<td>5.342</td>
</tr>
<tr>
<td>18</td>
<td>1020</td>
<td>133</td>
<td>7.693</td>
</tr>
<tr>
<td>21</td>
<td>1190</td>
<td>114</td>
<td>10.471</td>
</tr>
<tr>
<td>24</td>
<td>1360</td>
<td>100</td>
<td>13.676</td>
</tr>
<tr>
<td>27</td>
<td>1530</td>
<td>88</td>
<td>17.309</td>
</tr>
<tr>
<td>30</td>
<td>1700</td>
<td>80</td>
<td>21.369</td>
</tr>
<tr>
<td>33</td>
<td>1870</td>
<td>72</td>
<td>25.856</td>
</tr>
</tbody>
</table>

(D) An owner may stop a test if no pressure loss has occurred during the first 25% of the calculated testing time.
(E) If any pressure loss or leakage has occurred during the first 25% of a testing period, then the test must continue for the entire test duration as outlined above or until failure.
(F) Wastewater collection system pipes with a 27 inch or larger average inside diameter may be air tested at each joint instead of following the procedure outlined in this section.
(G) A testing procedure for pipe with an inside diameter greater than 33 inches must be approved by the executive director.

(2) Infiltration/Exfiltration Test.

(A) The total exfiltration, as determined by a hydrostatic head test, must not exceed 50 gallons per inch of diameter per mile of pipe per 24 hours at a minimum test head of 2.0 feet above the crown of a pipe at an upstream manhole.
(B) An owner shall use an infiltration test in lieu of an exfiltration test when pipes are installed below the groundwater level.
(C) The total exfiltration, as determined by a hydrostatic head test, must not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of two feet above the crown of a pipe at an upstream manhole, or at least two feet above existing groundwater level, whichever is greater.
(D) For construction within a 25-year flood plain, the infiltration or exfiltration must not exceed 10 gallons per inch diameter per mile of pipe per 24 hours at the same minimum test head as in subparagraph (C) of this paragraph.
(E) If the quantity of infiltration or exfiltration exceeds the maximum quantity specified, an owner shall undertake remedial action in order to reduce the infiltration or exfiltration to an amount within the limits specified. An owner shall retest a pipe following a remediation action.
(b) If a gravity collection pipe is composed of flexible pipe, deflection testing is also required. The following procedures must be followed:

(1) For a collection pipe with inside diameter less than 27 inches, deflection measurement requires a rigid mandrel.

(A) Mandrel Sizing.

(i) A rigid mandrel must have an outside diameter (OD) not less than 95% of the base inside diameter (ID) or average ID of a pipe, as specified in the appropriate standard by the ASTM, American Water Works Association, UNI-BELL, or American National Standards Institute, or any related appendix.

(ii) If a mandrel sizing diameter is not specified in the appropriate standard, the mandrel must have an OD equal to 95% of the ID of a pipe. In this case, the ID of the pipe, for the purpose of determining the OD of the mandrel, must equal be the average outside diameter minus two minimum wall thicknesses for OD controlled pipe and the average inside diameter for ID controlled pipe.

(iii) All dimensions must meet the appropriate standard.

(B) Mandrel Design.

(i) A rigid mandrel must be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed.

(ii) A mandrel must have nine or more odd number of runners or legs.

(iii) A barrel section length must equal at least 75% of the inside diameter of a pipe.

(iv) Each size mandrel must use a separate proving ring.

(C) Method Options.

(i) An adjustable or flexible mandrel is prohibited.

(ii) A test may not use television inspection as a substitute for a deflection test.

(iii) If requested, the executive director may approve the use of a deflectometer or a mandrel with removable legs or runners on a case-by-case basis.

(2) For a gravity collection system pipe with an inside diameter 27 inches and greater, other test methods may be used to determine vertical deflection.

(3) A deflection test method must be accurate to within plus or minus 0.2% deflection.

(4) An owner shall not conduct a deflection test until at least 30 days after the final backfill.

(5) Gravity collection system pipe deflection must not exceed five percent (5%).

(6) If a pipe section fails a deflection test, an owner shall correct the problem and conduct a second test after the final backfill has been in place at least 30 days.

(7) An owner shall not use any mechanical pulling devices during testing.

(8) An owner shall include a certification in the construction report or the notice of completion required in §217.14 of this title (relating to Completion Notice), that the wastewater collection system passed the deflection tests.
(c) An owner of a collection system must inspect the structural analysis of collection system under the direction of an engineer during the construction and testing phases of the project.

2.1.8. Testing Requirements for Manholes.

(a) All manholes must pass a leakage test.

(b) An owner shall test each manhole (after assembly and backfilling) for leakage, separate and independent of the collection system pipes, by hydrostatic exfiltration testing, vacuum testing, or other method approved by the executive director.


(A) The maximum leakage for hydrostatic testing or any alternative test methods is 0.025 gallons per foot diameter per foot of manhole depth per hour.
(B) To perform a hydrostatic exfiltration test, an owner shall seal all wastewater pipes coming into a manhole with an internal pipe plug, fill the manhole with water, and maintain the test for at least one hour.
(C) A test for concrete manholes may use a 24-hour wetting period before testing to allow saturation of the concrete.


(A) To perform a vacuum test, an owner shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering a manhole.
(B) No grout must be placed in horizontal joints before testing.
(C) Stub-outs, manhole boots, and pipe plugs must be secured to prevent movement while a vacuum is drawn.
(D) An owner shall use a minimum 60 inch/lb torque wrench to tighten the external clamps that secure a test cover to the top of a manhole.
(E) A test head must be placed at the inside of the top of a cone section, and the seal inflated in accordance with the manufacturer’s recommendations.
(F) There must be a vacuum of 10 inches of mercury inside a manhole to perform a valid test.
(G) A test does not begin until after the vacuum pump is off.
(H) A manhole passes the test if after 2.0 minutes and with all valves closed, the vacuum is at least 9.0 inches of mercury.

2.1.9. Lift Station Site Requirements.

(a) Site access.

1. A lift station design must include an access road located in a dedicated right-of-way or a permanent easement.
(2) A road surface must have a minimum width of 12 feet and must be constructed for use in all weather conditions.

(3) A road surface must be above the water level caused by a 25-year rainfall event.

(b) Security.

(1) The design of a lift station, including all mechanical and electrical equipment, must restrict access by an unauthorized person.

(2) A lift station must include an intruder-resistant fence, enclosure, or a lockable structure.

(3) An intruder-resistant fence must use a minimum of a 6.0 feet high chain link, masonry, or board fence with at least three strands of barbed wire or 8.0 feet high chain link, masonry, or board fence with at least one strand of barbed wire.

(c) Flood Protection. The design of a lift station, including all electrical and mechanical equipment, must be designed to withstand and operate during a 100-year flood event, including wave action.

(d) Odor Control. The design of a lift station must minimize potential odor. An owner shall include any design for odor control in the report.

### 2.1.10. Lift Station, Wet Well, and Dry Well Designs.

(a) Pump Controls.

(1) A lift station pump must operate automatically, based on the water level in a wet well.

(2) The location of a wet well level mechanism must ensure that the mechanism is unaffected by currents, rags, grease, or other floating materials.

(3) A level mechanism must be accessible without entering the wet well.

(4) Wet well controls with a bubbler system require dual air supply and dual controls.

(5) Motor control centers must be mounted at least 4.0 inches above grade to prevent water intrusion and corrosion from standing water in the enclosure.

(6) Electrical equipment and electrical connections in a wet well or a dry well must meet National Fire Prevention Association 70 National Electric Code explosion prevention requirements, unless continuous ventilation is provided.

(b) Wet Wells.

(1) A wet well must be enclosed by watertight and gas tight walls.

(2) A penetration through a wall of a wet well must be gas tight.

(3) A wet well must not contain equipment requiring regular or routine inspection or maintenance, unless inspection and maintenance can be done without staff entering the wet well.

(4) A gravity pipe discharging to a wet well must be located so that the invert elevation is above the liquid level of a pump's "on" setting.

(5) Gate valves and check valves are prohibited in a wet well.

(6) Gate valves and check valves may be located in a valve vault next to a wet well or in a dry well.
(7) Pump cycle time, based on peak flow, must equal or exceed those in the following table:

<table>
<thead>
<tr>
<th>Pump Horsepower</th>
<th>Minimum Cycle Times (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>6</td>
</tr>
<tr>
<td>50-100</td>
<td>10</td>
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<tr>
<td>&gt; 100</td>
<td>15</td>
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</tbody>
</table>

(8) An evaluation of minimum wet well volume requires the following formula:

\[ V = \frac{7.48 \times T \times Q}{4} \]

Where:
- \( V \) = Active volume (cubic feet)
- \( Q \) = Pump capacity (gallons per minute)
- \( T \) = Cycle time (minutes)
- 7.48 = Conversion factor (gallons/cubic foot)

(c) Dry well access.

1. An underground dry well must be accessible.
2. A stairway in a dry well must use non-slip steps and conform to Occupational Safety and Health Administration regulations with respect to rise and run.
3. A ladder in a dry well must made of non-conductive material and rated for the load necessary for staff and equipment to descend and ascend.

(d) Lift Station Ventilation.

1. Passive Ventilation for Wet Wells.
   
   (A) Passive ventilation structures must include screening to prevent the entry of birds and insects to a wet well.
   (B) All mechanical and electrical equipment in a wet well with passive ventilation must be constructed in compliance with explosion requirements in the National Fire Protection Association 70 National Electric Code.
   (C) A passive ventilation system must be sized to vent at a rate equal to the maximum pumping rate of a lift station, but not to exceed 600 feet per minute through a vent pipe.
   (D) The minimum acceptable diameter for an air vent is 4.0 inches.
   (E) A vent outlet must be at least 1.0 foot above a 100-year flood plain elevation.

(A) Dry Wells.

(i) A dry well must use mechanical ventilation.
(ii) Ventilation equipment under continuous operation must have a minimum capacity of six air exchanges per hour.
(iii) Ventilation equipment under intermittent operations must have a minimum capacity of 30 air exchanges per hour and be connected to a lift station's lighting system.

(B) Wet Wells.

(i) A wet well must use continuous mechanical ventilation.
(ii) The ventilation equipment must have a minimum capacity of 12 air exchanges per hour and be constructed of corrosion resistant material.
(iii) The design of a wet well must reduce odor potential in a populated area.

(e) Wet Well Slopes.

(1) A wet well floor must have a smooth finish and minimum slope of 10% to a pump intake.
(2) A wet well design must prevent deposition of solids under normal operating conditions.
(3) A lift station with greater than 5.0 million gallons per day firm pumping capacity must have anti-vortex baffling.

(f) Hoisting Equipment. A lift station must have permanent hoisting equipment or be accessible to portable hoisting equipment for removal of pumps, motors, valves, pipes, and other similar equipment.

(g) Valve Vault Drains. A floor drain from a valve vault to a wet well must prevent gas from entering a valve vault by including flap valves, "P" traps, submerged outlets, or a combination of these devices.

(h) Dry Well Sump Pumps.

(1) Pumps.

(A) A dry well must use dual sump pumps, each with a minimum capacity of 1,000 gallons per hour and capable of handling the volume of liquid generated during peak operations.
(B) A pump must have a submersible motor and watertight wiring.
(C) A dry well floor must slope toward a sump sized for proper drainage.
(D) The minimum sump depth is 6.0 inches and must prevent standing water on a dry well floor under normal operation.
(E) A sump pump must operate automatically by use of a float switch or other level-detecting device.

(2) Pipes.

(A) A sump pump must use separate pipes capable of discharging more than the maximum liquid level of an associated wet well.
(B) A sump pump outlet pipe must be at least 1.5 inches in diameter and have at least two check valves in series.

2.1.11. Lift Station Pumps.

(a) General Requirements. A raw wastewater pump, with the exception of a grinder pump, must:

(1) be designed to prevent clogging;
(2) be capable of passing a sphere of 2.5 inches in diameter or greater; and
(3) have greater than 3.0 inch diameter suction and discharge openings.

(b) Submersible and Non-submersible Pumps.

(1) A non-submersible pump must have inspection and cleanout plates on both the suction and discharge sides of each pumping unit that facilitate locating and removing blockage-causing materials, unless the pump design accommodates easy removal of the rotation elements.
(2) A pump support must prevent movement and vibration during operation.
(3) A submersible pump must use a rail-type pump support system with manufacturer-approved mechanisms designed to allow personnel to remove and replace any single pump without entering or dewatering the wet well.
(4) Submersible pump rails and lifting chains must be constructed of a material that performs to at least the standard of Series 300 stainless steel.

(c) Lift Station Pumping Capacity. The firm pumping capacity of a lift station must handle the expected peak flow.

(d) Pump Head Calculations.

(1) An owner shall select a pump based upon analysis of the system head and pump capacity curves that determine the pumping capacities alone and with other pumps as the total dynamic-head increases due to additional flows pumped through a force main.
(2) The pipe head loss calculations, using the Hydraulic Institute Standards, pertaining to head losses through pipes, valves, and fittings, must be included in the report.
(3) The selected friction coefficient (Hazen-Williams "C" value) used in friction head loss calculations must be based on the pipe material selected.
(4) For a lift station with more than two pumps, a force main in excess of one-half mile, or firm pumping capacity of 100 gallons per minute or greater, system curves must be provided for both the normal and peak operating conditions at C values for proposed and existing pipe.

(e) Flow Control.

(1) A lift station or a transfer pumping station located at or discharging directly to a wastewater treatment system must have a peak pump capacity equal to or less than the peak design flow, unless equalization is provided.
A wastewater treatment system with a peak flow that is greater than 300,000 gallon per day must use three or more pumps, unless duplex, automatically controlled, variable capacity pumps are provided.

(f) Self-Priming Pumps.

(1) A self-priming pump must be capable of priming without reliance upon a separate priming system, an internal flap valve, or any external means for priming.
(2) A self-priming pump must use a suction pipe velocity at least 3.0 feet per second but not more than 7.0 feet per second, and must incorporate its own suction pipe.
(3) A self-priming pump must vent air back into the wet well during priming.

(g) Vacuum-Priming Pumps.

(1) A vacuum-primed pump must be capable of priming by using a separate positive priming system with a dedicated vacuum pump for each main wastewater pump.
(2) A vacuum-priming pump must use a suction pipe velocity at least 3.0 feet per second but less than 7.0 feet per second and must have its own suction pipe.

(h) Vertical Positioning of Pumps. A raw wastewater pump must have positive static suction head during normal on-off cycling, except a submersible pump with "no suction" pipes, a vacuum-primed pump, or a self-priming unit capable of satisfactory operation under any negative suction head anticipated for the lift station.

(i) Individual Grinder Pumps. A grinder pump serving only one residential or commercial structure that is privately owned, maintained, and operated is not subject to the rules of this chapter.

(j) Pump for Low-Flow Lift Station. A pump used for a lift station with a peak flow of less than 120 gallons per minute must be submersible and include a grinder.

2.1.12 Lift Station Pipes.

(a) Horizontal Pump Suctions.

(1) Each pump must have a separate suction pipe that uses an eccentric reducer.
(2) Pipes in a wet well must have a turndown type flared intake.

(b) Valves.

(1) The discharge side of each pump followed by a full-closing isolation valve must also have a check valve.

(A) A check valve must be a swing type valve with an external lever.
(B) A valve must include a position indicator to show its open and closed positions, unless a full-closing valve is a rising-stem gate valve.
(2) A grinder pump installation may use a rubber-ball check valve or a swing-type check valve.

(3) A butterfly valve, tilting-disc check valve, or any other valve using a tilting-disc in a flow pipe is prohibited.

(c) Pipes.

(1) A lift station pipe must have flanged or flexible connections to allow for removal of pumps and valves without interruption of the lift station operations.

(2) Wall penetrations must allow for pipe flexure while excluding exfiltration or infiltration.

(3) Pipe suction velocities must be at least 3.0 feet per second but not more than 7.0 feet per second.


(a) A collection system lift station must be equipped with a tested quick-connect mechanism or a transfer switch properly sized to connect to a portable generator, if not equipped with an onsite generator.

(b) Lift stations must include an audiovisual alarm system and the system must transmit all alarm conditions through use of an auto-dialer system, Supervisory Control and Data Acquisition system, or telemetering system connected to a continuously monitored location.

(c) An alarm system must self-activate for a power outage, pump failure, or a high wet well water level.

(d) A lift station constructed to pump raw wastewater must have service reliability based on:

(1) Retention Capacity.

(A) The retention capacity in a lift station's wet well and incoming gravity pipes must prevent discharges of untreated wastewater at the lift station or any point upstream for a period of time equal to the longest electrical outage recorded during the past 24 months, but not less than 20 minutes.

(B) For calculation purposes, the outage period begins when a lift station pump finished its last normal cycle, excluding a standby pump.

(2) On-Site Generators. A lift station may be provided emergency power by on-site, automatic electrical generators sized to operate the lift station at its firm pumping capacity or at the average daily flow, if the peak flow can be stored in the collection system.

(3) Portable Generators and Pumps.

(A) A lift station may use portable generators and pumps to guarantee service if the report includes:

(i) the storage location of each generator and pump;
(ii) the amount of time that will be needed to transport each generator or pump to a lift station;
(iii) the number of lift stations for which each generator or pump is dedicated as a backup; and
(iv) the type of routine maintenance and upkeep planned for each portable generator and pump to ensure that they will be operational when needed.

(B) An operator that is knowledgeable in operation of the portable generators and pumps shall be on call 24 hours per day every day.

(C) The size of a portable generator must handle the firm pumping capacity of the lift station.

(e) Spill Containment Structures.

(1) The use of a spill containment structure as a sole means of providing service reliability is prohibited.
(2) A lift station may use a spill containment structure in addition to one of the service reliability options detailed in this subsection (a) of this section.
(3) The report must include a detailed management plan for cleaning and maintaining each spill containment structure.
(4) A spill containment structure must have a locked gate and be surrounded an intruder resistant fence that is 6.0 feet high chain link, masonry, or board fence with at least three strands of barbed wire or 8.0 feet high chain link, masonry, or board fence with at least one strand of barbed wire.

(f) A lift station must be fully accessible during a 25-year 24-hour rainfall event.

(g) Lift station system controls must prevent over-pumping upon resumption of normal power after a power failure. Backup or standby units must be electrically interlocked to prevent operation at the same time that other lift stations pumps are operating only on the resumption of normal power after a power failure.


(a) Force main pipe material must withstand the pressure generated by instantaneous pump stoppage due to power failure under maximum pumping conditions.

(b) The use of pipe or fittings rated at a working pressure of less than 150 pounds per square inch is prohibited.

(c) Pipe must be identified in the technical specifications with the appropriate specification number for both quality control and installation from the American Society For Testing And Materials, American National Standards Institute, or American Water Works Association.

(d) Pipe material specified for a force main must have an expected life equal to or longer than that of the lift station and must be suitable for the material being pumped.
2.1.15. Force Main Pipe Joints.

(a) An underground force main pipe joint must include either push-on rubber gaskets or mechanical joints with a pressure rating equal or greater than the force main pipe material.

(b) Exposed force main pipe joints must be flanged or flexible and adequately secured to prevent movement due to surges.

(c) American Society for Testing and Materials, American Water Works Association, or other widely accepted national reference standard for the joints must be included in the project specifications.

2.1.16. Identification of Force Main Pipes.

(a) A detector tape must be laid in the same trench as a force main pipe. The detector tape must be located above and parallel to the force main.

(b) The detector tape must bear the label "PRESSURIZED WASTEWATER" continuously repeated in at least 1.5 inch letters.

2.1.17. Force Main Design.

(a) Velocities.

(1) A force main must be a minimum of 4.0 inches in diameter, unless it is used in conjunction with a grinder pump station.

(2) For a duplex pump station, the minimum velocity is 3.0 feet per second with one pump in operation.

(3) For a pump station with three or more pumps:

   (A) the minimum velocity in a force main is 2.0 feet per second with only the smallest pump in operation; and
   (B) a minimum flushing velocity of 5.0 feet per second or greater must occur in a force main at least once daily.

(4) The report must certify that a pipeline with a velocity greater than 6.0 feet per second can withstand high and low negative surge pressures in event of sudden pump failure.

(b) Detention Time.

(1) A force main detention time calculations must be included in the report.

(2) The force main detention time calculations must be performed using a range of flow rates that represent the flows expected to be delivered to a force main by an upstream pump station during any 24-hour period.
(c) Water Hammer. A force main design must include surge control measures to manage pressure due to water hammer that may exceed the working strength of a force main pipe.

(d) Connection to Gravity Main.

1. A force main must terminate in an appropriate structure and either at a manhole on the wastewater collection system or at a wastewater treatment facility.
2. The discharge end of a force main inside a manhole must remain steady and produce non-turbulent flow.
3. A receiving wastewater collection system must accept the maximum pump discharge without surcharging.

(e) Pipe Separation. A separation distance between a force main and any water supply water pipe must meet the minimum separation requirements established in §217.53(d) of this title (relating to Pipe Design).

(f) Odor Control.

1. A force main must terminate below a manhole invert with the top of the pipe matching the water level in the manhole at design flow.
2. A force main must be designed to abate any anticipated odor.

(g) Air Release Valves in Force Mains.

1. Any high point along the vertical force main alignment must include an air release valve or a combination of air release and air vacuum valves.
2. An air release valve must have an isolation valve between the air release valve and the force main.
3. An air release valve must be inside of a vault that is at least 48 inches in diameter and has a vented access opening at least 30 inches in diameter.

(h) Valves. A force main must have valves spaced at no more than 2,000 foot intervals to facilitate initial testing and subsequent maintenance and repairs.

2.1.18. Force Main Testing.

(a) The final plans and specifications must include the pressure testing procedures.

(b) A pressure test must use 50 pounds per square inch above the normal operating pressure of a force main.

(c) A temporary valve for pressure testing may be installed near the discharge point of a force main and removed after a test is successfully completed.
(d) A pump isolation valve may be used as an opposite termination point.

(e) A test must involve filling a force main with water.

(f) A pipe must hold the designated test pressure for a minimum of 4.0 hours.

(g) The leakage rate must not exceed 10.0 gallons per inch diameter per mile of pipe per day.


(a) In accordance with §217.6 of this title (relating to Submittal Requirements and Review Process), the design of a distribution system that will convey reclaimed water to a user must be submitted, reviewed, and approved by the executive director before the distribution system may be used.

(b) A municipality may be the review authority in accordance with §217.8 of this title (relating to Municipality Reviews), and may approve a reclaimed water distribution system.

(c) A distribution system designed to transport Type II reclaimed water, as defined by §210.33(2) of this title (relating to Quality Standards for Using Reclaimed Water), must comply with Subchapter C of this chapter (relating to Conventional Collection Systems), as applicable to the project.

(d) A distribution system designed to transport Type I reclaimed water, as defined by §210.33 of this title must meet the following requirements:

(1) Type I reclaimed water gravity pipes must comply with 2.1.3 – 2.1.5, 2.1.8, and 2.1.9. of this title (relating to Pipe Design; Criteria for Laying Pipe; Manholes and Related Structures; Testing Requirements for Manholes; and Lift Station Site Requirements).

(2) A design must prevent pipe and bedding displacement.

(3) The design of a pipe must prevent the deposition of solids in a gravity pipe.

(e) Each appurtenance designed to handle reclaimed water must be identified.

(1) An above-ground hose bib, spigot, or other hand-operated connection is prohibited, excepted in secured areas of a facility that only trained staff has access to.

(2) An underground hose bib must be:

(A) located in locked, below-grade vaults, and clearly labeled "NON-POTABLE WATER"; or

(B) operated only by a special tool in non-lockable, underground service boxes clearly labeled as non-potable water;

(C) purple; and

(D) designed to prevent a connection to a standard water hose.
(3) Storage areas, hose bibs, and faucets must include signs in both English and Spanish reading "NON-POTABLE WATER, DO NOT DRINK" and "El AGUA NO-POTABLE, NO BEBE."

(f) Cross Connection Control and Separation Distances.

(1) A type I reclaimed water pipe must be at least 4.0 feet from a potable water pipe, as measured from the outside surface of each of the respective pipes.
(2) A physical connection between a potable water pipe and a reclaimed water pipe is prohibited.
(3) An appurtenance must prevent any possibility of reclaimed water entering a drinking water system.
(4) Where a 4.0 foot separation distance cannot be achieved, a reclaimed water pipe must meet the following requirements:

(A) If a new Type I reclaimed water pipe is installed parallel to an existing potable water pipe, the reclaimed water pipe must:

   (i) maintain a horizontal separation distance of no less than 3.0 feet with a potable water pipe at the same level or above a reclaimed water pipe;
   (ii) have a minimum pipe stiffness of 115 pounds per square inch (psi) with compatible joints, or a pressure rating of 150 psi for both pipe and joints;
   (iii) is embedded in cement stabilized sand, if parallel to a potable water pipe, is placed in the same benched trench as a reclaimed water pipe; and
   (iv) if cement-stabilized sand is used, the sand must:

       (I) have a minimum of 10% cement, based on loose dry weight volume;
       (II) be a minimum of 6.0 inches above and one quarter of the pipe diameter on either side and below a reclaimed water pipe.

(B) New Type I Reclaimed Water Pipe - Crossing Pipes.

   (i) If a new Type I reclaimed water pipe is installed crossing an existing potable water pipe, one segment of a Type I reclaimed water pipe must be centered on a potable water pipe such that the joints of the reclaimed water pipe are equidistant from the center point of the potable water pipe.
   (ii) A crossing of the two pipes must be centered between the joints of the potable water pipe.

(C) A Type I reclaimed water pipe must have either a pressure rating of 150 psi for both pipe and joints or a pipe stiffness of at least 115 psi with compatible joints for a minimum distance of 4.0 feet in each direction, as measured perpendicularly from any point on the potable water pipe to the Type I reclaimed water pipe.
(D) The minimum distance between a reclaimed water pipe and any potable water pipe is 6.0 inches.
(E) Any portions of reclaimed water pipe within 4.0 feet of a potable water pipe must be embedded in cement stabilized sand.
(F) The cement stabilized sand must comply with the requirements listed in subparagraph (A) of this paragraph.

(g) Site Selection of Type I Reclaimed Water Pump Stations. A design must comply with 2.1.9(a) - (c) of this title.

(h) Design of Type I Reclaimed Water Pump Stations. A design must comply with 2.1.10(d) and (g), 2.1.11(d), and 2.1.12(a) and (c) of this title (relating to Lift Station, Wet Well, and Dry Well Designs; Lift Station Pumps; and Lift Station Pipes), and paragraphs (1) - (3) of this subsection.

1. Pump Controls.

(A) All electrical equipment must be operable during a 100-year flood event and be protected from potential flooding from a wet well.
(B) Motor control centers must be mounted at least 4.0 inches above grade to prevent water intrusion and corrosion from standing water in the enclosure.

2. Pumps.

(A) A pump support must prevent movement or vibration during operation.
(B) A submersible pump must use a rail-type pump support incorporating manufacturer-approved mechanisms designed to allow an operator to remove and replace any single pump without first entering or dewatering the wet well.
(C) Submersible pump rails and lifting chains must be made of a material that is equivalent to Series 300 stainless steel at minimum.

3. Pump Station Valves.

(A) The discharge side of each pump must include a check valve followed by a full-closing isolation valve.
(B) Check valves must be swing type with an external lever.
(C) All valve types other than rising stem gate valves must include a position indicator to show their open or closed position.

(i) Force Main Pipe for Type I Reclaimed Water. A force main pipe for Type I reclaimed water must comply with sections §§217.54, 217.64, 217.65, 217.67(a) - (c) and (e), and 217.68 of this title (relating to Materials for Force Main Pipes; Force Main Joints; Force Main Design; and Force Main Testing) and the following:

1. A valve casing for an underground isolation valve must include "REUSE" or "NPW" cast into its lid.
2. A force main pipe must be purple in color or contained in an 8.0 millimeter purple polyethylene sleeve conforming to American Water Works Association C105, Class C and in-line
isolation valves for reuse pipes must open clockwise to distinguish them from potable water isolation valves.

2.1.20. Storage Tanks for Reclaimed Water.

(a) Ground level storage tanks and elevated storage tanks for reclaimed water must be designed, installed, and constructed in accordance with the American Water Works Association standards with reference to materials and construction practices, except for health-based standards strictly related to potable water storage and contact practices.
ANNEX 3 – CITY OF FORT WORTH
WASTEWATER UTILITIES
SPECIFICATIONS
SECTION 01 45 23
TESTING AND INSPECTION SERVICES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Testing and inspection services procedures and coordination
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.
      a. Contractor is responsible for performing, coordinating, and payment of all
         Quality Control testing.
      b. City is responsible for performing and payment for first set of Quality
         Assurance testing.
      1) If the first Quality Assurance test performed by the City fails, the
         Contractor is responsible for payment of subsequent Quality Assurance
         testing until a passing test occurs.
      a) Final acceptance will not be issued by City until all required payments
         for testing by Contractor have been paid in full.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS
A. Testing
   1. Complete testing in accordance with the Contract Documents.
   2. Coordination
      a. When testing is required to be performed by the City, notify City, sufficiently
         in advance, when testing is needed.
      b. When testing is required to be completed by the Contractor, notify City,
         sufficiently in advance, that testing will be performed.
   3. Distribution of Testing Reports
      a. Electronic Distribution
      1) Confirm development of Project directory for electronic submittals to be
         uploaded to City’s Buzzsaw site, or another external FTP site approved by
         the City.
2) Upload test reports to designated project directory and notify appropriate City representatives via email of submittal posting.
3) Hard Copies
   a) 1 copy for all submittals submitted to the Project Representative
   b) Hard Copy Distribution (if required in lieu of electronic distribution)
      1) Tests performed by City
         a) Distribute 1 hard copy to the Contractor
      2) Tests performed by the Contractor
         a) Distribute 3 hard copies to City’s Project Representative
4. Provide City’s Project Representative with trip tickets for each delivered load of Concrete or Lime material including the following information:
   a. Name of pit
   b. Date of delivery
   c. Material delivered
B. Inspection
   1. Inspection or lack of inspection does not relieve the Contractor from obligation to perform work in accordance with the Contract Documents.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

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Revision Log
SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provide temporary facilities and controls needed for the Work including, but not
      necessarily limited to:
      a. Temporary utilities
      b. Sanitary facilities
      c. Storage Sheds and Buildings
      d. Dust control
      e. Temporary fencing of the construction site
   2. Deviations from this City of Fort Worth Standard Specification
      1. None.
   3. Related Specification Sections include, but are not necessarily limited to:
      1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
      2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Temporary Utilities
   1. Obtaining Temporary Service
      a. Make arrangements with utility service companies for temporary services.
      b. Abide by rules and regulations of utility service companies or authorities
         having jurisdiction.
      c. Be responsible for utility service costs until Work is approved for Final
         Acceptance.
         1) Included are fuel, power, light, heat and other utility services necessary for
            execution, completion, testing and initial operation of Work.
   2. Water
      a. Contractor to provide water required for and in connection with Work to be
         performed and for specified tests of piping, equipment, devices or other use as
         required for the completion of the Work.
      b. Provide and maintain adequate supply of potable water for domestic
         consumption by Contractor personnel and City’s Project Representatives.
      c. Coordination
         1) Contact City 1 week before water for construction is desired
d. Contractor Payment for Construction Water
   1) Obtain construction water meter from City for payment as billed by City’s
      established rates.

3. Electricity and Lighting
   a. Provide and pay for electric powered service as required for Work, including
      testing of Work.
      1) Provide power for lighting, operation of equipment, or other use.
   b. Electric power service includes temporary power service or generator to
      maintain operations during scheduled shutdown.

4. Telephone
   a. Provide emergency telephone service at Site for use by Contractor personnel
      and others performing work or furnishing services at Site.

5. Temporary Heat and Ventilation
   a. Provide temporary heat as necessary for protection or completion of Work.
   b. Provide temporary heat and ventilation to assure safe working conditions.

B. Sanitary Facilities
   1. Provide and maintain sanitary facilities for persons on Site.
      a. Comply with regulations of State and local departments of health.
   2. Enforce use of sanitary facilities by construction personnel at job site.
      a. Enclose and anchor sanitary facilities.
      b. No discharge will be allowed from these facilities.
      c. Collect and store sewage and waste so as not to cause nuisance or health
         problem.
      d. Haul sewage and waste off-site at no less than weekly intervals and properly
         dispose in accordance with applicable regulation.
   3. Locate facilities near Work Site and keep clean and maintained throughout Project.
   4. Remove facilities at completion of Project

C. Storage Sheds and Buildings
   1. Provide adequately ventilated, watertight, weatherproof storage facilities with floor
      above ground level for materials and equipment susceptible to weather damage.
   2. Storage of materials not susceptible to weather damage may be on blocks off
      ground.
   3. Store materials in a neat and orderly manner.
      a. Place materials and equipment to permit easy access for identification,
         inspection and inventory.
   4. Equip building with lockable doors and lighting, and provide electrical service for
      equipment space heaters and heating or ventilation as necessary to provide storage
      environments acceptable to specified manufacturers.
   5. Fill and grade site for temporary structures to provide drainage away from
      temporary and existing buildings.
   6. Remove building from site prior to Final Acceptance.

D. Temporary Fencing
   1. Provide and maintain for the duration or construction when required in contract
      documents

E. Dust Control
1. Contractor is responsible for maintaining dust control through the duration of the
   project.
   a. Contractor remains on-call at all times
   b. Must respond in a timely manner
F. Temporary Protection of Construction
   1. Contractor or subcontractors are responsible for protecting Work from damage due
to weather.

1.5 SUBMITTALS [NOT USED]
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]
3.1 INSTALLERS [NOT USED]
3.2 EXAMINATION [NOT USED]
3.3 PREPARATION [NOT USED]
3.4 INSTALLATION
   A. Temporary Facilities
      1. Maintain all temporary facilities for duration of construction activities as needed.
3.5 [REPAIR]/[RESTORATION]
3.6 RE-INSTALLATION
3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES
   A. Temporary Facilities
1. Remove all temporary facilities and restore area after completion of the Work, to a condition equal to or better than prior to start of Work.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 01 55 26
STREET USE PERMIT AND MODIFICATIONS TO TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative procedures for:
      a. Street Use Permit
      b. Modification of approved traffic control
      c. Removal of Street Signs
   B. Deviations from this City of Fort Worth Standard Specification
      1. None.
   C. Related Specification Sections include, but are not necessarily limited to:
      1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
      2. Division 1 – General Requirements
      3. Section 34 71 13 – Traffic Control

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
   No separate payment will be allowed for this Item.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this specification refer to the current reference standard
      published at the time of the latest revision date logged at the end of this
      specification, unless a date is specifically cited.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Traffic Control
   1. General
      a. When traffic control plans are included in the Drawings, provide Traffic
         Control in accordance with Drawings and Section 34 71 13.
      b. When traffic control plans are not included in the Drawings, prepare traffic
         control plans in accordance with Section 34 71 13 and submit to City for
         review.
         1) Allow minimum 10 working days for review of proposed Traffic Control.
   B. Street Use Permit
      1. Prior to installation of Traffic Control, a City Street Use Permit is required.
      a. To obtain Street Use Permit, submit Traffic Control Plans to City
         Transportation and Public Works Department.
1) Allow a minimum of 5 working days for permit review.
2) Contractor’s responsibility to coordinate review of Traffic Control plans for Street Use Permit, such that construction is not delayed.

C. Modification to Approved Traffic Control
   1. Prior to installation traffic control:
      a. Submit revised traffic control plans to City Department Transportation and Public Works Department.
      1) Revise Traffic Control plans in accordance with Section 34 71 13.
      2) Allow minimum 5 working days for review of revised Traffic Control.
      3) It is the Contractor’s responsibility to coordinate review of Traffic Control plans for Street Use Permit, such that construction is not delayed.

D. Removal of Street Sign
   1. If it is determined that a street sign must be removed for construction, then contact City Transportation and Public Works Department, Signs and Markings Division to remove the sign.

E. Temporary Signage
   1. In the case of regulatory signs, replace permanent sign with temporary sign meeting requirements of the latest edition of the Texas Manual on Uniform Traffic Control Devices (MUTCD).
   2. Install temporary sign before the removal of permanent sign.
   3. When construction is complete, to the extent that the permanent sign can be reinstalled, contact the City Transportation and Public Works Department, Signs and Markings Division, to reinstall the permanent sign.

F. Traffic Control Standards
   1. Traffic Control Standards can be found on the City’s Buzzsaw website.

1.5 SUBMITTALS [NOT USED]
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

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Revision Log
SECTION 01 57 13
STORM WATER POLLUTION PREVENTION

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Procedures for Storm Water Pollution Prevention Plans
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the
      Contract
   2. Division 1 – General Requirements
   3. Section 31 25 00 – Erosion and Sediment Control

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Construction Activities resulting in less than 1 acre of disturbance
      a. Work associated with this Item is considered subsidiary to the various Items
         bid. No separate payment will be allowed for this Item.
   2. Construction Activities resulting in greater than 1 acre of disturbance
      a. Measurement and Payment shall be in accordance with Section 31 25 00.

1.3 REFERENCES
A. Abbreviations and Acronyms
   1. Notice of Intent: NOI
   2. Notice of Termination: NOT
   3. Storm Water Pollution Prevention Plan: SWPPP
   4. Texas Commission on Environmental Quality: TCEQ
   5. Notice of Change: NOC
A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   2. Integrated Storm Management (iSWM) Technical Manual for Construction
      Controls

1.4 ADMINISTRATIVE REQUIREMENTS
A. General
   1. Contractor is responsible for resolution and payment of any fines issued associated
      with compliance to Stormwater Pollution Prevention Plan.
B. Construction Activities resulting in:

1. Less than 1 acre of disturbance
   a. Provide erosion and sediment control in accordance with Section 31 25 00 and
      Drawings.

2. 1 to less than 5 acres of disturbance
   a. Texas Pollutant Discharge Elimination System (TPDES) General Construction
      Permit is required
   b. Complete SWPPP in accordance with TCEQ requirements
      1) TCEQ Small Construction Site Notice Required under general permit
         TXR150000
         a) Sign and post at job site
         b) Prior to Preconstruction Meeting, send 1 copy to City Department of
            Transportation and Public Works, Environmental Division, (817) 392-
            6088.
      2) Provide erosion and sediment control in accordance with:
         a) Section 31 25 00
         b) The Drawings
         c) TXR150000 General Permit
         d) SWPPP
         e) TCEQ requirements

3. 5 acres or more of Disturbance
   a. Texas Pollutant Discharge Elimination System (TPDES) General Construction
      Permit is required
   b. Complete SWPPP in accordance with TCEQ requirements
      1) Prepare a TCEQ NOI form and submit to TCEQ along with required fee
         a) Sign and post at job site
         b) Send copy to City Department of Transportation and Public Works,
            Environmental Division, (817) 392-6088.
      2) TCEQ Notice of Change required if making changes or updates to NOI
      3) Provide erosion and sediment control in accordance with:
         a) Section 31 25 00
         b) The Drawings
         c) TXR150000 General Permit
         d) SWPPP
         e) TCEQ requirements
      4) Once the project has been completed and all the closeout requirements of
         TCEQ have been met a TCEQ Notice of Termination can be submitted.
         a) Send copy to City Department of Transportation and Public Works,
            Environmental Division, (817) 392-6088.

1.5 SUBMITTALS

A. SWPPP

1. Submit in accordance with Section 01 33 00, except as stated herein.
   a. Prior to the Preconstruction Meeting, submit a draft copy of SWPPP to the City
      as follows:
      1) 1 copy to the City Project Manager
      a) City Project Manager will forward to the City Department of
         Transportation and Public Works, Environmental Division for review
B. Modified SWPPP
   1. If the SWPPP is revised during construction, resubmit modified SWPPP to the City in accordance with Section 01 33 00.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

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Revision Log

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15
SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. A listing of the approved products for use in the City
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES [NOT USED]

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS
A. A list of City approved products for use is attached to this Section.
B. Only products specifically included on City’s Standard Product List in these Contract Documents shall be allowed for use on the Project.
   1. Any subsequently approved products will only be allowed for use upon specific approval by the Engineer.
C. Any specific product requirements in the Contract Documents supersede similar products included on the City’s Standard Product List.
   1. The City reserves the right to not allow products to be used for certain projects even though the product is listed on the City’s Standard Product List.
D. Although a specific product is included on City’s Standard Product List, not all products from that manufacturer are approved for use, including but not limited to, that manufacturer’s standard product.
E. See Section 01 33 00 for submittal requirements of Product Data included on City’s Standard Product List.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

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Revision Log
SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Scheduling of product delivery
   2. Packaging of products for delivery
   3. Protection of products against damage from:
      a. Handling
      b. Exposure to elements or harsh environments

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY AND HANDLING

A. Delivery Requirements
   1. Schedule delivery of products or equipment as required to allow timely installation
      and to avoid prolonged storage.
   2. Provide appropriate personnel and equipment to receive deliveries.
   3. Delivery trucks will not be permitted to wait extended periods of time on the Site
      for personnel or equipment to receive the delivery.
4. Deliver products or equipment in manufacturer’s original unbroken cartons or other
containers designed and constructed to protect the contents from physical or
environmental damage.
5. Clearly and fully mark and identify as to manufacturer, item and installation
location.
6. Provide manufacturer’s instructions for storage and handling.

B. Handling Requirements
1. Handle products or equipment in accordance with these Contract Documents and
manufacturer’s recommendations and instructions.

C. Storage Requirements
1. Store materials in accordance with manufacturer’s recommendations and
requirements of these Specifications.
2. Make necessary provisions for safe storage of materials and equipment.
   a. Place loose soil materials and materials to be incorporated into Work to prevent
damage to any part of Work or existing facilities and to maintain free access at
all times to all parts of Work and to utility service company installations in
vicinity of Work.
3. Keep materials and equipment neatly and compactly stored in locations that will
cause minimum inconvenience to other contractors, public travel, adjoining owners,
tenants and occupants.
   a. Arrange storage to provide easy access for inspection.
4. Restrict storage to areas available on construction site for storage of material and
equipment as shown on Drawings, or approved by the Engineer
5. Provide off-site storage and protection when on-site storage is not adequate.
   a. Provide addresses of and access to off-site storage locations for inspection by
   City’s Project Representative.
6. Do not use lawns, grass plots or other private property for storage purposes without
written permission of owner or other person in possession or control of premises.
7. Store in manufacturers’ unopened containers.
8. Neatly, safely and compactly stack materials delivered and stored along line of
Work to avoid inconvenience and damage to property owners and general public
and maintain at least 3 feet from fire hydrant.
10. Repair or replace damaged lawns, sidewalks, streets or other improvements to
satisfaction of City’s Project Representative.
    a. Total length which materials may be distributed along route of construction at
one time is 1,000 linear feet, unless otherwise approved in writing by the Engineer
1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 ERECTION [NOT USED]

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

A. Tests and Inspections
   1. Inspect all products or equipment delivered to the site prior to unloading.

B. Non-Conforming Work
   1. Reject all products or equipment that are damaged, used or in any other way unsatisfactory for use on the project.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION

A. Protect all products or equipment in accordance with manufacturer's written directions.

B. Store products or equipment in location to avoid physical damage to items while in storage.

C. Protect equipment from exposure to elements and keep thoroughly dry if required by the manufacturer.

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 01 71 23
CONSTRUCTION STAKING AND SURVEY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Requirements for construction staking and surveying.
B. Deviations from this City of Fort Worth Standard Specification
   1. 1.4.A
   2. 3.4
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Construction Stakes
   1. Construction staking will be performed by the Contractor.
   2. Coordination
      a. Contact City’s Project Representative to coordinate sequencing of Construction
         Staking.
   3. General
      a. It is the Contractor’s responsibility to coordinate staking such that construction
         activities are not delayed or negatively impacted.
      b. Contractor is responsible for preserving and maintaining stakes.
      c. If in the opinion of the City, a sufficient number of stakes or markings have
         been lost, destroyed or disturbed, by Contractor’s neglect such that the
         contracted Work cannot take place, then the Contractor will be required to re-
         stake the Work area.

1.5 SUBMITTALS

A. Submittals, if required, shall be in accordance with Section 01 33 00.
   1. All submittals shall be approved by the Engineer prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Certificates
1. Provide certificate certifying that elevations and locations of improvements are in conformance or non-conformance with requirements of the Contract Documents.
   a. Certificate must be sealed by a registered professional land surveyor in the State of Texas.

B. Field Quality Control Submittals
   1. Documentation verifying accuracy of field engineering work

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE
   A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work.

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION
   A. Verify location and protect control points before commencing Work.
   B. Notify City’s Project Representative immediately of any discrepancies discovered.

3.4 APPLICATION
   A. Construction Survey
      1. Project Record Survey
         a. Contractor shall maintain complete and accurate log of control and survey Work as it progresses. Including, but not limited to the following items:
            1) All: Rim and flowline elevations and coordinates for each manhole or junction structure
            2) Water Lines: Top of pipe elevations and coordinates at the following intervals:
               a) Every 250 linear feet
               b) Horizontal and vertical points of inflection, curvature, etc. (all fittings)
               c) Cathodic Protection test stations
               d) Sampling stations
               e) Meter boxes/vaults (all sizes)
3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Preserve permanent reference points during progress of the Work.
B. Do not change or relocate reference points without approval from the Engineer.
C. Utilize recognized engineering survey practices.
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Intermediate and final cleaning for Work not including special cleaning of closed
      systems specified elsewhere

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 32 92 13 – Hydro-Mulching, Seeding and Sodding

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Scheduling
   1. Schedule cleaning operations so that dust and other contaminants disturbed by
      cleaning process will not fall on newly painted surfaces.
   2. Schedule final cleaning upon completion of Work and immediately prior to final
      inspection.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Store cleaning products and cleaning wastes in containers specifically designed for
      those materials.
1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIEDPRODUCTS [NOT USED]

2.2 MATERIALS

A. Cleaning Agents

  1. Compatible with surface being cleaned
  2. New and uncontaminated
  3. For manufactured surfaces
     a. Material recommended by manufacturer

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 APPLICATION [NOT USED]

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. General

  1. Prevent accumulation of wastes that create hazardous conditions.
  2. Conduct cleaning and disposal operations to comply with laws and safety orders of
     governing authorities.
  3. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in
     storm or sanitary drains or sewers.
  4. Dispose of degradable debris at an approved solid waste disposal site.
  5. Dispose of nondegradable debris at an approved solid waste disposal site or in an
     alternate manner approved by the Engineer and regulatory agencies.
6. Handle materials in a controlled manner with as few handlings as possible.

7. Thoroughly clean, sweep, wash and polish all Work and equipment associated with this project.

8. Remove all signs of temporary construction and activities incidental to construction of required permanent Work.

9. If project is not cleaned to the satisfaction of the City, the City reserves the right to have the cleaning completed at the expense of the Contractor.

10. Do not burn on-site.

B. Intermediate Cleaning during Construction

1. Keep Work areas clean so as not to hinder health, safety or convenience of personnel in existing facility operations.

2. At maximum weekly intervals, dispose of waste materials, debris and rubbish.

3. Confine construction debris daily in strategically located container(s):
   a. Cover to prevent blowing by wind
   b. Store debris away from construction or operational activities
   c. Haul from site at a minimum of once per week

4. Vacuum clean interior areas when ready to receive finish painting.
   a. Continue vacuum cleaning on an as-needed basis, until Final Acceptance.

5. Prior to storm events, thoroughly clean site of all loose or unsecured items, which may become airborne or transported by flowing water during the storm.

C. Interior Final Cleaning

1. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed surfaces.

2. Wipe all lighting fixture reflectors, lenses, lamps and trims clean.

3. Wash and shine glazing and mirrors.

4. Polish glossy surfaces to a clear shine.

5. Ventilating systems
   a. Clean permanent filters and replace disposable filters if units were operated during construction.
   b. Clean ducts, blowers and coils if units were operated without filters during construction.

6. Replace all burned out lamps.

7. Broom clean process area floors.

8. Mop office and control room floors.

D. Exterior (Site or Right of Way) Final Cleaning

1. Remove trash and debris containers from site.
   a. Re-seed areas disturbed by location of trash and debris containers in accordance with Section 32 92 13.

2. Sweep roadway to remove all rocks, pieces of asphalt, concrete or any other object that may hinder or disrupt the flow of traffic along the roadway.

3. Clean any interior areas including, but not limited to, vaults, manholes, structures, junction boxes and inlets.
4. If no longer required for maintenance of erosion facilities, and upon approval by the Engineer, remove erosion control from site.

5. Clean signs, lights, signals, etc.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log
SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. The procedure for closing out a contract
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS
A. Guarantees, Bonds and Affidavits
   1. No application for final payment will be accepted until all guarantees, bonds, certificates, licenses and affidavits required for Work or equipment as specified are satisfactorily filed with the City.
B. Release of Liens or Claims
   1. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the City.

1.5 SUBMITTALS
A. Submit all required documentation to City’s Project Representative.
1.6  INFORMATIONAL SUBMITTALS [NOT USED]

1.7  CLOSEOUT SUBMITTALS [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1  INSTALLERS [NOT USED]

3.2  EXAMINATION [NOT USED]

3.3  PREPARATION [NOT USED]

3.4  CLOSEOUT PROCEDURE

A. Prior to requesting Final Inspection, submit:

1. Project Record Documents in accordance with Section 01 78 39
2. Operation and Maintenance Data, if required, in accordance with Section 01 78 23

B. Prior to requesting Final Inspection, perform final cleaning in accordance with Section
   01 74 23.

C. Final Inspection

1. After final cleaning, provide notice to the City Project Representative that the Work
   is completed.
   a. The City will make an initial Final Inspection with the Contractor present.
   b. Upon completion of this inspection, the City will notify the Contractor, in
      writing within 10 business days, of any particulars in which this inspection
      reveals that the Work is defective or incomplete.

2. Upon receiving written notice from the City, immediately undertake the Work
   required to remedy deficiencies and complete the Work to the satisfaction of the
   City.

3. Upon completion of Work associated with the items listed in the City's written
   notice, inform the City, that the required Work has been completed. Upon receipt
   of this notice, the City, in the presence of the Contractor, will make a subsequent
   Final Inspection of the project.

4. Provide all special accessories required to place each item of equipment in full
   operation. These special accessory items include, but are not limited to:
   a. Specified spare parts
   b. Adequate oil and grease as required for the first lubrication of the equipment
   c. Initial fill up of all chemical tanks and fuel tanks
   d. Light bulbs
   e. Fuses
   f. Vault keys
   g. Handwheels
   h. Other expendable items as required for initial start-up and operation of all
      equipment

D. Notice of Project Completion
1. Once the City Project Representative finds the Work subsequent to Final Inspection to be satisfactory, the City will issue a Notice of Project Completion (Green Sheet).

E. Supporting Documentation
   1. Coordinate with the City Project Representative to complete the following additional forms:
      a. Final Payment Request
      b. Statement of Contract Time
      c. Affidavit of Payment and Release of Liens
      d. Consent of Surety to Final Payment
      e. Pipe Report (if required)
      f. Contractor’s Evaluation of City
      g. Performance Evaluation of Contractor

F. Letter of Final Acceptance
   1. Upon review and acceptance of Notice of Project Completion and Supporting Documentation, in accordance with General Conditions, City will issue Letter of Final Acceptance and release the Final Payment Request for payment.

3.5 REPAIR / RESTORATION [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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END OF SECTION

Revised July 1, 2011
SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Product data and related information appropriate for City's maintenance and
   operation of products furnished under Contract
2. Such products may include, but are not limited to:
   a. Traffic Controllers
   b. Irrigation Controllers (to be operated by the City)
   c. Butterfly Valves
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
   No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Schedule
   1. Submit manuals in final form to the City within 30 calendar days of product
      shipment to the project site.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 Submittal Procedures. All
   submittals shall be approved by the Engineer prior to delivery.

1.6 INFORMATIONAL SUBMITTALS

A. Submittal Form
   1. Prepare data in form of an instructional manual for use by City personnel.
   2. Format
      a. Size: 8 1/2 inches x 11 inches
      b. Paper
         1) 40 pound minimum, white, for typed pages
         2) Holes reinforced with plastic, cloth or metal
      c. Text: Manufacturer’s printed data, or neatly typewritten
d. Drawings
   1) Provide reinforced punched binder tab, bind in with text
   2) Reduce larger drawings and fold to size of text pages.

e. Provide fly-leaf for each separate product, or each piece of operating equipment.
   1) Provide typed description of product, and major component parts of equipment.
   2) Provide indexed tabs.

f. Cover
   1) Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS".
   2) List:
      a) Title of Project
      b) Identity of separate structure as applicable
      c) Identity of general subject matter covered in the manual

3. Binders
   a. Commercial quality 3-ring binders with durable and cleanable plastic covers
   b. When multiple binders are used, correlate the data into related consistent groupings.

4. If available, provide an electronic form of the O&M Manual.

B. Manual Content

1. Neatly typewritten table of contents for each volume, arranged in systematic order
   a. Contractor, name of responsible principal, address and telephone number
   b. A list of each product required to be included, indexed to content of the volume
   c. List, with each product:
      1) The name, address and telephone number of the subcontractor or installer
      2) A list of each product required to be included, indexed to content of the volume
      3) Identify area of responsibility of each
      4) Local source of supply for parts and replacement
   d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

2. Product Data
   a. Include only those sheets which are pertinent to the specific product.
   b. Annotate each sheet to:
      1) Clearly identify specific product or part installed
      2) Clearly identify data applicable to installation
      3) Delete references to inapplicable information

3. Drawings
   a. Supplement product data with drawings as necessary to clearly illustrate:
      1) Relations of component parts of equipment and systems
      2) Control and flow diagrams
   b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
   c. Do not use Project Record Drawings as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation:
   a. Organize in consistent format under separate headings for different procedures.
   b. Provide logical sequence of instructions of each procedure.
5. Copy of each warranty, bond and service contract issued
   a. Provide information sheet for City personnel giving:
      1) Proper procedures in event of failure
      2) Instances which might affect validity of warranties or bonds

C. Manual for Materials and Finishes
   1. Submit 5 copies of complete manual in final form.
   2. Content, for architectural products, applied materials and finishes:
      a. Manufacturer's data, giving full information on products
         1) Catalog number, size, composition
         2) Color and texture designations
         3) Information required for reordering special manufactured products
      b. Instructions for care and maintenance
         1) Manufacturer's recommendation for types of cleaning agents and methods
         2) Cautions against cleaning agents and methods which are detrimental to
            product
         3) Recommended schedule for cleaning and maintenance
   3. Content, for moisture protection and weather exposure products:
      a. Manufacturer's data, giving full information on products
         1) Applicable standards
         2) Chemical composition
         3) Details of installation
      b. Instructions for inspection, maintenance and repair

D. Manual for Equipment and Systems
   1. Submit 5 copies of complete manual in final form.
   2. Content, for each unit of equipment and system, as appropriate:
      a. Description of unit and component parts
         1) Function, normal operating characteristics and limiting conditions
         2) Performance curves, engineering data and tests
         3) Complete nomenclature and commercial number of replaceable parts
      b. Operating procedures
         1) Start-up, break-in, routine and normal operating instructions
         2) Regulation, control, stopping, shut-down and emergency instructions
         3) Summer and winter operating instructions
         4) Special operating instructions
      c. Maintenance procedures
         1) Routine operations
         2) Guide to "trouble shooting"
         3) Disassembly, repair and reassembly
         4) Alignment, adjusting and checking
      d. Servicing and lubrication schedule
         1) List of lubricants required
      e. Manufacturer's printed operating and maintenance instructions
      f. Description of sequence of operation by control manufacturer
         1) Predicted life of parts subject to wear
         2) Items recommended to be stocked as spare parts
      g. As installed control diagrams by controls manufacturer
      h. Each contractor's coordination drawings
         1) As installed color coded piping diagrams
1. Charts of valve tag numbers, with location and function of each valve
2. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage
3. Other data as required under pertinent Sections of Specifications

3. Content, for each electric and electronic system, as appropriate:
   a. Description of system and component parts
      1) Function, normal operating characteristics, and limiting conditions
      2) Performance curves, engineering data and tests
      3) Complete nomenclature and commercial number of replaceable parts
   b. Circuit directories of panelboards
      1) Electrical service
      2) Controls
      3) Communications
   c. As installed color coded wiring diagrams
   d. Operating procedures
      1) Routine and normal operating instructions
      2) Sequences required
      3) Special operating instructions
   e. Maintenance procedures
      1) Routine operations
      2) Guide to "trouble shooting"
      3) Disassembly, repair and reassembly
      4) Adjustment and checking
   f. Manufacturer's printed operating and maintenance instructions
   g. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage
   h. Other data as required under pertinent Sections of Specifications

4. Prepare and include additional data when the need for such data becomes apparent during instruction of City's personnel.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE
   A. Provide operation and maintenance data by personnel with the following criteria:
      1. Trained and experienced in maintenance and operation of described products
      2. Skilled as technical writer to the extent required to communicate essential data
      3. Skilled as draftsmen competent to prepare required drawings
1 1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
2 1.11 FIELD [SITE] CONDITIONS [NOT USED]
3 1.12 WARRANTY [NOT USED]

4 PART 2 - PRODUCTS [NOT USED]

5 PART 3 - EXECUTION [NOT USED]

6 END OF SECTION

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8
SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Work associated with the documenting the project and recording changes to project
documents, including:
      a. Record Drawings
      b. Water Meter Service Reports
      c. Sanitary Sewer Service Reports
      d. Large Water Meter Reports
   
B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is considered subsidiary to the various Items bid.
      No separate payment will be allowed for this Item.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Prior to submitting a request for Final Inspection, deliver Project Record Documents to
   City’s Project Representative.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Accuracy of Records
   1. Thoroughly coordinate changes within the Record Documents, making adequate
      and proper entries on each page of Specifications and each sheet of Drawings and
      other Documents where such entry is required to show the change properly.
   2. Accuracy of records shall be such that future search for items shown in the Contract
      Documents may rely reasonably on information obtained from the approved Project
      Record Documents.
3. To facilitate accuracy of records, make entries within 24 hours after receipt of information that the change has occurred.

4. Provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation and examination.

1.10 STORAGE AND HANDLING

A. Storage and Handling Requirements

1. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the Work and transfer of all recorded data to the final Project Record Documents.

2. In the event of loss of recorded data, use means necessary to again secure the data to the Engineer’s approval.

   a. In such case, provide replacements to the standards originally required by the Contract Documents.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 RECORD DOCUMENTS

A. Job set

1. Promptly following receipt of the Notice to Proceed, secure from the City, at no charge to the Contractor, 1 complete set of all Documents comprising the Contract.

B. Final Record Documents

1. At a time nearing the completion of the Work and prior to Final Inspection, provide the City 1 complete set of all Final Record Drawings in the Contract.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 MAINTENANCE DOCUMENTS

A. Maintenance of Job Set

1. Immediately upon receipt of the job set, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
2. Preservation
   a. Considering the Contract completion time, the probable number of occasions
      upon which the job set must be taken out for new entries and for examination,
      and the conditions under which these activities will be performed, devise a
      suitable method for protecting the job set.
   b. Do not use the job set for any purpose except entry of new data and for review
      by the City, until start of transfer of data to final Project Record Documents.
   c. Maintain the job set at the site of work.

3. Coordination with Construction Survey
   a. At a minimum, in accordance with the intervals set forth in Section 01 71 23,
      clearly mark any deviations from Contract Documents associated with
      installation of the infrastructure.

4. Making entries on Drawings
   a. Record any deviations from Contract Documents.
   b. Use an erasable colored pencil (not ink or indelible pencil), clearly describe the
      change by graphic line and note as required.
   c. Date all entries.
   d. Call attention to the entry by a "cloud" drawn around the area or areas affected.
   e. In the event of overlapping changes, use different colors for the overlapping
      changes.

5. Conversion of schematic layouts
   a. In some cases on the Drawings, arrangements of conduits, circuits, piping,
      ducts, and similar items, are shown schematically and are not intended to
      portray precise physical layout.
      1) Final physical arrangement is determined by the Contractor, subject to the
         Engineer’s approval.
      2) However, design of future modifications of the facility may require
         accurate information as to the final physical layout of items which are
         shown only schematically on the Drawings.
   b. Show on the job set of Record Drawings, by dimension accurate to within 1
      inch, the centerline of each run of items.
      1) Final physical arrangement is determined by the Contractor, subject to the
         Engineer’s approval.
      2) Show, by symbol or note, the vertical location of the Item ("under slab", "in
         ceiling plenum", "exposed", and the like).
      3) Make all identification sufficiently descriptive that it may be related
         reliably to the Specifications.
   c. The City may waive the requirements for conversion of schematic layouts
      where, in the City's judgment, conversion serves no useful purpose. However,
      do not rely upon waivers being issued except as specifically issued in writing
      by the City.

B. Final Project Record Documents
   1. Transfer of data to Drawings
      a. Carefully transfer change data shown on the job set of Record Drawings to the
         corresponding final documents, coordinating the changes as required.
      b. Clearly indicate at each affected detail and other Drawing a full description of
         changes made during construction, and the actual location of items.
c. Call attention to each entry by drawing a "cloud" around the area or areas affected.
d. Make changes neatly, consistently and with the proper media to assure longevity and clear reproduction.

2. Transfer of data to other Documents

a. If the Documents, other than Drawings, have been kept clean during progress of the Work, and if entries thereon have been orderly to the approval of the Engineer, the job set of those Documents, other than Drawings, will be accepted as final Record Documents.
b. If any such Document is not so approved by the Engineer, secure a new copy of that Document from the City at the City's usual charge for reproduction and handling, and carefully transfer the change data to the new copy to the approval of the Engineer.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 02 41 13
SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Removing sidewalks and steps.
2. Removing ADA ramps and landings.
3. Removing driveways.
4. Removing fences.
5. Removing guardrail
6. Removing retaining walls (less than 4 feet tall).
7. Removing mailboxes.
8. Removing rip rap.
9. Removing miscellaneous concrete structures including porches and foundations.
10. Disposal of removed materials.

B. Standard Details
1. Paving Removal and Selective Site Demolition – Removal Pay Limits

C. Deviations from City of Fort Worth Standards
1. None

D. Related Specification Sections include but are not necessarily limited to
1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 1 - General Requirements.
3. Section 31 23 23 - Fill.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Measurement:
a. Remove Sidewalk: measure by square foot.
b. Remove Steps: measure by the square foot as seen in the plan view only.
c. Remove ADA Ramp: measure by each.
d. Remove Driveway: measure by the square foot by type.
e. Remove Fence: measure by the linear foot.
f. Remove Guardrail: measure by the linear foot along the face of the rail in place including metal beam guard fence transitions and single guard rail terminal sections from the center of end posts.
g. Remove Retaining Wall (less than 4 feet tall): measure by the linear foot
h. Remove Mailbox: measure by each.
i. Remove Rip Rap: measure by the square foot.
j. Remove Miscellaneous Concrete Structure: measure by the lump sum.

2. Payment:
a. Remove Sidewalk: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work. Sidewalk adjacent to or attached to retaining wall (including sidewalk that acts as a wall footing) shall be paid as sidewalk removal.

b. Remove Steps: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

c. Remove ADA Ramp and landing: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work. Work includes ramp landing removal.

d. Remove Driveway: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to remove improved driveway by type.

e. Remove Fence: full compensation for removal, hauling, disposal, tools, equipment, labor and incidentals needed to remove fence.

f. Remove Guardrail: full compensation for removing materials, loading, hauling, unloading, and storing or disposal; furnishing backfill material; backfilling the postholes; and equipment, labor, tools, and incidentals.

g. Remove Retaining Wall (less than 4 feet tall): full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work. Sidewalk adjacent to or attached to retaining wall (including sidewalk that acts as a wall footing) shall be paid as sidewalk removal.

h. Remove Mailbox: full compensation for removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

i. Remove Rip Rap: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

j. Remove Miscellaneous Concrete Structure: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

1.3 REFERENCES

A. Definitions

1. Improved Driveway: Driveway constructed of concrete, asphalt paving or brick unit pavers.
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]
1.5 SUBMITTALS [NOT USED]
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS
2.1 OWNER-FURNISHED PRODUCTS [NOT USED]
2.2 MATERIALS
   A. Fill Material: See Section 31.23.23.
2.3 ACCESSORIES [NOT USED]
2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION
3.1 INSTALLERS [NOT USED]
3.2 EXAMINATION [NOT USED]
3.3 PREPARATION [NOT USED]
3.4 REMOVAL
   A. Remove Sidewalk
      1. Remove sidewalk to nearest existing dummy, expansion or construction joint.
      2. Sawcut when removing to nearest joint is not practical. See 3.4.K.
   B. Remove Steps
      1. Remove step to nearest existing dummy, expansion or construction joint.
      2. Sawcut when removing to nearest joint is not practical. See 3.4.K.
   C. Remove ADA Ramp
      1. Sawcut existing curb and gutter and pavement prior to wheel chair ramp removal. See 3.4.K.
      2. Remove ramp to nearest existing dummy, expansion or construction joint on existing sidewalk.
   D. Remove Driveway
      1. Sawcut existing drive, curb and gutter and pavement prior to drive removal. See 3.4.K.
      2. Remove drive to nearest existing dummy, expansion or construction joint.
3. Sawcut when removing to nearest joint is not practical. See 3.4.K.
4. Remove adjacent sidewalk to nearest existing dummy, expansion or construction joint on existing sidewalk.

E. Remove Fence
1. Remove all fence components above and below ground and backfill with acceptable fill material.
2. Use caution in removing and salvaging fence materials.
3. Salvaged materials may be used to reconstruct fence as approved by the Engineer or as shown on plans.
4. CONTRACTOR responsible for keeping animals (livestock, pets, etc.) within the fenced areas during construction operation and while removing fences.

F. Remove Guardrail
1. Remove rail elements in original lengths.
2. Remove fittings from the posts and the metal rail and then pull the posts.
3. Do not mar or damage salvageable materials during removal.
4. Completely remove posts and any concrete surrounding the posts.
5. Furnish backfill material and backfill the hole with material equal in composition and density to the surrounding soil unless otherwise directed.
6. Cut off or bend down eyebolts anchored to the dead man to an elevation at least 1-foot below the new subgrade elevation and leave in place along with the dead man.

G. Remove Retaining Wall (less than 4 feet tall)
1. Remove wall to nearest existing joint.
2. Sawcut when removing to nearest joint is not practical. See 3.4.K.
3. Removal includes all components of the retaining wall including footings.
4. Sidewalk adjacent to or attached to retaining wall: See 3.4.A

H. Remove Mailbox
1. Salvage existing materials for reuse. Mailbox materials may need to be used for reconstruction.

I. Remove Rip Rap
1. Remove rip rap to nearest existing dummy, expansion or construction joint.
2. Sawcut when removing to nearest joint is not practical. See 3.4.K.

J. Remove Miscellaneous Concrete Structure
1. Remove portions of miscellaneous concrete structures including foundations and slabs that do not interfere with proposed construction to 2 feet below the finished ground line.
2. Cut reinforcement close to the portion of the concrete to remain in place.
3. Break or perforate the bottom of structures to remain to prevent the entrapment of water.

K. Sawcut
1. Sawing Equipment
   a. Power-driven
b. Manufactured for the purpose of sawing pavement

c. In good operating condition

d. Shall not spall or fracture the pavement to the removal area

2. Sawcut perpendicular to the surface completely through existing pavement.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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16

17
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Direction for the removal, abandonment or salvaging of the following utilities:
      a. Cathodic Protection Test Stations
      b. Water Lines
      c. Gate Valves
      d. Water Valves
      e. Fire Hydrants
      f. Water Meters and Meter Box
      g. Water Sampling Station
      h. Concrete Water Vaults
      i. Sanitary Sewer Lines
      j. Sanitary Sewer Manholes
      k. Sanitary Sewer Junction Boxes
      l. Storm Sewer Lines
      m. Storm Sewer Manhole Risers
      n. Storm Sewer Junction Boxes
      o. Storm Sewer Inlets
      p. Box Culverts
      q. Headwalls and Safety End Treatments
      r. Trench Drains

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 03 34 13 – Controlled Low Strength Material (CLSM)
   4. Section 33 05 10 – Utility Trench Excavation, Embedment and Backfill
   5. Section 33 05 24 – Installation of Carrier Pipe
   6. Section 33 11 11 – Ductile Iron Fittings
   7. Section 33 11 13 – Concrete Pressure Pipe, Bar-wrapped Pipe, Steel Cylinder Type
   8. Section 33 11 14 – Buried Steel Pipe and Fittings
   9. Section 33 12 25 – Connection to Existing Water Mains

1.2 PRICE AND PAYMENT PROCEDURES

A. Utility Lines
   1. Abandonment of Utility Line by Grouting
      a. Measurement
1) Measurement for this Item shall be per cubic yard of existing utility line to be grouted. Measure by tickets showing cubic yards of grout applied.

b. Payment
1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price per cubic yard of “Line Grouting” for:
   a) Various types of utility line

c. The price bid shall include:
1) Low density cellular grout or CLSM
2) Water
3) Pavement removal
4) Excavation
5) Hauling
6) Disposal of excess materials
7) Furnishing, placement and compaction of backfill
8) Clean-up

2. Utility Line Removal, Separate Trench

a. Measurement
1) Measurement for this Item shall be per linear foot of existing utility line to be removed.

b. Payment
1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot of “Remove Line” for:
   a) Various types of existing utility line
   b) Various sizes

c. The price bid shall include:
1) Removal and disposal of existing utility pipe
2) Pavement removal
3) Excavation
4) Hauling
5) Disposal of excess materials
6) Furnishing, placement and compaction of backfill
7) Clean-up

3. Utility Line Removal, Same Trench

a. Measurement
1) This Item is considered subsidiary the proposed utility line being installed.

b. Payment
1) The work performed and materials furnished in accordance with this Item are subsidiary to the installation of proposed utility pipe and shall be subsidiary to the unit price bid per linear foot of pipe complete in place, and no other compensation will be allowed.

4. Cathodic Test Station Abandonment

a. Measurement
1) Measurement for this Item will be per each cathodic test station to be abandoned.

b. Payment
1) The work performed and materials furnished in accordance with this Item 
and measured as provided under “Measurement” shall be paid for at the 
unit price bid per each “Abandon Cathodic Test Station”.

c. The price bid shall include:
1) Abandon cathodic test station 
2) CLSM 
3) Pavement removal 
4) Excavation 
5) Hauling 
6) Disposal of excess materials 
7) Furnishing, placement and compaction of backfill 
8) Clean-up

B. Water Lines and Appurtenances

1. Installation of a Water Line Pressure Plug
   a. Measurement
      1) Measurement for this Item shall be per each pressure plug to be installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item 
and measured as provided under “Measurement” shall be paid for at the 
unit price bid for each “Pressure Plug” installed for:
         a) Various sizes
   c. The price bid shall include:
      1) Furnishing and installing pressure plug 
      2) Pavement removal 
      3) Excavation 
      4) Hauling 
      5) Disposal of excess material 
      6) Gaskets 
      7) Bolts and Nuts 
      8) Furnishing, placement and compaction of embedment 
      9) Furnishing, placement and compaction of backfill 
     10) Disinfection 
     11) Testing 
     12) Clean-up

2. Abandonment of Water Line by Cut and installation of Abandonment Plug
   a. Measurement
      1) Measurement for this Item shall be per each cut and abandonment plug 
installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item 
and measured as provided under “Measurement” shall be paid for at the 
unit price bid for each “Water Abandonment Plug” installed for:
         a) Various sizes
   c. The price bid shall include:
      1) Furnishing and installing abandonment plug 
      2) Pavement removal 
      3) Excavation 
      4) Hauling 
      5) CLSM
6) Disposal of excess material
7) Furnishing, placement and compaction of
8) Clean-up

3. Water Valve Removal
   a. Measurement
      1) Measurement for this Item will be per each water valve to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         unit price bid per each “Remove Water Valve” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and disposal of valve
      2) CLSM
      3) Pavement removal
      4) Excavation
      5) Hauling
      6) Disposal of excess materials
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

4. Water Valve Removal and Salvage
   a. Measurement
      1) Measurement for this Item will be per each water valve to be removed and
         salvaged.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         unit price bid per each “Salvage Water Valve” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and Salvage of valve
      2) CLSM
      3) Delivery to City
      4) Pavement removal
      5) Excavation
      6) Hauling
      7) Disposal of excess materials
      8) Furnishing, placement and compaction of backfill
      9) Clean-up

5. Water Valve Abandonment
   a. Measurement
      1) Measurement for this Item will be per each water valve to be abandoned.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         unit price bid per each “Abandon Water Valve” for:
         a) Various Sizes
   c. The price bid shall include:
      1) Abandonment of valve
2) CLSM
3) Pavement removal
4) Excavation
5) Hauling
6) Disposal of excess materials
7) Furnishing, placement and compaction of backfill
8) Clean-up

6. Fire Hydrant Removal and Salvage
   a. Measurement
      1) Measurement for this Item will be per each fire hydrant to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Salvage Fire Hydrant”.
   c. The price bid shall include:
      1) Removal and salvage of fire hydrant
      2) Delivery to City
      3) Pavement removal
      4) Excavation
      5) Hauling
      6) Disposal of excess materials
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

7. Water Meter Removal and Salvage
   a. Measurement
      1) Measurement for this Item will be per each water meter to be removed and salvaged.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Salvage Water Meter” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and salvage of water meter
      2) Delivery to City
      3) Pavement removal
      4) Excavation
      5) Hauling
      6) Disposal of excess materials
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

8. Water Sampling Station Removal and Salvage
   a. Measurement
      1) Measurement for this Item will be per each water sampling station to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Salvage Water Sampling Station”.
c. The price bid shall include:
   1) Removal and salvage of water sampling station
   2) Delivery to City
   3) Pavement removal
   4) Excavation
   5) Hauling
   6) Disposal of excess materials
   7) Furnishing, placement and compaction of backfill
   8) Clean-up

9. Concrete Water Vault Removal
   a. Measurement
      1) Measurement for this Item will be per each concrete water vault to be
         removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         unit price bid per each “Remove Concrete Water Vault”.
   c. The price bid shall include:
      1) Removal and disposal of concrete water vault
      2) Removal, salvage and delivery of cast iron lid to City, if applicable
      3) Removal, salvage and delivery of any valves to City, if applicable
      4) Removal, salvage and delivery of any water meters to City, if applicable
      5) Pavement removal
      6) Excavation
      7) Hauling
      8) Disposal of excess materials
      9) Furnishing, placement and compaction of backfill
      10) Clean-up

C. Sanitary Sewer Lines and Appurtenances

1. Abandonment of Sanitary Sewer Line by Cut and installation of Abandonment Plug
   a. Measurement
      1) Measurement for this Item shall be per each cut and abandonment plug
         installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         unit price bid for each “Sewer Abandonment Plug” for:
            a) Various sizes
   c. The price bid shall include:
      1) Furnishing and installing abandonment plug
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) CLSM
      6) Disposal of excess material
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

2. Sanitary Sewer Manhole Removal
   a. Measurement
1) Measurement for this Item will be per each sanitary sewer manhole to be removed.

b. Payment

1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Remove Sewer Manhole” for:

a) Various diameters

c. The price bid shall include:

1) Removal and disposal of manhole
2) Removal, salvage and delivery of cast iron lid to City, if applicable
3) Cutting and plugging of existing sewer lines
4) Pavement removal
5) Excavation
6) Hauling
7) Disposal of excess materials
8) Furnishing, placement and compaction of backfill
9) Clean-up

3. Sanitary Sewer Junction Structure Removal

a. Measurement

1) Measurement for this Item will be per each sanitary sewer junction structure being removed.

b. Payment

1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the lump sum bid per each “Remove Sewer Junction Box” location.

c. The price bid shall include:

1) Removal and disposal of junction box
2) Pavement removal
3) Excavation
4) Hauling
5) Disposal of excess materials
6) Furnishing, placement and compaction of backfill
7) Clean-up

D. Storm Sewer Lines and Appurtenances

1. Abandonment of Storm Sewer Line by Cut and installation of Abandonment Plug

a. Measurement

1) Measurement for this Item shall be per each cut and abandonment plug to be installed.

b. Payment

1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid for each “Storm Abandonment Plug” installed for:

a) Various sizes

c. The price bid shall include:

1) Furnishing and installing abandonment plug
2) Pavement removal
3) Excavation
4) Hauling
5) CLSM
2. Storm Sewer Manhole Removal
   a. Measurement
      1) Measurement for this Item will be per each storm sewer manhole to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Remove Manhole Riser” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and disposal of manhole
      2) Removal, salvage and delivery of cast iron lid to City, if applicable
      3) Pavement removal
      4) Excavation
      5) Hauling
      6) Disposal of excess materials
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

3. Storm Sewer Junction Box Removal
   a. Measurement
      1) Measurement for this Item will be per each storm sewer junction structure to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Remove Storm Junction Box” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and disposal of junction box
      2) Removal, salvage and delivery of cast iron lid to City, if applicable
      3) Pavement removal
      4) Excavation
      5) Hauling
      6) Disposal of excess materials
      7) Furnishing, placement and compaction of backfill
      8) Clean-up

4. Storm Sewer Junction Structure Removal
   a. Measurement
      1) Measurement for this Item will be per each storm sewer junction structure being removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the lump sum bid per each “Remove Storm Junction Structure” location.
   c. The price bid shall include:
      1) Removal and disposal of junction structure
2) Removal, salvage and delivery of cast iron lid to City, if applicable
3) Pavement removal
4) Excavation
5) Hauling
6) Disposal of excess materials
7) Furnishing, placement and compaction of backfill
8) Clean-up

5. Storm Sewer Inlet Removal
   a. Measurement
      1) Measurement for this Item will be per each storm sewer inlet to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Remove Storm Inlet” for:
         a) Various types
         b) Various sizes
   c. The price bid shall include:
      1) Removal and disposal of inlet
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess materials
      6) Furnishing, placement and compaction of backfill
      7) Clean-up

6. Storm Sewer Junction Box Removal
   a. Measurement
      1) Measurement for this Item shall be per linear foot of existing storm sewer box to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot of “Remove Storm Junction Box” for all sizes.
   c. The price bid shall include:
      1) Removal and disposal of Storm Sewer Box
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess materials
      6) Furnishing, placement and compaction of backfill
      7) Clean-up

7. Headwall/SET Removal
   a. Measurement
      1) Measurement for this Item will be per each headwall or safety end treatment (SET) to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per each “Remove Headwall/SET”.

CITY OF FORT WORTH
STANDARD CONSTRUCTION SPECIFICATION DOCUMENTS
Draft 5/14/2012 2:56 PM
Revised July 1, 2011
c. The price bid shall include:
   1) Removal and disposal of Headwall/SET
   2) Pavement removal
   3) Excavation
   4) Hauling
   5) Disposal of excess materials
   6) Furnishing, placement and compaction of
   7) Clean-up

8. Trench Drain Removal
   a. Measurement
      1) Measurement for this Item shall be per linear foot of storm sewer trench
      drain to be removed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
      and measured as provided under “Measurement” shall be paid for at the
      unit price bid per linear foot of “Remove Trench Drain” for:
         a) Various sizes
   c. The price bid shall include:
      1) Removal and disposal of storm sewer line
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess materials
      6) Furnishing, placement and compaction of backfill
      7) Clean-up

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

  A. Coordination
     1. Contact Inspector and the Water Department Field Operation Storage Yard for
        coordination of salvage material return.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

  A. Storage and Handling Requirements
     1. Protect and salvage all materials such that no damage occurs during delivery to the
        City.
1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 REMOVAL, SALVAGE, AND ABANDONMENT

A. Water Lines and Appurtenances

1. Water Line Pressure Plugs

a. Ductile Iron Water Lines

1) Excavate, embed, and backfill in accordance with Section 33 05 10.

2) Plug with an MJ Plug with mechanical restraint and blocking in accordance
   with Section 33 11 11.

3) Perform Cut and Plug in accordance with Section 33 12 25.

b. PVC C900 and C905 Water Lines

1) Excavate, embed, and backfill in accordance with Section 33 05 10.

2) Plug with an MJ Plug with mechanical restraint and blocking in accordance
   with Section 33 11 11.

3) Perform Cut and Plug in accordance with Section 33 12 25.

c. Concrete Pressure Pipe, Bar Wrapped, Steel Cylinder Type Water Lines

1) Excavate, embed, and backfill in accordance with Section 33 05 10.

2) Plug using:

   a) A fabricated plug restrained by welding or by a Snap Ring in
      accordance with Section 33 11 13; or

   b) A blind flange in accordance with Section 33 11 13

3) Perform Cut and Plug in accordance with Section 33 12 25.

d. Buried Steel Water Lines

1) Excavate, embed, and backfill in accordance with Section 33 05 10.

2) Plug using:

   a) A fabricated plug restrained by welding in accordance with Section 33
      11 14; or

   b) A blind flange in accordance with Section 33 11 14

3) Perform Cut and Plug in accordance with Section 33 12 25.

2. Water Line Abandonment Plug
a. Excavate and backfill in accordance with Section 33 05 10.
b. Plug with CLSM in accordance with Section 03 34 13.

3. Water Line Abandonment by Grouting
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Dewater from existing line to be grouted.
   c. Fill line with Low Density Cellular Grout in accordance with Section 33 05 24
      or CLSM in accordance with 03 34 13.
   d. Dispose of any excess material.

4. Water Line Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Cut existing line from the utility system prior to removal.
   c. Cut any services prior to removal.
   d. Remove existing pipe line and properly dispose as approved by the Engineer.

5. Water Valve Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove and dispose of valve bonnet, wedge and stem.
   c. Fill valve body with CLSM in accordance with Section 03 34 13.

6. Water Valve Removal and Salvage
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove valve bonnet, wedge and stem.
   c. Deliver salvaged material to the Water Department Field Operation Storage
      Yard.
   d. Protect salvaged materials from damage.
   e. Fill valve body with CLSM in accordance with Section 03 34 13.

7. Water Valve Abandonment
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove the top 2 feet of the valve stack and any valve extensions.
   c. Fill the remaining valve stack with CLSM in accordance with Section 03 34 13.

8. Fire Hydrant Removal and Salvage
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove Fire Hydrant.
   c. Place abandonment plug on fire hydrant lead line.
   d. Deliver salvaged fire hydrant to the Water Department Field Operation Storage
      Yard.
   e. Protect salvaged materials from damage.

9. Water Meter Removal and Salvage
   a. Remove and salvage water meter.
   b. Return salvaged meter to Project Representative.
   c. City will provide replacement meter for installation.
   d. Meter Box and Lid
      1) Remove and salvage cast iron meter box lid.
      2) Remove and dispose of any non-cast iron meter box lid.
      3) Return salvaged material to the Water Department Field Operation Storage
         Yard.
      4) Remove and dispose of meter box.

10. Water Sample Station Removal and Salvage
    a. Remove and salvage existing water sample station.
b. Deliver salvaged material to the Water Department Field Operation Storage Yard.

11. Concrete Water Vault Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove and salvage vault lid.
   c. Remove and salvage valves.
   d. Remove and salvage meters.
   e. Deliver salvaged material to the Water Department Field Operation Storage Yard.
   f. Remove and dispose of any piping or other appurtenances.
   g. Demolish and remove entire concrete vault.
   h. Dispose of all excess materials.

12. Cathodic Test Station Abandonment
   a. Excavate and backfill in accordance with Section 33 05 10
   b. Remove the top 2 feet of the cathodic test station stack and contents.
   c. Fill any remaining voids with CLSM in accordance with Section 03 34 13.

B. Sanitary Sewer Lines and Appurtenances

1. Sanitary Sewer Line Abandonment Plug
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove and dispose of any sewage.
   c. Plug with CLSM in accordance with Section 03 34 13.

2. Sanitary Sewer Line Abandonment by Grouting
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Dewater and dispose of any sewage from the existing line to be grouted.
   c. Fill line with Low Density Cellular Grout in accordance with Section 33 05 24
      or CLSM in accordance with 03 34 13.
   d. Dispose of any excess material.

3. Sanitary Sewer Line Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Cut existing line from the utility system prior to removal.
   c. Cut any services prior to removal.
   d. Remove existing pipe line and properly dispose as approved by the Engineer.

4. Sanitary Sewer Manholes Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove and salvage manhole lid.
   c. Deliver salvaged material to the Water Department Field Operation Storage.
   d. Demolish and remove entire concrete manhole.
   e. Cut and plug sewer lines to be abandoned.

5. Sanitary Sewer Junction Structure Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove and salvage manhole lid.
   c. Deliver salvaged material to the Water Department Field Operation Storage.
   d. Demolish and remove entire concrete manhole.
   e. Cut and plug sewer lines to be abandoned.

C. Storm Sewer Lines and Appurtenances

1. Storm Sewer Abandonment Plug
   a. Excavate and backfill in accordance with Section 33 05 10.
2. Storm Sewer Line Abandonment by Grouting
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Dewater the existing line to be grouted.
   c. Fill line with Low Density Cellular Grout in accordance with Section 33 05 24
      or CLSM in accordance with 03 34 13.
   d. Dispose of any excess material.

3. Storm Sewer Line Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove existing pipe line and properly dispose as approved by the Engineer.

4. Storm Sewer Manholes Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Demolish and remove entire concrete manhole.
   c. Cut and plug storm sewer lines to be abandoned.

5. Storm Sewer Junction Box and/or Junction Structure Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Demolish and remove entire concrete structure.
   c. Cut and plug storm sewer lines to be abandoned.

6. Storm Sewer Inlet Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Demolish and remove entire concrete inlet.
   c. Cut and plug storm sewer lines to be abandoned.

7. Storm Sewer Box Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Cut existing line from the utility system prior to removal.
   c. Cut any services prior to removal.
   d. Remove existing pipe line and properly dispose as approved by the Engineer.

8. Headwall/SET Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Demolish and remove entire concrete inlet.
   c. Cut and plug storm sewer lines to be abandoned.

9. Storm Sewer Trench Drain Removal
   a. Excavate and backfill in accordance with Section 33 05 10.
   b. Remove existing pipe line and dispose as approved by the Engineer.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 02 41 15
PAVING REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Removing concrete paving, asphalt paving and brick paving.
2. Removing concrete curb and gutter.
3. Removing concrete valley gutter.
5. Pulverization of existing pavement.

B. Deviations from City of Fort Worth Standards
1. None

C. Related Specification Sections include but are not necessarily limited to
1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 1 - General Requirements
3. Section 32 11 33 - Cement Treated Base Course

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Measurement
   a. Remove Concrete Paving: measure by the square yard from back-to-back of curbs.
   b. Remove Asphalt Paving: measure by the square yard between the lips of gutters.
   c. Remove Brick Paving: measure by the square yard.
   d. Remove Concrete Curb and Gutter: measure by the linear foot.
   e. Remove Concrete Valley Gutter: measure by the square yard
   f. Wedge Milling: measure by the square yard for varying thickness.
   g. Surface Milling: measure by the square yard for varying thickness.
   h. Butt Milling: measured by the linear foot.
   i. Pavement Pulverization: measure by the square yard.
   j. Remove Speed Cushion: measure by each.

2. Payment
   a. Remove Concrete Paving: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.
   b. Remove Asphalt Paving: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.
   c. Remove Brick Paving: full compensation for saw cutting, removal, salvaging, cleaning, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.
d. Remove Concrete Curb and Gutter: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

e. Remove Concrete Valley Gutter: full compensation for saw cutting, removal, hauling, disposal, tools, equipment, labor and incidentals needed to execute work.

f. Wedge Milling: full compensation for all milling, hauling milled material to salvage stockpile or disposal, tools, labor, equipment and incidentals necessary to execute the work.

g. Surface Milling: full compensation for all milling, hauling milled material to salvage stockpile or disposal, tools, labor, equipment and incidentals necessary to execute the work.

h. Butt Milling: full compensation for all milling, hauling milled material to salvage stockpile or disposal, tools, labor, equipment and incidentals necessary to execute the work.

i. Pavement Pulverization: full compensation for all labor, material, equipment, tools and incidentals necessary to pulverize, remove and store the pulverized material, undercut the base, mixing, compaction, haul off, sweep, and dispose of the undercut material.

j. Remove speed cushion: full compensation for removal, hauling, disposal, tools, equipment, labor, and incidentals needed to execute the work.

k. No payment for saw cutting of pavement or curbs and gutters will be made under this section. Include cost of such work in unit prices for items listed in bid form requiring saw cutting.

l. No payment will be made for work outside maximum payment limits indicated on plans, or for pavements or structures removed for CONTRACTOR’s convenience.

1.3 REFERENCES

A. ASTM International (ASTM):

   a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]
1.5 SUBMITTALS [NOT USED]
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]
2.2 EQUIPMENT [NOT USED]
2.3 ACCESSORIES [NOT USED]
2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 EXAMINATION [NOT USED]
3.2 INSTALLERS [NOT USED]
3.3 PREPARATION

A. General:
   1. Mark paving removal limits for the Engineer approval prior to beginning removal.
   2. Identify known utilities below grade - Stake and flag locations.

3.4 PAVEMENT REMOVAL

A. General.
   1. Exercise caution to minimize damage to underground utilities.
   2. Minimize amount of earth removed.
   3. Remove paving to neatly sawed joints.
   4. Use care to prevent fracturing adjacent, existing pavement.

B. Sawing
   1. Sawing Equipment.
      a. Power-driven.
      b. Manufactured for the purpose of sawing pavement.
      c. In good operating condition.
      d. Shall not spall or fracture the pavement structure adjacent to the removal area.
   2. Sawcut perpendicular to the surface to full pavement depth, parallel and
      perpendicular to existing joint.
   3. Sawcut parallel to the original sawcut in square or rectangular fashion.
4. If a sawcut falls within 5 feet of an existing dummy joint, construction joint, saw joint, cold joint, expansion joint, edge of paving or gutter lip, remove paving to that joint, edge or lip.

5. If a pavement edge of a cut is damaged subsequent to saw cutting, saw to a new, neat, straight line for the purpose of removing the damaged area.

C. Remove Concrete Paving and Concrete Valley Gutter
   1. Sawcut: See 3.4.B.
   2. Remove concrete to the nearest expansion joint or vertical saw cut.

D. Remove Concrete Curb and Gutter
   1. Sawcut: See 3.4.B.

E. Remove Asphalt Paving
   1. Sawcut: See 3.4.B.
   2. Remove pavement without disturbing the base material.
   3. When shown on the plans or as directed, stockpile materials designated as salvageable at designated sites.
   4. Prepare stockpile area by removing vegetation and trash and by providing for proper drainage.

F. Milling
   1. General:
      a. Mill surfaces to the depth shown in the plans or as directed.
      b. Do not damage or disfigure adjacent work or existing surface improvements.
      c. If milling exposes smooth underlying pavement surfaces, mill the smooth surface to make rough.
      d. Provide safe temporary transition where vehicles or pedestrians must pass over the milled edges.
      e. Remove excess material and clean milled surfaces.
      f. Stockpiling of planed material will not be permitted within the right of way unless approved by the Engineer.
      g. If the existing base is brick and cannot be milled, remove a 5 foot width of the existing brick base. See 3.3.G. for brick paving removal.
   2. Milling Equipment
      a. Power operated milling machine capable of removing, in one pass or two passes, the necessary pavement thickness in a five-foot minimum width.
      b. Self-propelled with sufficient power, traction and stability to maintain accurate depth of cut and slope.
      c. Equipped with an integral loading and reclaiming means to immediately remove material cut from the surface of the roadway and discharge the cuttings into a truck, all in one operation.
      d. Equipped with means to control dust created by the cutting action.
      e. Equipped with a manual system providing for uniformly varying the depth of cut while the machine is in motion making it possible to cut flush to all inlets, manholes, or other obstructions within the paved area.
      f. Variable Speed in order to leave the specified grid pattern.
      g. Equipped to minimize air pollution.
3. Wedge Milling and Surface Milling
   a. Wedge Mill existing asphalt, concrete or brick pavement from the lip of gutter
      at a depth of 2 inches and transitioning to match the existing pavement (0-inch
cut) at a minimum width of 5 feet.
   b. Surface Mill existing asphalt pavement to the depth specified.
   c. Provide a milled surface that provides a uniform surface free from gouges,
      ridges, oil film, and other imperfections of workmanship with a uniform
      textured appearance.
   d. In all situations where the existing H.M.A.C. surface contacts the curb face, the
      wedge milling includes the removal of the existing asphalt covering the gutter
      up to and along the face of curb.
   e. Perform wedge or surface milling operation in a continuous manner along both
      sides of the street or as directed.
4. Butt Joint Milling
   a. Mill butt joints into the existing surface, in association with the wedge milling
      operation.
   b. Butt joint will provide a full width transition section and a constant depth at the
      point where the new overlay is terminated.
   c. Typical locations for butt joints are at all beginning and ending points of streets
      where paving material is removed. Prior to the milling of the butt joints,
      consult with the City for proper location and limits of these joints.
   d. Butt Milled joints are required on both sides of all railroad tracks and concrete
      valley gutters, bridge decks and culverts and all other items which transverse
      the street and end the continuity of the asphalt surface.
   e. Make each butt joint 20 feet long and milled out across the full width of the
      street section to a tapered depth of 2 inch.
   f. Taper the milled area within the 20-feet to a depth from 0-inch to 2-inch at a
      line adjacent to the beginning and ending points or intermediate transverse
      items.
   g. Provide a temporary wedge of asphalt at all butt joints to provide a smooth ride
      over the bump.
G. Remove Brick Paving
   1. Remove masonry paving units to the limits specified in the plans or as directed by
      the City.
   2. Salvage existing bricks for re-use, clean, palletize, and deliver to the City Stock pile
      yard at 3300 Yuma Street or as directed.
H. Pavement Pulverization
   1. Pulverization
      a. Pulverize the existing pavement to depth of 8 inches. See Section 32 11 33.
      b. Temporarily remove and store the 8-inch deep pulverized material, then cut the
         base 2 inches.
      c. Start 2-inch base cut at a depth of 8 inches from the existing pulverized surface.
   2. Cement Application
      a. Use 3.5% Portland cement.
      b. See Section 32 11 33.
   3. Mixing: see Section 32 11 33.
   4. Compaction: see Section 32 11 33.
5. Finishing: see Section 32 11 33.
6. Curing: see Section 32 11 33.
7. If the existing pavement has a combination of 10 inches of H.M.A.C. and crushed stone/gravel:
   a. Undercut not required
   b. Pulverize 10 inches deep.
   c. Remove 2-inch the total pulverized amount.

I. Remove speed cushion
   1. Scrape or sawcut speed cushion from existing pavement without damaging existing pavement.

| 3.5 | REPAIR [NOT USED] |
| 3.6 | RE-INSTALLATION [NOT USED] |
| 3.7 | FIELD QUALITY CONTROL [NOT USED] |
| 3.8 | SYSTEM STARTUP [NOT USED] |
| 3.9 | ADJUSTING [NOT USED] |
| 3.10 | CLEANING [NOT USED] |
| 3.11 | CLOSEOUT ACTIVITIES [NOT USED] |
| 3.12 | PROTECTION [NOT USED] |
| 3.13 | MAINTENANCE [NOT USED] |
| 3.14 | ATTACHMENTS [NOT USED] |

**END OF SECTION**

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Revised July 1, 2011
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Cast-in-place concrete, including formwork, reinforcement, concrete materials,
mixture design, placement procedures and finishes, for the following:
   a. Piers
   b. Footings
   c. Slabs-on-grade
   d. Foundation walls
   e. Retaining walls
   f. Suspended slabs
   g. Blocking

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. This Item is considered subsidiary to the structure or Items being placed.
   2. Payment
      a. The work performed and the materials furnished in accordance with this Item
         are subsidiary to the structure or Items being placed and no other compensation
         will be allowed.

1.3 REFERENCES

A. Definitions
   1. Cementitious Materials
      a. Portland cement alone or in combination with 1 or more of the following:
         1) Blended hydraulic cement
         2) Fly ash
         3) Other pozzolans
         4) Ground granulated blast-furnace slag
         5) Silica fume
      b. Subject to compliance with the requirements of this specification

B. Reference Standards
1. Reference standards cited in this Specification refer to the current reference
   standard published at the time of the latest revision date logged at the end of this
   Specification, unless a date is specifically cited.

2. American Association of State Highway and Transportation (AASHTO):
   a. M182, Burlap Cloth Made from Jute or Kenaf.

3. American Concrete Institute (ACI):
   a. ACI 117 Specification for Tolerances for Concrete Construction and Materials
   b. ACI 301 Specifications for Structural Concrete
   c. ACI 305.1 Specification for Hot Weather Concreting
   d. ACI 306.1 Standard Specification for Cold Weather Concreting
   e. ACI 308.1 Standard Specification for Curing Concrete
   f. ACI 318 Building Code Requirements for Structural Concrete
   g. ACI 347 Guide to Formwork for Concrete

4. American Institute of Steel Construction (AISC):

5. ASTM International (ASTM):
   b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel
      Hardware.
   c. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting
      Materials for High-Temperature Service and Other Special Purpose
      Applications.
   d. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for
      Concrete Reinforcement.
   e. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for
      Concrete Reinforcement.
   f. C31, Standard Practice for Making and Curing Concrete Test Specimens in the
      Field.
   g. C33, Standard Specification for Concrete Aggregates.
   h. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete
      Specimens.
   i. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed
      Beams of Concrete.
      Mortars (Using 2-inch or [50-milimeter] Cube Specimens)
   o. C172, Standard Practice for Sampling Freshly Mixed Concrete.
   q. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the
      Pressure Method.
   s. C309, Standard Specification for Liquid Membrane-Forming Compounds for
      Curing Concrete.
1. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

   a. D1.1, Structural Welding Code - Steel.
   b. D1.4, Structural Welding Code - Reinforcing Steel.

7. Concrete Reinforcing Steel Institute (CRSI)
   a. Manual of Standard Practice

8. Texas Department of Transportation
   a. Standard Specification for Construction and Maintenance of Highways, Streets and Bridges

1.4 ADMINISTRATIVE REQUIREMENTS

A. Work Included
   1. Design, fabrication, erection and stripping of formwork for cast-in-place concrete including shoring, reshoring, falsework, bracing, proprietary forming systems, prefabricated forms, void forms, permanent metal forms, bulkheads, keys, blockouts, sleeves, pockets and accessories.
      a. Erection shall include installation in formwork of items furnished by other trades.
   2. Furnish all labor and materials required to fabricate, deliver and install reinforcement and embedded metal assemblies for cast-in-place concrete, including steel bars, welded steel wire fabric, ties, supports and sleeves.
   3. Furnish all labor and materials required to perform the following:
      a. Cast-in-place concrete
      b. Concrete mix designs
      c. Grouting

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery and/or fabrication for specials.
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Required for each type of product indicated

B. Design Mixtures
   1. For each concrete mixture submit proposed mix designs in accordance with ACI 318, chapter 5.
   2. Submit each proposed mix design with a record of past performance.
   3. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results or other circumstances warrant adjustments.
   4. Indicate amounts of mixing water to be withheld for later addition at Project site.
      a. Include this quantity on delivery ticket.

C. Steel Reinforcement Submittals for Information
   1. Mill test certificates of supplied concrete reinforcing, indicating physical and chemical analysis.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment
   2. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities"

B. Source Limitations
   1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from 1 source and obtain admixtures through 1 source from a single manufacturer.

C. ACI Publications
   1. Comply with the following unless modified by requirements in the Contract Documents:
      a. ACI 301 Sections 1 through 5
      b. ACI 117

D. Concrete Testing Service
   1. Engage a qualified independent testing agency to perform material evaluation tests.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement
   1. Deliver, store, and handle steel reinforcement to prevent bending and damage.
   2. Avoid damaging coatings on steel reinforcement.
B. Waterstops
   1. Store waterstops under cover to protect from moisture, sunlight, dirt, oil and other contaminants.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED OR OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Manufacturers
   1. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
      a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
      b. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

B. Form-Facing Materials
   1. Rough-Formed Finished Concrete
      a. Plywood, lumber, metal or another approved material
      b. Provide lumber dressed on at least 2 edges and 1 side for tight fit.
   2. Chamfer Strips
      a. Wood, metal, PVC or rubber strips
      b. ¾-inch x ¾-inch, minimum
   3. Rustication Strips
      a. Wood, metal, PVC or rubber strips
      b. Kerfed for ease of form removal
   4. Form-Release Agent
      a. Commercially formulated form-release agent that will not bond with, stain or adversely affect concrete surfaces
      b. Shall not impair subsequent treatments of concrete surfaces
      c. For steel form-facing materials, formulate with rust inhibitor.
   5. Form Ties
      a. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
      b. Furnish units that will leave no corroding metal closer than 1 inch to the plane of exposed concrete surface.
      c. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
d. Furnish ties with integral water-barrier plates to walls indicated to receive
damproofing or waterproofing.

C. Steel Reinforcement

1. Reinforcing Bars
   a. ASTM A615, Grade 60, deformed

D. Reinforcement Accessories

1. Smooth Dowel Bars
   a. ASTM A615, Grade 60, steel bars (smooth)
   b. Cut bars true to length with ends square and free of burrs.

2. Bar Supports
   a. Bolsters, chairs, spacers and other devices for spacing, supporting and fastening
      reinforcing bars and welded wire reinforcement in place
   b. Manufacture bar supports from steel wire, plastic or precast concrete according
      to CRSI's "Manual of Standard Practice," of greater compressive strength than
      concrete and as follows:
      1) For concrete surfaces exposed to view where legs of wire bar supports
         contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI
         Class 2 stainless-steel bar supports.
      2) For slabs-on-grade, provide sand plates, horizontal runners or precast
         concrete blocks on bottom where base material will not support chair legs
         or where vapor barrier has been specified.

E. Embedded Metal Assemblies

1. Steel Shapes and Plates: ASTM A36

2. Headed Studs: Heads welded by full-fusion process, as furnished by TRW Nelson
   Stud Welding Division or approved equal

F. Expansion Anchors

1. Available Products
   a. Wej-it Bolt, Wej-it Corporation, Tulsa, Oklahoma
   b. Kwik Bolt II, Hilti Fastening Systems, Tulsa, Oklahoma
   c. Trubolt, Ramset Fastening Systems, Paris, Kentucky

G. Adhesive Anchors and Dowels

1. Adhesive anchors shall consist of threaded rods anchored with an adhesive system
   into hardened concrete or grout-filled masonry.
   a. The adhesive system shall use a 2-component adhesive mix and shall be
      injected with a static mixing nozzle following manufacturer’s instructions.
   b. The embedment depth of the rod shall provide a minimum allowable bond
      strength that is equal to the allowable yield capacity of the rod, unless otherwise
      specified.

2. Available Products
   a. Hilti HIT HY 150 Max
   b. Simpson Acrylic-Tie
   c. Powers Fasteners AC 100+ Gold

3. Threaded Rods: ASTM A193
H. Inserts
  1. Provide metal inserts required for anchorage of materials or equipment to concrete
     construction where not supplied by other trades:
     a. In vertical concrete surfaces for transfer of direct shear loads only, provide
        adjustable wedge inserts of malleable cast iron complete with bolts, nuts and
        washers.
        1) Provide ¾-inch bolt size, unless otherwise indicated.
     b. In horizontal concrete surfaces and whenever inserts are subject to tension
        forces, provide threaded inserts of malleable cast iron furnished with full depth
        bolts.
        1) Provide ¾-inch bolt size, unless otherwise indicated.

I. Concrete Materials
  1. Cementitious Material
     a. Use the following cementitious materials, of the same type, brand, and source,
        throughout Project:
        1) Portland Cement
           a) ASTM C150, Type I/II, gray
           b) Supplement with the following:
              (1) Fly Ash
              (a) ASTM C618, Class C or F
              (2) Ground Granulated Blast-Furnace Slag
              (a) ASTM C989, Grade 100 or 120.
        2) Silica Fume
           a) ASTM C1240, amorphous silica
        3) Normal-Weight Aggregates
           a) ASTM C33, Class 3S coarse aggregate or better, graded
           b) Provide aggregates from a single source.
        4) Maximum Coarse-Aggregate Size
           a) ¾-inch nominal
        5) Fine Aggregate
           a) Free of materials with deleterious reactivity to alkali in cement
        6) Water
           a) ASTM C94 and potable

J. Admixtures
  1. Air-Entraining Admixture
     a. ASTM C260
  2. Chemical Admixtures
     a. Provide admixtures certified by manufacturer to be compatible with other ad-
        mixtures and that will not contribute water-soluble chloride ions exceeding
        those permitted in hardened concrete.
     b. Do not use calcium chloride or admixtures containing calcium chloride.
     c. Water-Reducing Admixture
        1) ASTM C494, Type A
d. Retarding Admixture
   1) ASTM C494, Type B

e. Water-Reducing and Retarding Admixture
   1) ASTM C494, Type D

f. High-Range, Water-Reducing Admixture
   1) ASTM C494, Type F

g. High-Range, Water-Reducing and Retarding Admixture
   1) ASTM C494, Type G

h. Plasticizing and Retarding Admixture
   1) ASTM C1017, Type II

K. Waterstops

  1. Self-Expanding Butyl Strip Waterstops
   a. Manufactured rectangular or trapezoidal strip, butyl rubber with sodium
      bentonite or other hydrophilic polymers, for adhesive bonding to concrete, ¾-
      inch x 1-inch.
   b. Available Products
      1) Colloid Environmental Technologies Company; Volclay Waterstop-RX
      2) Concrete Sealants Inc.; Conseat CS-231
      3) Greenstreak; Swellstop
      4) Henry Company, Sealants Division; Hydro-Flex
      5) JP Specialties, Inc.; Earthshield Type 20
      6) Progress Unlimited, Inc.; Superstop
      7) TCMiraDRI; Mirastop

L. Curing Materials

  1. Absorptive Cover
     a. AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing
        approximately 9 ounces/square yard when dry

  2. Moisture-Retaining Cover
     a. ASTM C171, polyethylene film or white burlap-polyethylene sheet

  3. Water
     a. Potable

  4. Clear, Waterborne, Membrane-Forming Curing Compound
     a. ASTM C309, Type 1, Class B, dissipating
     b. Available Products
        1) Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB
        2) Burke by Edoco; Aqua Resin Cure
        3) ChemMasters; Safe-Cure Clear
        4) Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior
           Company; W.B. Resin Cure
        5) Dayton Superior Corporation; Day Chem Rez Cure (J-11-W)
        6) Euclid Chemical Company (The); Kurez DR VOX
        7) Kaufman Products, Inc.; Thinfilm 420
        8) Lambert Corporation; Aqua Kure-Clear
        9) L&M Construction Chemicals, Inc.; L&M Cure R
        10) Meadows, W. R., Inc.; 1100 Clear
        11) Nox-Crete Products Group, Kinsman Corporation; Resin Cure E
12) Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure
13) Tamms Industries, Inc.; Horncure WB 30
14) Unitex; Hydro Cure 309
15) US Mix Products Company; US Spec Maxcure Resin Clear
16) Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100

M. Related Materials

1. Bonding Agent
   a. ASTM C1059, Type II, non-dispersible, acrylic emulsion or styrene
   butadiene

2. Epoxy Bonding Adhesive
   a. ASTM C881, 2-component epoxy resin, capable of humid curing and bonding
   to damp surfaces, of class suitable for application temperature and of grade to
   suit requirements, and as follows:
   1) Types I and II, non-load bearing
   2) IV and V, load bearing, for bonding
   3) Hardened or freshly mixed concrete to hardened concrete

3. Reglets
   a. Fabricate reglets of not less than 0.0217-inch thick, galvanized steel sheet
   b. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete
   or debris.

4. Sleeves and Blockouts
   a. Formed with galvanized metal, galvanized pipe, polyvinyl chloride pipe, fiber
   tubes or wood

5. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages
   a. Sized as required
   b. Shall be of strength and character to maintain formwork in place while placing
   concrete

N. Repair Materials

1. Repair Underlayement
   a. Cement-based, polymer-modified, self-leveling product that can be applied in
   thicknesses of 1/8 inch or greater
   1) Do not feather.
   b. Cement Binder
   1) ASTM C150, portland cement or hydraulic or blended hydraulic cement as
   defined in ASTM C219
   c. Primer
   1) Product of underlayment manufacturer recommended for substrate, condi-
   tions, and application
   d. Aggregate
   1) Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as
   recommended by underlayment manufacturer
   e. Compressive Strength
   1) Not less than 4100 psi at 28 days when tested according to
   ASTM C109/C109M

2. Repair Overlayment
a. Cement-based, polymer-modified, self-leveling product that can be applied in
thicknesses of 1/8 inch or greater
  1) Do not feather.

b. Cement Binder
  1) ASTM C150, portland cement or hydraulic or blended hydraulic cement as
defined in ASTM C219

c. Primer
  1) Product of topping manufacturer recommended for substrate, conditions,
and application

d. Aggregate
  1) Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommend-
ed by topping manufacturer

e. Compressive Strength
  1) Not less than 5000 psi at 28 days when tested according to ASTM C109

O. Concrete Mixtures, General

1. Prepare design mixtures for each type and strength of concrete, proportioned on the
basis of laboratory trial mixture or field test data, or both, according to ACI 301.

a. Required average strength above specified strength
  1) Based on a record of past performance
     a) Determination of required average strength above specified strength
        shall be based on the standard deviation record of the results of at least
        30 consecutive strength tests in accordance with ACI 318, Chapter 5.3
        by the larger amount defined by formulas 5-1 and 5-2.

     2) Based on laboratory trial mixtures
        a) Proportions shall be selected on the basis of laboratory trial batches
           prepared in accordance with ACI 318, Chapter 5.3.2.2 to produce an
           average strength greater than the specified strength $f'_c$ by the amount
           defined in table 5.3.2.2.

     3) Proportions of ingredients for concrete mixes shall be determined by an in-
        dependent testing laboratory or qualified concrete supplier.

     4) For each proposed mixture, at least 3 compressive test cylinders shall be
        made and tested for strength at the specified age.
         a) Additional cylinders may be made for testing for information at earlier
            ages.

2. Cementitious Materials

a. Limit percentage, by weight, of cementitious materials other than portland ce-
   ment in concrete as follows, unless specified otherwise:
   1) Fly Ash: 25 percent
   2) Combined Fly Ash and Pozzolan: 25 percent
   3) Ground Granulated Blast-Furnace Slag: 50 percent
   4) Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace
      Slag: 50 percent
   5) Portland cement minimum, with fly ash or pozzolan not exceeding 25 per-
      cent
   6) Silica Fume: 10 percent
7) Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent

8) Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent

3. Limit water-soluble, chloride-ion content in hardened concrete to 0.1 percent by weight of cement.

4. Admixtures
   a. Use admixtures according to manufacturer's written instructions.
   b. Do not use admixtures which have not been incorporated and tested in accepted mixes.
   c. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   d. Use water-reducing and retarding admixture when required by high temperatures, low humidity or other adverse placement conditions.
   e. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
   f. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

P. Concrete Mixtures
   1. Refer to TxDOT “Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges” for:
      a. Culverts
      b. Headwalls
      c. Wingwalls
   2. Proportion normal-weight concrete mixture as follows:
      a. Minimum Compressive Strength: 3,000 psi at 28 days
      b. Maximum Water-Cementitious Materials Ratio: 0.50
      c. Slump Limit: 5 inches or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch
      d. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size

Q. Fabricating Reinforcement
   1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

R. Fabrication of Embedded Metal Assemblies
   1. Fabricate metal assemblies in the shop. Holes shall be made by drilling or punching. Holes shall not be made by or enlarged by burning. Welding shall be in accordance with AWS D1.1.
   2. Metal assemblies exposed to earth, weather or moisture shall be hot dip galvanized. All other metal assemblies shall be either hot dip galvanized or painted with an epoxy paint. Repair galvanizing after welding with a Cold Galvanizing compound installed in accordance with the manufacturer's instructions. Repair painted assemblies after welding with same type of paint.
S. Concrete Mixing

1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.
   a. When air temperature is between 85 and 90 degrees Fahrenheit, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees Fahrenheit, reduce mixing and delivery time to 60 minutes.

2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   a. For mixer capacity of 1 cubic yard or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   b. For mixer capacity larger than 1 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
   c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Formwork

1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
   a. Vertical alignment
      1) Lines, surfaces and arises less than 100 feet in height - 1 inch.
      2) Outside corner of exposed corner columns and control joints in concrete exposed to view less than 100 feet in height - 1/2 inch.
      3) Lines, surfaces and arises greater than 100 feet in height - 1/1000 times the height but not more than 6 inches.
      4) Outside corner of exposed corner columns and control joints in concrete exposed to view greater than 100 feet in height - 1/2000 times the height but not more than 3 inches.
b. Lateral alignment
   1) Members - 1 inch.
   2) Centerline of openings 12 inches or smaller and edge location of larger
      openings in slabs - 1/2 inch.
   3) Sawcuts, joints, and weakened plane embedments in slabs - 3/4 inch.

c. Level alignment
   1) Elevation of slabs-on-grade - 3/4 inch.
   2) Elevation of top surfaces of formed slabs before removal of shores - 3/4
      inch.

d. Cross-sectional dimensions: Overall dimensions of beams, joists, and columns
   and thickness of walls and slabs.
   1) 12 inch dimension or less - plus 1/2 inch to minus 1/4 inch.
   2) Greater than 12 inch to 3 foot dimension - plus 1/2 inch to minus 3/8 inch.
   3) Greater than 3 foot dimension - plus 1 inch to minus 3/4 inch.

e. Relative alignment
   1) Stairs
      a) Difference in height between adjacent risers - 1/8 inch.
      b) Difference in width between adjacent treads - 1/4 inch.
      c) Maximum difference in height between risers in a flight of stairs - 3/8
         inch.
      d) Maximum difference in width between treads in a flight of stairs - 3/8
         inch.
   2) Grooves
      a) Specified width 2 inches or less - 1/8 inch.
      b) Specified width between 2 inches and 12 inches - 1/4 inch.
   3) Vertical alignment of outside corner of exposed corner columns and control
      joint grooves in concrete exposed to view - 1/4 inch in 10 feet.
   4) All other conditions - 3/8 inch in 10 feet.

3. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual,
   as follows:
   a. Class B, 1/4 inch for smooth-formed finished surfaces.
   b. Class C, 1/2 inch for rough-formed finished surfaces.

4. Construct forms tight enough to prevent loss of concrete mortar.

5. Fabricate forms for easy removal without hammering or prying against concrete
   surfaces. Provide crush or wrecking plates where stripping may damage cast
   concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5
   horizontal to 1 vertical.
   a. Install keyways, reglets, recesses, and the like, for easy removal.
   b. Do not use rust-stained steel form-facing material.

6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve
   required elevations and slopes in finished concrete surfaces. Provide and secure
   units to support screed strips; use strike-off templates or compacting-type screeds.

7. Construct formwork to cambers shown or specified on the Drawings to allow for
   structural deflection of the hardened concrete. Provide additional elevation or
   camber in formwork as required for anticipated formwork deflections due to weight
   and pressures of concrete and construction loads.
8. Foundation Elements: Form the sides of all below grade portions of beams, pier
caps, walls, and columns straight and to the lines and grades specified. Do no earth
form foundation elements unless specifically indicated on the Drawings.
9. Provide temporary openings for cleanouts and inspection ports where interior area
of formwork is inaccessible. Close openings with panels tightly fitted to forms and
securely braced to prevent loss of concrete mortar. Locate temporary openings in
forms at inconspicuous locations.
10. Chamfer exterior corners and edges of permanently exposed concrete.
11. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and
bulkheads required in the Work. Determine sizes and locations from trades
providing such items.
12. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood,
sawdust, dirt, and other debris just before placing concrete.
13. Retighten forms and bracing before placing concrete, as required, to prevent mortar
leaks and maintain proper alignment.
14. Coat contact surfaces of forms with form-release agent, according to manufacturer's
written instructions, before placing reinforcement, anchoring devices, and
embedded items.
   a. Do not apply form release agent where concrete surfaces are scheduled to
      receive subsequent finishes which may be affected by agent. Soak contact
      surfaces of untreated forms with clean water. Keep surfaces wet prior to
      placing concrete.

B. Embedded Items
1. Place and secure anchorage devices and other embedded items required for
adjoining work that is attached to or supported by cast-in-place concrete. Use
setting drawings, templates, diagrams, instructions, and directions furnished with
items to be embedded.
   a. Install anchor rods, accurately located, to elevations required and complying
      with tolerances in AISC 303, Section 7.5.
      1) Spacing within a bolt group: 1/8 inch
      2) Location of bolt group (center): ½ inch
      3) Rotation of bolt group: 5 degrees
      4) Angle off vertical: 5 degrees
      5) Bolt projection: ± 3/8 inch
   b. Install reglets to receive waterproofing and to receive through-wall flashings in
      outer face of concrete frame at exterior walls, where flashing is shown at lintels,
      shelf angles, and other conditions.

C. Removing and Reusing Forms
1. Do not backfill prior to concrete attaining 75 percent of its 28-day design
compressive strength.
2. General: Formwork for sides of beams, walls, columns, and similar parts of the
Work that does not support weight of concrete may be removed after cumulatively
curing at not less than 50 degrees Fahrenheit for 24 hours after placing concrete, if
concrete is hard enough to not be damaged by form-removal operations and curing
and protection operations are maintained.
a. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

b. Do not remove formwork supporting conventionally reinforced concrete until concrete has attained 70 percent of its specified 28 day compressive strength as established by tests of field cured cylinders. In the absence of cylinder tests, supporting formwork shall remain in place until the concrete has cured at a temperature of at least 50 degrees Fahrenheit for the minimum cumulative time periods given in ACI 347, Section 3.7.2.3. Add the period of time when the surrounding air temperature is below 50 degrees Fahrenheit, to the minimum listed time period. Formwork for 2-way conventionally reinforced slabs shall remain in place for at least the minimum cumulative time periods specified for 1-way slabs of the same maximum span.

c. Immediately resshore 2-way conventionally reinforced slabs after formwork removal. Reshores shall remain until the concrete has attained the specified 28 day compressive strength.

d. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems which allow form removal without disturbing shores, but only after the Contractor has demonstrated to the satisfaction of the Engineer that the early removal of forms will not cause excessive sag, distortion or damage to the concrete elements.

e. Completely remove wood forms. Provide temporary openings if required.

f. Provide adequate methods of curing and thermal protection of exposed concrete if forms are removed prior to completion of specified curing time.

g. Reshore areas required to support construction loads in excess of 20 pounds per square foot to properly distribute construction loading. Construction loads up to the rated live load capacity may be placed on unshored construction provided the concrete has attained the specified 28 day compressive strength.

h. Obtaining concrete compressive strength tests for the purposes of form removal is the responsibility of the Contractor.

i. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

3. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

4. When forms are reused, clean surfaces, remove fins and laittance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

D. Shores and Reshores

1. The Contractor is solely responsible for proper shoring and reshoring.

2. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

   a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

E. Steel Reinforcement

   a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   a. Weld reinforcing bars according to AWS D1.4, where indicated. Only steel conforming to ASTM A706 may be welded.

4. Installation tolerances
   a. Top and bottom bars in slabs, girders, beams and joists:
      1) Members 8 inches deep or less: ±3/8 inch
      2) Members more than 8 inches deep: ±1/2 inch
   b. Concrete Cover to Formed or Finished Surfaces: ±3/8 inches for members 8 inches deep or less; ±1/2 inches for members over 8 inches deep, except that tolerance for cover shall not exceed 1/3 of the specified cover.

5. Concrete Cover
   a. Reinforcing in structural elements deposited against the ground: 3 inches
   b. Reinforcing in formed beams, columns and girders: 1-1/2 inches
   c. Grade beams and exterior face of formed walls and columns exposed to weather or in contact with the ground: 2 inches
   d. Interior faces of walls: 1 inches
   e. Slabs: 3/4 inches


7. Field Welding of Embedded Metal Assemblies
   a. Remove all paint and galvanizing in areas to receive field welds.
   b. Field Prepare all areas where paint or galvanizing has been removed with the specified paint or cold galvanizing compound, respectively.

F. Joints

1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

2. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
   a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
c. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
   Offset joints in girders a minimum distance of twice the beam width from a
   beam-girder intersection.

d. Locate horizontal joints in walls and columns at underside of floors, slabs,
   beams, and girders and at the top of footings or floor slabs.

e. Space vertical joints in walls as indicated. Locate joints beside piers integral
   with walls, near corners, and in concealed locations where possible.

f. Use a bonding agent at locations where fresh concrete is placed against
   hardened or partially hardened concrete surfaces.

3. Doweled Joints: Install dowel bars and support assemblies at joints where
   indicated. Lubricate or asphalt coat 1-1/2 of dowel length to prevent concrete
   bonding to 1 side of joint.

G. Waterstops

1. Flexible Waterstops: Install in construction joints and at other joints indicated to
   form a continuous diaphragm. Install in longest lengths practicable. Support and
   protect exposed waterstops during progress of the Work. Field fabricate joints in
   waterstops according to manufacturer’s written instructions.

2. Self-Expanding Strip Waterstops: Install in construction joints and at other
   locations indicated, according to manufacturer’s written instructions, adhesive
   bonding, mechanically fastening, and firmly pressing into place. Install in longest
   lengths practicable.

H. Adhesive Anchors

1. Comply with the manufacturer’s installation instructions on the hole diameter and
   depth required to fully develop the tensile strength of the adhesive anchor or
   reinforcing bar.

2. Properly clean out the hole utilizing a wire brush and compressed air to remove all
   loose material from the hole, prior to installing adhesive material.

I. Concrete Placement

1. Before placing concrete, verify that installation of formwork, reinforcement, and
   embedded items is complete and that required inspections have been performed.

2. Do not add water to concrete during delivery, at Project site, or during placement
   unless approved by Engineer.

3. Before test sampling and placing concrete, water may be added at Project site,
   subject to limitations of ACI 301.
   a. Do not add water to concrete after adding high-range water-reducing
      admixtures to mixture.
   b. Do not exceed the maximum specified water/cement ratio for the mix.

4. Deposit concrete continuously in 1 layer or in horizontal layers of such thickness
   that no new concrete will be placed on concrete that has hardened enough to cause
   seams or planes of weakness. If a section cannot be placed continuously, provide
   construction joints as indicated. Deposit concrete to avoid segregation.
   a. Deposit concrete in horizontal layers of depth to not exceed formwork design
      pressures, 15 feet maximum and in a manner to avoid inclined construction
      joints.
b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

d. Do not permit concrete to drop freely any distance greater than 10 feet for concrete containing a high range water reducing admixture (superplasticizer) or 5 feet for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.

e. Discard pump priming grout and do not use in the structure.

5. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

   a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   b. Maintain reinforcement in position on chairs during concrete placement.
   c. Screed slab surfaces with a straightedge and strike off to correct elevations.
   d. Slope surfaces uniformly to drains where required.
   e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

6. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

   a. When average high and low temperature is expected to fall below 40 degrees Fahrenheit for 3 successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

7. Hot-Weather Placement: Comply with ACI 305.1 and as follows:

   a. Maintain concrete temperature below 95 degrees Fahrenheit at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

J. Finishing Formed Surfaces
1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces not exposed to public view.

2. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

K. Miscellaneous Concrete Items
   1. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

   2. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

   3. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
       a. Housekeeping pads: Normal weight concrete (3000 psi), reinforced with #3@16 inches on center set at middepth of pad. Trowel concrete to a dense, smooth finish. Set anchor bolts for securing mechanical or electrical equipment during pouring of concrete fill.

   4. Protective slabs ("Mud slabs"): Normal weight concrete (2500 psi minimum) with a minimum thickness of 3-1/2 inches. Finish slab to a wood float finish.

L. Concrete Protecting and Curing
   1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

   2. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.


   4. Cure concrete according to ACI 308.1, by 1 or a combination of the following methods:
       a. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
          1) Water
          2) Continuous water-fog spray
3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than 7 days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.5 REPAIR

A. Concrete Surface Repairs

1. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer’s approval.

2. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spills, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

a. Immediately after form removal, cut-out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

c. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   a. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   b. After concrete has cured at least 14 days, correct high areas by grinding.
   c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   d. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   e. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

5. Perform structural repairs of concrete, subject to Engineer’s approval, using epoxy adhesive and patching mortar.

6. Repair materials and installation not specified above may be used, subject to Engineer’s approval.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Testing and Inspecting: City will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections

1. Steel reinforcement placement
2. Headed bolts and studs
3. Verification of use of required design mixture
4. Concrete placement, including conveying and depositing
5. Curing procedures and maintenance of curing temperature
6. Verification of concrete strength before removal of shores and forms from beams and slabs
C. Concrete Tests: Perform testing of composite samples of fresh concrete obtained according to ASTM C172 according to the following requirements:

1. Testing Frequency: Obtain 1 composite sample for each day's pour of each concrete mixture exceeding 5 cubic yard, but less than 25 cubic yard, plus 1 set for each additional 50 cubic yard or fraction thereof.

2. Slump: ASTM C143; 1 test at point of placement for each composite sample, but not less than 1 test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C231, pressure method, for normal-weight concrete; 1 test for each composite sample, but not less than 1 test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064; 1 test hourly when air temperature is 40 degrees Fahrenheit and below and when 80 degrees Fahrenheit and above, and 1 test for each composite sample.

   a. Cast and laboratory cure 4 cylinders for each composite sample.
      1) Do not transport field cast cylinders until they have cured for a minimum of 24 hours.

   a. Test 1 cylinder at 7 days.
   b. Test 2 cylinders at 28 days.
   c. Hold 1 cylinder for testing at 56 days as needed.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

8. Strength of each concrete mixture will be satisfactory if every average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Report test results in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Engineer.
a. When the strength level of the concrete for any portion of the structure, as
indicated by cylinder tests, falls below the specified requirements, provide
improved curing conditions and/or adjustments to the mix design as required to
obtain the required strength. If the average strength of the laboratory control
cylinders falls so low as to be deemed unacceptable, follow the core test
procedure set forth in ACI 301, Chapter 17. Locations of core tests shall be
approved by the Engineer. Core sampling and testing shall be at Contractors
expense.
b. If the results of the core tests indicate that the strength of the structure is
inadequate, any replacement, load testing, or strengthening as may be ordered
by the Engineer shall be provided by the Contractor without cost to the City.
11. Additional testing and inspecting, at Contractor's expense, will be performed to
determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate does not
comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E1155 within 48
hours of finishing.

E. Concrete Finish Measurement and Tolerances

1. All floors are subject to measurement for flatness and levelness and comply with
the following:
a. Slabs shall be flat within a tolerance of 5/16 inches in 10 feet when tested with
a 10 foot long straightedge. Apply straightedge to the slab at 3 foot intervals in
both directions, lapping straightedge 3 feet on areas previously checked. Low
spots shall not exceed the above dimension anywhere along the straightedge.
Flatness shall be checked the next work day after finishing.
b. Slabs shall be level within a tolerance of ± 1/4 inch in 10 feet, not to exceed 3/4
inches total variation, anywhere on the floor, from elevations indicated on the
Drawings. Levelness shall be checked on a 10 foot grid using a level after
removal of forms.
c. Measurement Standard: All floors are subject to measurement for flatness and
levelness, according to ASTM E1155.

2. 2 Tiered Measurement Standard
a. Each floor test section and the overall floor area shall conform to the 2-tiered
measurement standard as specified herein.
1) Minimum Local Value: The minimum local FF/FL values represent the ab-
solute minimum surface profile that will be acceptable for any 1 test sample
(line of measurements) anywhere within the test area.
2) Specified Overall Value: The specified overall FF/FL values represent the
minimum values acceptable for individual floor sections as well as the floor
as a whole.

3. Floor Test Sections
a. A floor test section is defined as the smaller of the following areas:
1) The area bounded by column and/or wall lines
2) The area bounded by construction and/or control joint lines
3) Any combination of column lines and/or control joint lines
b. Test sample measurement lines within each test section shall be
multidirectional along 2 orthogonal lines, as defined by ASTM E1155, at a
spacing to be determined by the City's testing agency.
c. The precise layout of each test section shall be determined by the City's testing
agency.

4. Concrete Floor Finish Tolerance
   a. The following values apply before removal of shores. Levelness values (FL) do
      not apply to intentionally sloped or cambered areas, nor to slabs poured on
      metal deck or precast concrete.
      1) Slabs
         Overall Value FF45/FL30
         Minimum Local Value FF30/FL20

5. Floor Elevation Tolerance Envelope
   a. The acceptable tolerance envelope for absolute elevation of any point on the
      slab surface, with respect to the elevation shown on the Drawings, is as follows:
      1) Slab-on-Grade Construction: ± ¾ inch
      2) Top surfaces of formed slabs measured prior to removal of supporting
         shores: ± ¾ inch
      3) Top surfaces of all other slabs: ± ¾ inch
      4) Slabs specified to slope shall have a tolerance from the specified slope of
         3/8 inch in 10 feet at any point, up to ¾ inch from theoretical elevation at
         any point.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Defective Work
   1. Imperfect or damaged work or any material damaged or determined to be defective
      before final completion and acceptance of the entire job shall be satisfactorily re-
      placed at the Contractor's expense, and in conformity with all of the requirements of
      the Drawings and Specifications.
   2. Perform removal and replacement of concrete work in such manner as not to impair
      the appearance or strength of the structure in any way.

B. Cleaning
   1. Upon completion of the work remove from the site all forms, equipment, protective
      coverings and any rubbish resulting therefrom.
   2. After sweeping floors, wash floors with clean water.
   3. Leave finished concrete surfaces in a clean condition, satisfactory to the City.
3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

Revision Log

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REVISED: July 1, 2011
SECTION 03 34 13
CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes:
   1. Controlled low strength material (CLSM) for use in the following:
      a. Flowable backfill

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 03 30 00 - Cast-in-Place Concrete

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Measurement
      a. This Item is considered subsidiary to the structure or Items being placed.
   2. Payment
      a. The work performed and the materials furnished in accordance with this Item
         are subsidiary to the structure or Items being placed and no other compensation
         will be allowed.

1.3 REFERENCES
A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.

B. ASTM International (ASTM):
   1. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the
      Field.
   3. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete
      Specimens.
   5. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the
      Pressure Method.
7. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS/INFO\RATIONAL SUBMITTALS

A. Product data
B. Sieve analysis
   1. Submit sieve analyses of fine and coarse aggregates being used.
      a. Resubmit at any time there is a significant change in grading of materials.
   2. Mix
      a. Submit full details, including mix design calculations for mix proposed for use.
C. Trial batch test data
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED OR OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Materials
   1. Portland cement: Type II low alkali portland cement as specified in Section 03 30 00.
   2. Fly ash: Class F fly ash in accordance with ASTM C618.
   3. Water: As specified in Section 03 30 00.
5. Fine aggregate: Concrete sand (does not need to be in accordance with ASTM C33). No more than 12 percent of fine aggregate shall pass a No. 200 sieve, and no plastic fines shall be present.


B. Mixes

1. Performance requirements
   a. Total calculated air content
      1) Not less than 8.0 percent or greater than 12.0 percent.
   b. Minimum unconfined compressive strength
      1) Not less than 50 psi measured at 28 days.
   c. Maximum unconfined compressive strength
      1) Not greater than 150 psi measured at 28 days.
      2) Limit the long-term strength (90 days) to 200 psi such that material could be re-excavated with conventional excavation equipment in the future if necessary.
   d. Wet density
      1) No greater than 132 pounds per cubic foot.
   e. Color
      1) No coloration required unless noted.
      2) Submit dye or other coloration means for approval.

2. Suggested design mix

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<th>Weight</th>
<th>Specific Gravity</th>
<th>Absolute Volume Cubic Foot</th>
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<td>Cement</td>
<td>30 pounds</td>
<td>3.15</td>
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<tr>
<td>Fly Ash</td>
<td>300 pounds</td>
<td>2.30</td>
<td>2.09</td>
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<tr>
<td>Water</td>
<td>283 pounds</td>
<td>1.00</td>
<td>4.54</td>
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<tr>
<td>Coarse Aggregate</td>
<td>1,465 pounds</td>
<td>2.68</td>
<td>8.76</td>
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<tr>
<td>Fine Aggregate</td>
<td>1,465 pounds</td>
<td>2.68</td>
<td>8.76</td>
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<td>Admixture</td>
<td>4-6 ounces</td>
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<td>2.70</td>
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<td>TOTAL</td>
<td>3,543 pounds</td>
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2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

A. Trial batch

1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.

2. Prepare trial batches using specified cementitious materials and aggregates proposed to be used for the Work.

3. Prepare trial batch with sufficient quantity to determine slump, workability, consistency, and to provide sufficient test cylinders.
B. Test cylinders:
   1. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:
      a. Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.
      b. Do not rod the concrete mix.
      c. Strike off the excess material.
   2. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   3. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.
   4. The test cylinders may be capped with standard sulfur compound or neoprene pads:
      a. Perform the capping carefully to prevent premature fractures.
      b. Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.
      c. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

C. Compression test 8 test cylinders: Test 4 test cylinders at 3 days and 4 at 28 days in accordance with ASTM C39 except as modified herein:
   1. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but not exceed maximum compression strength.

D. If the trial batch tests do not meet the Specifications for strength or density, revise and resubmit the mix design, and prepare additional trial batch and tests. Repeat until an acceptable trial batch is produced that meets the Specifications.
   1. All the trial batches and acceptability of materials shall be paid by the CONTRACTOR.
   2. After acceptance, do not change the mix design without submitting a new mix design, trial batches, and test information.

E. Determine slump in accordance with ASTM C143 with the following exceptions:
   1. Do not rod the concrete material.
   2. Place material in slump cone in 1 semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Place CLSM by any method which preserves the quality of the material in terms of compressive strength and density:

1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 4 feet or the lift height indicated on the Drawings. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent lateral load due to the weight of the next lift of CLSM.

2. The basic requirement for placement equipment and placement methods is the maintenance of its fluid properties.

3. Transport and place material so that it flows easily around, beneath, or through walls, pipes, conduits, or other structures.

4. Use a slump of the placed material greater than 9 inches, and sufficient to allow the material to flow freely during placement:

   a. After trial batch testing and acceptance, maintain slump developed during testing during construction at all times within ± 1 inch.

5. Use a slump, consistency, workability, flow characteristics, and pumpability (where required) such that when placed, the material is self-compacting, self-densifying, and has sufficient plasticity that compaction or mechanical vibration is not required.

6. When using as embedment for pipe take appropriate measures to ensure line and grade of pipe.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. General

1. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Engineer in preparing said specimens.

2. Be responsible for the care of and providing curing condition for the test specimens.

B. Tests by the City

1. During the progress of construction, the City will have tests made to determine whether the CLSM, as being produced, complies with the requirements specified hereinbefore. Test cylinders will be made and delivered to the laboratory by the Engineer and the testing expense will be borne by the City.

2. Test cylinders

   a. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:
1) Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.
2) Do not rod the concrete mix.
3) Strike off the excess material.

b. Place the cylinders in a safe location away from the construction activities. Keep the cylinders moist by covering with wet burlap, or equivalent. Do not sprinkle water directly on the cylinders.

c. After 2 days, place the cylinders in a protective container for transport to the laboratory for testing. The concrete test cylinders are fragile and shall be handled carefully. The container may be a box with a Styrofoam or similar lining that will limit the jarring and bumping of the cylinders.

d. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.

e. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

f. The test cylinders may be capped with standard sulfur compound or neoprene pads:
   1) Perform the capping carefully to prevent premature fractures.
   2) Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.
   3) Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

3. The number of cylinder specimens taken each day shall be determined by the Inspector.
   a. Test 1 cylinder at 3 days and 2 at 28 days in accordance with ASTM C39 except as modified herein.
   b. The compression strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but not exceed maximum compression strength.

4. The City will test the air content of the CLSM. Test will be made immediately after discharge from the mixer in accordance with ASTM C231.

5. Test the slump of CLSM using a slump cone in accordance with ASTM C143 with the following exceptions:
   a. Do not rod the concrete material.
   b. Place material in slump cone in 1 semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.

6. If compressive strength of test cylinders does not meet requirements, make corrections to the mix design to meet the requirements of this specification.
END OF SECTION

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SECTION 03 34 16
CONCRETE BASE MATERIAL FOR TRENCH REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Concrete base material for trench repair

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 03 30 00 – Cast-in-Place Concrete

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. This Item is considered subsidiary to the structure or Items being placed.
   2. Payment
      a. The work performed and the materials furnished in accordance with this Item
         are subsidiary to the structure or Items being placed and no other compensation
         will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.

B. ASTM International (ASTM):
   1. C31, Standard Practice for Making and Curing Concrete Test Specimens in the
      Field.
   3. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete
      Specimens.
   5. C172, Standard Practice for Sampling Freshly Mixed Concrete.
   6. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the
      Pressure Method.
   8. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural
      Pozzolan for Use in Concrete.
   9. C1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-
      Cement Concrete.
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Submit proposed mix design for Engineer’s review a minimum of 2 weeks prior to start of low density concrete backfill work.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED OR OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Mix Design

1. Performance requirements
   a. Concrete Base Material for Trench Repair
      1) 28-day compressive strength of not less than 750 psi and not more than 1,200 psi.

B. Materials

1. Portland cement
   a. Type II low alkali portland cement as specified in Section 03 30 00.

2. Fly ash
   a. Class F fly ash in accordance with ASTM C618.

3. Water
   a. As specified in Section 03 30 00.

4. Admixture
   a. Air entraining admixture in accordance with ASTM C260.

5. Fine aggregate
   a. Concrete sand (does not need to be in accordance with ASTM C33).
   b. No more than 12 percent of fine aggregate shall pass a No. 200 sieve, and no plastic fines shall be present.

6. Coarse aggregate
   a. Pea gravel no larger than 3/8 inch.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Place concrete base material by any method which preserves the quality of the material in terms of compressive strength and density.
   1. The basic requirement for placement equipment and placement methods is the maintenance of its fluid properties.
   2. Transport and place material so that it flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   3. Use a slump, consistency, workability, flow characteristics, and pumpability (where required) such that when placed, the material is self-compacting, self-densifying, and has sufficient plasticity that compaction or mechanical vibration is not required.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. General
   1. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Engineer in preparing said specimens.
   2. Be responsible for the care of and providing curing condition for the test specimens.

B. Concrete Tests: Perform testing of composite samples of fresh concrete obtained according to ASTM C172 according to the following requirements:
   1. Testing Frequency: Obtain 1 composite sample for each day's pour of each concrete mixture up to 25 cubic yards, plus 1 set for each additional 50 cubic yards or fraction thereof.
   2. Slump: ASTM C143; 1 test at point of placement for each composite sample, but not less than 1 test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C231, pressure method, for normal-weight concrete; 1 test for each composite sample, but not less than 1 test for each day's pour of each concrete mixture.
   4. Concrete Temperature: ASTM C1064; 1 test hourly when air temperature is 40 degrees Fahrenheit and below and when 80 degrees Fahrenheit and above, and 1 test for each composite sample.
      a. Cast and laboratory cure 4 cylinders for each composite sample.
       1) Do not transport field cast cylinders until they have cured for a minimum of 24 hours.
   a. Test 1 cylinder at 7 days.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 03 80 00
MODIFICATIONS TO EXISTING CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Modifications to existing concrete structures, including:
      a. Manholes
      b. Junction boxes
      c. Vaults
      d. Retaining walls
      e. Wing and head walls
      f. Culverts
   2. This section does not include modifications to Reinforced Concrete Pipe.

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. This Item is considered subsidiary to the structure or Items being placed.
   2. Payment
      a. The work performed and the materials furnished in accordance with this Item
         are subsidiary to the structure or Items being placed and no other compensation
         will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   2. ASTM International (ASTM):
      a. A615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
         Concrete.
      c. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used
         with Concrete by Slant Sheer.
h. D790, Standard Test Methods for Flexural Properties of Unreinforced and
   Reinforced Plastics and Electrical Insulating Materials.

B. Where reference is made to 1 of the above standards, the revision in effect at the time of
   bid opening applies.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer prior to delivery and/or
   fabrication for specials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Submit manufacturer's Product Data on all product brands proposed for use to the
      Engineer for review.
   2. Include the manufacturer's installation and/or application instructions.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. When removing materials or portions of existing structures and when making openings
   in existing structures, take precautions and all erect all necessary barriers, shoring and
   bracing, and other protective devices to prevent damage to the structures beyond the
   limits necessary for the new work, protect personnel, control dust, and to prevent
   damage to the structures or contents by falling or flying debris.

B. Core sanitary sewer manhole penetrations.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified products in original, unopened containers with the manufacturer's
   name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED OR OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Manufacturers
1. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   a. Available Products
      1) Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   b. Available Manufacturers
      1) Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

B. Materials
   1. General
      a. Comply with this Section and any state or local regulations.

C. Steel Reinforcement
   1. Reinforcing Bars
      a. ASTM A615, Grade 60, deformed.

D. Epoxy Bonding Agent
   1. A 2-component, solvent-free, asbestos-free, moisture-insensitive epoxy resin material used to bond plastic concrete to hardened concrete complying with the requirements of ASTM C881, Type V, and the additional requirements specified herein.
   2. Properties of the cured material
      a. Compressive Strength (ASTM D695)
         1) 8,500 psi minimum at 28 days
      b. Tensile Strength (ASTM D638)
         1) 4,000 psi minimum at 14 days
      c. Flexural Strength (ASTM D790 - Modulus of Rupture)
         1) 6,300 psi minimum at 14 days
      d. Shear Strength (ASTM D732)
         1) 5,000 psi minimum at 14 days
      e. Water Absorption (ASTM D570 - 2 hour boil)
         1) 1 percent maximum at 14 days
      f. Bond Strength (ASTM C882) Hardened to Plastic
         1) 1,500 psi minimum at 14 days moist cure
      g. Color
         1) Gray
      h. Available Manufacturers:
         1) Sika Corporation, Lyndhurst, New Jersey - Sikadur 32, Hi-Mod
         2) BASF, Cleveland, Ohio - Concreive 1438

E. Epoxy Paste
   1. A 2-component, solvent-free, asbestos free, moisture insensitive epoxy resin material used to bond dissimilar materials to concrete such as setting railing posts, dowels, anchor bolts, and all-threads into hardened concrete and complying with the requirements of ASTM C881, Type 1, Grade 3, and the additional requirements specified herein.
   2. Properties of the cured material
      a. Compressive Properties (ASTM D695): 10,000 psi minimum at 28 days
b. Tensile Strength (ASTM D638): 3,000 psi minimum at 14 days. Elongation at
   Break - 0.3 percent minimum

c. Flexural Strength (ASTM D790 - Modulus of Rupture): 3,700 psi minimum at
   14 days

d. Shear Strength (ASTM D732): 2,800 psi minimum at 14 days

e. Water Absorption (ASTM D570): 1.0 percent maximum at 7 days

f. Bond Strength (ASTM C882): 2,000 psi at 14 days moist cure

g. Color: Concrete grey

h. Available Manufacturers
   1) Overhead Applications
      a) Sika Corporation, Lyndhurst, New Jersey - Sikadur 32, Hi-Mod LV
      b) BASF - Concreseive 1438
   2) All Other Applications
      a) Sika Corporation, Lyndhurst, New Jersey - Sikadur Hi-mod LV 31
      b) BASF - Concreseive 1401

F. Repair Mortars
   1. Provide an asbestos free, moisture insensitive, polymer-modified, Portland cement-
      based cementitious trowel grade mortar for repairs on horizontal or vertical
      surfaces.
      a. Available Manufacturers
         1) Sika Corporation, Lyndhurst New Jersey - SikaTop 122
         2) BASF – Emaco Nanocrete R3

G. Pipe Penetration Sealants
   1. 1 component polyurethane, extrudable swelling bentonite-free waterstop that is
      chemically resistant, not soluble in water and capable of withstanding wet/dry
      cycling.
      a. Available Manufacturers
         1) Sika Corporation, Lyndhurst New Jersey – SikaSwell S-2
         2) Approved equal

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. General
   1. Cut, repair, reuse, demolish, excavate or otherwise modify parts of the existing
      structures or appurtenances, as indicated on the Drawings, specified herein, or
      necessary to permit completion of the Work. Finishes, joints, reinforcements,
      sealants, etc., are specified in respective Sections. Comply with other requirements
      of this of Section and as shown on the Drawings.
2. Store, mix, and apply all commercial products specified in this Section in strict compliance with the manufacturer's recommendations.

3. Make repairs in all cases where concrete is repaired in the vicinity of an expansion joint or control joint to preserve the isolation between components on either side of the joint.

4. When drilling holes for dowels/bolts at new or existing concrete, stop drilling if rebar is encountered and relocate the hole to avoid rebar as approved by the Engineer. Do not cut rebar without prior approval by the Engineer.

B. Concrete Removal

1. Remove concrete designated to be removed to specific limits as shown on the Drawings or directed by the Engineer, by chipping, jack-hammering, or saw-cutting as appropriate in areas where concrete is to be taken out. Do not jackhammer sanitary sewer manhole penetrations. Remove concrete in such a manner that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged.

2. Where existing reinforcing is exposed due to saw cutting/core drilling and no new material is to be placed on the sawcut surface, apply a coating or surface treatment of epoxy paste to the entire cut surface to a thickness of 1/4 inch.

3. In all cases where the joint between new concrete or grout and existing concrete will be exposed in the finished work, except as otherwise shown or specified, provide a 1-inch deep saw cut on each exposed surface of the existing concrete at the edge of concrete removal.

4. Repair concrete specified to be left in place that is damaged using approved means to the satisfaction of the Engineer.

5. The Engineer may from time to time direct additional repairs to existing concrete. Make these repairs as specified or by such other methods as may be appropriate.

C. Connection Surface Preparation

1. Prepare connection surfaces as specified below for concrete areas requiring patching, repairs or modifications as shown on the Drawings, specified herein, or as directed by the Engineer.

2. Remove all deteriorated materials, dirt, oil, grease, and all other bond inhibiting materials from the surface by dry mechanical means, i.e., sandblasting, grinding, etc., as approved by the Engineer. Be sure the areas are not less than 1/2-inch in depth. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete, subject to the Engineer's final inspection.

3. If reinforcing steel is exposed, it must be cleaned by wire brush or other similar means to remove all contaminants, rust, etc., as approved by the Engineer. If 1/2 of the diameter of the reinforcing steel is exposed, chip out behind the steel. Chip a minimum of 1 inch behind the steel. Do not Damage reinforcing to be saved during the demolition operation.

4. Clean reinforcing from existing demolished concrete that is shown to be incorporated in new concrete by wire brush or other similar means to remove all loose material and products of corrosion before proceeding with the repair. Cut, bend, or lap to new reinforcing as shown on the Drawings and provided with 1-inch minimum cover all around.
5. The following are specific concrete surface preparation "methods" to be used where called for on the Drawings, specified herein, or as directed by the Engineer.

   a. Method A
      1) After the existing concrete surface at connection has been roughened and cleaned, thoroughly moisten the existing surface with water.
      2) Brush on a 1/16-inch layer of cement and water mixed to the consistency of a heavy paste.
      3) Immediately after application of cement paste, place new concrete or grout mixture as detailed on the Drawings.

   b. Method B
      1) After the existing concrete surface has been roughened and cleaned, apply epoxy bonding agent at connection surface.
      2) Comply strictly with the manufacturer's recommendations for the field preparation and application of the epoxy bonding agent.
      3) Place new concrete or grout mixture to limits shown on the Drawings within time constraints recommended by the manufacturer to ensure bond.

   c. Method C
      1) Drill a hole 1/4 inch larger than the diameter of the dowel.
      2) Blow the hole clear of loose particles and dust just prior to installing epoxy. First fill the drilled hole with epoxy paste, then butter the dowels/bolts with paste then insert by tapping.
      3) Unless otherwise shown on the Drawings, drill and set deformed bars to a depth of 10 bar diameters and smooth bars to a depth of 15 bar diameters.
      4) If not noted on the Drawings, the Engineer will provide details regarding the size and spacing of dowels.

   d. Method D
      1) Combination of Method B and C.

3.4 INSTALLATION [NOT USED]
3.5 REPAIR [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Preparation of right-of-way and other designated areas for construction operations
      by removing and disposing of all obstructions including clearing and grubbing and
      trees, when removal of such obstructions is not specifically shown on the Drawings
      to be paid by other Sections. The City of Fort Worth’s Urban Forestry Ordinance
      governs all tree removals.
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include but are not necessarily limited to
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 02 41 13 – Selective Site Demolition
   4. Section 02 41 14 – Utility Removal/Abandonment

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Site Clearing
      a. Measurement
         1) Measurement for this Item shall be by lump sum.
      b. Payment
         1) The work performed and the materials furnished in accordance with this
            Item shall be paid for at the lump sum price bid for “Site Clearing”.
      c. The price bid shall include:
         1) Pruning of designated trees and shrubs
         2) Removal and disposal of trees, structures and obstructions
         3) Backfilling of holes
         4) Clean-up
   2. Tree Removal
      a. Measurement
         1) Measurement for this Item shall be per each.
      b. Payment
         1) The work performed and the materials furnished in accordance with this
            Item shall be paid for at the unit price bid per each “Tree Removal” for:
            a) Various caliper ranges
      c. The price bid shall include:
         1) Pruning of designated trees and shrubs
         2) Removal and disposal of structures and obstructions
         3) Grading and backfilling of holes
3. Tree Removal and Transplantation
   a. Measurement
      1) Measurement for this Item shall be per each.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item shall be paid for at the unit price bid per each “Tree Transplant” for:
            a) Various caliper ranges
      c. The price bid shall include:
         1) Pruning of designated trees and shrubs
         2) Removal and disposal of structures and obstructions
         3) Moving tree with truck mounted tree spade
         4) Grading and backfilling of holes
         5) Replanting tree at temporary location (determined by Contractor)
         6) Maintaining tree until Work is completed
         7) Replanting tree into original or designated location
         8) Excavation
         9) Fertilization
        10) Clean-up

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Permits
   1. Contractor shall obtain Tree Removal Permits and Urban Forestry Permits when
      required by the City Ordinance No. 18615-05-2009.

B. Preinstallation Meetings
   1. Hold a preliminary site clearing meeting and include the Contractor, City Arborist,
      City Inspector, and the Project Manager for the purpose of reviewing the
      Contractor’s tree removal plan. Clearly mark all trees to remain on the project site
      prior to the meeting.
   2. The Contractor will provide the City with a Disposal Letter in accordance to
      Division 01.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]
PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. All trees identified to be protected and/or preserved should be clearly flagged with survey tape.

B. Following taping and prior to any removals or site clearing, the Contractor shall meet with the City, the Engineer and the Landowner, if necessary, to confirm trees to be saved.

3.4 INSTALLATION

A. Protection of Trees

1. Protect designated trees and prune trees and shrubs as shown on the Drawings. Refer to the Drawings for tree protection details.

2. If the Drawings do not provide tree protection details, protected trees shall be fenced by placing 6-foot tall metal T-posts in a square around the tree trunk with the corners located on the canopy drip line, unless instructed otherwise.

3. When site conditions do not allow for the T-posts to be installed at the drip line, the T-posts may be installed no less than 8 feet from the tree trunk. 4-foot high 12½ gauge stock fencing or orange plastic snow fence shall be attached to the T-posts to form the enclosure.

4. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation.

5. When shown on the Drawings, treat cuts on trees with an approved tree wound dressing within 20 minutes of making a pruning cut or otherwise causing damage to the tree.

6. Trees and brush shall be mulched on-site.
   a. Burning as a method of disposal is not allowed.

B. Hazardous Materials

1. The Contractor will notify the Engineer immediately if any hazardous or questionable materials not shown on the Drawings are encountered. This includes; but not limited to:
   a. Floor tiles
   b. Roof tiles
   c. Shingles
   d. Siding
   e. Utility piping

2. The testing, removal, and disposal of hazardous materials will be in accordance with Division 1.

C. Site Clearing
1. Clear areas shown on the Drawings of all obstructions, except those landscape features that are to be preserved. Such obstructions include, but are not limited to:
   a. Remains of buildings and other structures
   b. Foundations
   c. Floor slabs
   d. Concrete
   e. Brick
   f. Lumber
   g. Plaster
   h. Septic tank drain fields
   i. Abandoned utility pipes or conduits
   j. Equipment
   k. Trees
   l. Fences
   m. Retaining walls
   n. Other items as specified on the Drawings
2. Remove vegetation and other landscape features not designated for preservation, whether above or below ground, including, but not limited to:
   a. Curb and gutter
   b. Driveways
   c. Paved parking areas
   d. Miscellaneous stone
   e. Sidewalks
   f. Drainage structures
   g. Manholes
   h. Inlets
   i. Abandoned railroad tracks
   j. Scrap iron
   k. Other debris
3. Remove culverts, storm sewers, manholes, and inlets in proper sequence to maintain traffic and drainage in accordance with Section 02 41 14.
4. In areas receiving embankment, remove obstructions not designated for preservation to 2 feet below natural ground.
5. In areas to be excavated, remove obstructions to 2 feet below the excavation level.
6. In all other areas, remove obstructions to 1 foot below natural ground.
7. When allowed by the Drawings or directed by the Engineer, cut trees and stumps off to ground level.
   a. Removal of existing structures shall be as per Section 02 41 13.

D. Disposal
1. Dispose of all trees within 24 hours of removal.
2. All materials and debris removed becomes the property of the Contractor, unless otherwise stated on the Drawings.
3. The Contractor will dispose of material and debris off-site in accordance with local, state, and federal laws and regulations.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnish, place and compact Borrow material for grading.

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 31 24 00 – Embankments

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Borrow
      a. Measurement
         1) Measurement for this Item shall be by the cubic yard of loose Borrow
         material as delivered to the Site and recorded by truck ticket provided to the
         City.
      b. Payment
         1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” will be paid for at the unit
         price bid per cubic yard of “Borrow” delivered to the Site for:
         a) Various Borrow materials
         c. The price shall include:
            1) Furnishing, placing, compacting and finishing Borrow
            2) Hauling
            3) Reworking
            4) Disposal of excess or waste material
            5) Clean-up

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   2. ASTM Standards
      a. ASTM D2487, Standard Practice for Classification of Soils for Engineering
         Purposes (Unified Soil Classification System)
      b. ASTM D4318-10, Standard Test Methods for Liquid Limit, Plastic Limit, and
         Plasticity Index of Soils
c. ASTM D6913, Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

d. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer prior to construction.

C. Submit laboratory tests reports for each soil borrow source used to supply general borrow and select fill materials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Shop Drawings

1. Stockpiled Borrow material

a. Provide a description of the storage of the delivered Borrow material only if the Contract Documents do not allow storage of materials in the right-of-way of the easement.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Borrow material shall be tested prior to delivery to the Site.

1. Provide Proctor Test results, Gradation and Atterberg Limits for Borrow material from each source.

a. All testing listed above shall be performed in terms of ASTM D698, ASTM D6913 and ASTM D4318-10 respectively.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Coordinate all deliveries and haul-off.

B. Storage

1. Within Existing Rights-of-Way (ROW)

a. Borrow materials may be stored within existing ROW, easements or temporary construction easements, unless specifically disallowed in the Contract Documents.

b. Do not block drainage ways, inlets or driveways.

c. Provide erosion control in accordance with Section 31 25 00.

d. Store materials only in areas barricaded as provided in the traffic control plans.

e. In non-paved areas, do not store material on the root zone of any trees or in landscaped areas.

2. Designated Storage Areas
a. If the Contract Documents do not allow the storage of Borrow materials within
the ROW, easement or temporary construction easement, then secure and
maintain an adequate storage location.
b. Provide an affidavit that rights have been secured to store the materials on
private property.
c. Provide erosion control in accordance with Section 31 25 00.
d. Do not block drainage ways.
e. Only materials used for 1 working day will be allowed to be stored in the work
zone.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Borrow

1. Additional soil beneath pavements, roadways, foundations and other structures
required to achieve the elevations shown on the Drawings.

2. Acceptable Fill Material
   a. In-situ or imported soils classified as CL, CH, SC or GC in accordance with
      ASTM D2487
   b. Free from deleterious materials, boulders over 6 inches in size and organics
   c. Can be placed free from voids
   d. Must have 20 percent passing the number 200 sieve

3. Blended Fill Material
   a. In-situ soils classified as SP, SM, GP or GM in accordance with ASTM D2487
   b. Blended with in-situ or imported Acceptable Fill material to meet the
      requirements of an Acceptable Fill Material
   c. Free from deleterious materials, boulders over 6 inches in size and organics
   d. Must have 20 percent passing the number 200 sieve

4. Select Fill
   a. Classified as SC or CL in accordance with ASTM D2487
   b. Liquid limit less than 35
   c. Plasticity index between 8 and 20

5. Cement Stabilized Sand (CSS)
   a. Sand or silty sand
   b. Free of clay or plastic material
   c. Minimum of 4 percent cement content of Type I/II portland cement
   d. 100 to 150 psi compressive strength at 2 days in accordance with ASTM
      D1633, Method A
   e. 200 to 250 psi compressive strength at 23 days in accordance with ASTM
      D1633, Method A
   f. Mix in a stationary pug mill, weigh-batch or continuous mixing plant
PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]
3.2 EXAMINATION [NOT USED]
3.3 PREPARATION [NOT USED]
3.4 INSTALLATION
   A. All Borrow placement shall be performed in accordance to Section 31 24 00.

3.5 REPAIR [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL
   A. Field quality control will be performed in accordance to Section 31 24 00.

3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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Revision Log
PART 1 - GENERAL

1.3 SUMMARY

A. Section Includes:
   1. Implementation of the project’s Storm Water Pollution Prevention Plan (SWPPP) and installation, maintenance and removal of erosion and sediment control devices

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Storm Water Pollution Prevention Plan <1 acre
      a. Measurement
         1) This Item is considered subsidiary to the various Items bid.
      b. Payment
         1) The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being bid and no other compensation will be allowed.
   2. Storm Water Pollution Prevention Plan ≥ 1 acre
      a. Measurement for this Item shall be by lump sum.
      b. Payment
         1) The work performed and the materials furnished in accordance with this Item shall be paid for at the lump sum price bid for “SWPPP ≥ 1 acre”.
      c. The price bid shall include:
         1) Preparation of SWPPP
         2) Implementation
         3) Permitting fees
         4) Installation
         5) Maintenance
         6) Removal

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. ASTM Standard:
3. Texas Commission on Environmental Quality (TCEQ) TPDES General Permit No. TXR150000
4. TxDOT Departmental Material Specifications (DMS)
a. DMS-6230 “Temporary Sediment Control Fence Fabric”

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Storm Water Pollution Prevention Plan (SWPPP)
B. TCEQ Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity under the TPDES General Permit
C. Construction Site Notice
D. TCEQ Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under the TPDES General Permit
E. Notice of Change (if applicable)

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES AND MATERIALS

A. Rock Filter Dams
1. Aggregate
   a. Furnish aggregate with hardness, durability, cleanliness and resistance to crumbling, flaking and eroding acceptable to the Engineer.
   b. Provide the following:
      1) Types 1, 2 and 4 Rock Filter Dams
a) Use 3 to 6 inch aggregate.

2) Type 3 Rock Filter Dams
   a) Use 4 to 8 inch aggregate.

2. Wire
   a. Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams
   b. Type 4 dams require:
      1) Double-twisted, hexagonal weave with a nominal mesh opening of 2½ inches x 3 ⅛ inches
      2) Minimum 0.0866 inch steel wire for netting
      3) Minimum 0.1063 inch steel wire for selvages and corners
      4) Minimum 0.0866 inch for binding or tie wire

B. Geotextile Fabric
   1. Place the aggregate over geotextile fabric meeting the following criteria:
      a. Tensile Strength of 250 pounds, per ASTM D4632
      b. Puncture Strength of 135 pounds, per ASTM D4833
      c. Mullen Burst Rate of 420 psi, per ASTM D3786
      d. Apparent Opening Size of No. 20 (max), per ASTM D4751

C. Sandbag Material
   1. Furnish sandbags meeting Section 2.5 except that any gradation of aggregate may be used to fill the sandbags.

D. Stabilized Construction Entrances
   1. Provide materials that meet the details shown on the Drawings and this Section.
      a. Provide crushed aggregate for long and short-term construction exits.
      b. Furnish aggregates that are clean, hard, durable and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials and organic and injurious matter.
      c. Use 3 to 5 inch coarse aggregate with a minimum thickness of 12 inches.
      d. The aggregate shall be placed over a geotextile fabric meeting the following criteria:
         1) Tensile Strength of 300 pounds, per ASTM D4632
         2) Puncture Strength of 120 pounds, per ASTM D4833
         3) Mullen Burst Rate of 600 psi, per ASTM D3786
         4) Apparent Opening Size of No. 40 (max), per ASTM D4751

E. Embankment for Erosion Control
   1. Provide rock, loam, clay, topsoil or other earth materials that will form a stable embankment to meet the intended use.

F. Sandbags
   1. Provide sandbag material of polypropylene, polyethylene or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70 percent.
   2. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags.
   3. Filled sandbags must be 24 to 30 inches long, 16 to 18 inches wide, and 6 to 8 inches thick.

Table 1
### Sand Gradation

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<td>4</td>
<td>3 percent</td>
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<tr>
<td>100</td>
<td>80 percent</td>
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<tr>
<td>200</td>
<td>95 percent</td>
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G. Temporary Sediment Control Fence

2. Logos visible to the traveling public will not be allowed.
   a. Fabric
      1) Provide fabric materials in accordance with DMS-6230, “Temporary Sediment Control Fence Fabric.”
   b. Posts
      1) Provide essentially straight wood or steel posts with a minimum length of 48 inches, unless otherwise shown on the Drawings.
      2) Soft wood posts must be at least 3 inches in diameter or nominal 2 x 4 inch
      3) Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inch
      4) T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.
   c. Net Reinforcement
      1) Provide net reinforcement of at least 12-1/2 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 inch, at least 24 inches wide, unless otherwise shown on the Drawings.
   d. Staples
      1) Provide staples with a crown at least 3/4 inch wide and legs 1/2 inch long.

### ACCESSORIES [NOT USED]

### SOURCE QUALITY CONTROL [NOT USED]

### PART 3 - EXECUTION

#### 3.1 INSTALLERS [NOT USED]

#### 3.2 EXAMINATION [NOT USED]

#### 3.3 PREPARATION [NOT USED]

#### 3.4 INSTALLATION

A. Storm Water Pollution Prevention Plan

1. Develop and implement the project’s Storm Water Pollution Prevention Plan (SWPPP) in accordance with the TPDES Construction General Permit TXR150000 requirements. Prevent water pollution from storm water runoff by using and maintaining appropriate structural and nonstructural BMPs to reduce pollutants discharges to the MS4 from the construction site.

B. Control Measures

1. Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the Drawings or as directed.
2. Control site waste such as discarded building materials, concrete truck washout water, chemicals, litter and sanitary waste at the construction site.

3. If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the disturbed area to that which the Contractor is able to control. Minimize disturbance to vegetation.

4. Immediately correct ineffective control measures. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable storm water permit.

5. Upon acceptance of vegetative cover by the City, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed.

C. Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed.

D. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the Engineer.

E. Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.

F. Installation and Maintenance

1. Perform work in accordance with the TPDES Construction General Permit TXR150000.

2. When approved, sediments may be disposed of within embankments, or in areas where the material will not contribute to further siltation.

3. Dispose of removed material in accordance with federal, state, and local regulations.

4. Remove devices upon approval or when directed.
   a. Upon removal, finish-grade and dress the area.
   b. Stabilize disturbed areas in accordance with the permit, and as shown on the Drawings or directed.

5. The Contractor retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.

G. Rock Filter Dams for Erosion Control

1. Remove trees, brush, stumps and other objectionable material that may interfere with the construction of rock filter dams.

2. Place sandbags as a foundation when required or at the Contractor’s option.

3. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids.

4. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed.

5. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed.
6. Construct filter dams according to the following criteria, unless otherwise shown on the Drawings:
   a. Type 1 (Non-reinforced)
      1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
      2) Top Width - At least 2 feet
      3) Slopes - At most 2:1
   b. Type 2 (Reinforced)
      1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
      2) Top Width - At least 2 feet
      3) Slopes - At most 2:1
   c. Type 3 (Reinforced)
      1) Height - At least 36 inches measured vertically from existing ground to top of filter dam
      2) Top Width - At least 2 feet
      3) Slopes - At most 2:1
   d. Type 4 (Sack Gabions)
      1) Unfold sack gabions and smooth out kinks and bends.
      2) For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-inches spacing. At 1 end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 inches remaining, and twist wires 4 times.
      3) For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above.
      4) Lift and place without damaging the gabion.
      5) Shape sack gabions to existing contours.
   e. Type 5
      1) Provide rock filter dams as shown on the Drawings.

H. Construction Entrances
   1. When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction entrances.
   2. Place the exit over a foundation course, if necessary.
      a. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the Drawings or as directed.
   3. At drive approaches, make sure the construction entrance is the full width of the drive and meets the length shown on the Drawings.
      a. The width shall be at least 14 feet for 1-way and 24 feet for 2-way traffic for all other points of ingress or egress or as directed by the Engineer.

I. Earthwork for Erosion Control
   1. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
      a. Excavation and Embankment for Erosion Control Measures
         1) Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover.
2) Place swales and dikes at other locations as shown on the Drawings or as directed to prevent runoff spillover or to divert runoff.

3) Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides.

4) Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the Drawings or as directed.

5) Where required, create a sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at 1 time, not including offsite areas.

b. Excavation of Sediment and Debris
   1) Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.

J. Sandbags for Erosion Control
   1. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment and release water in sheet flow.

2. Fill each bag with sand so that at least the top 6 inches of the bag is unfilled to allow for proper tying of the open end.

3. Place the sandbags with their tied ends in the same direction.

4. Offset subsequent rows of sandbags 1/2 the length of the preceding row.

5. Place a single layer of sandbags downstream as a secondary debris trap.

6. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.

K. Temporary Sediment-Control Fence
   1. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.

2. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the Drawings, as specified in this Section, or as directed.
   a. Post Installation
      1) Embed posts at least 18 inches deep, or adequately anchor, if in rock, with a spacing of 6 to 8 feet and install on a slight angle toward the run-off source.
   b. Fabric Anchoring
      1) Dig trenches along the uphill side of the fence to anchor 6 to 8 inches of fabric.
      2) Provide a minimum trench cross-section of 6 x 6 inches
      3) Place the fabric against the side of the trench and align approximately 2 inches of fabric along the bottom in the upstream direction.
      4) Backfill the trench, then hand-tamp.
   c. Fabric and Net Reinforcement Attachment
      1) Unless otherwise shown under the Drawings, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced.
      2) Sewn vertical pockets may be used to attach reinforcement to end posts.
      3) Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 inches or less.
d. Fabric and Net Splices
   1) Locate splices at a fence post with a minimum lap of 6 inches attached in at least 6 places equally spaced, unless otherwise shown under the Drawings.
      a) Do not locate splices in concentrated flow areas.
   2) Requirements for installation of used temporary sediment-control fence include the following:
      a) Fabric with minimal or no visible signs of biodegradation (weak fibers)
      b) Fabric without excessive patching (more than 1 patch every 15 to 20 feet)
      c) Posts without bends
      d) Backing without holes

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

   A. Waste Management
      1. Remove sediment, debris and litter as needed.

3.11 CLOSEOUT ACTIVITIES

   A. Erosion control measures remain in place and are maintained until all soil disturbing activities at the project site have been completed.

   B. Establish a uniform vegetative cover with a density of 70 percent on all unpaved areas, on areas not covered by permanent structures, or in areas where permanent erosion control measures (i.e. riprap, gabions, or geotextiles) have been employed.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE

   A. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer.

   B. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary.

   C. Perform inspections of the construction site as prescribed in the Construction General Permit TXR150000.

   D. Records of inspections and modifications based on the results of inspections must be maintained and available in accordance with the permit.
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log
SECTION 32 01 18
TEMPORARY ASPHALT PAVING REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Utility cuts (water, sanitary sewer, drainage, etc.) along streets programmed for
total reconstruction under a Capital Improvement Program or resurfacing under a
Street Maintenance Program.
   2. Repairs of damage caused by CONTRACTOR.
   3. Any other temporary pavement repair needed during the course of construction.

B. Deviations from City of Fort Worth Standards.
   1. None.

C. Related Specification Sections include but are not necessarily limited to
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the
      Contract.
   2. Division 1 - General Requirements.
   3. Section 32 11 23 - Flexible Base Courses.
   4. Section 32 12 16 - Asphalt Paving.
   5. Section 33 05 10 - Utility Trench Excavation, Embedment and Backfill.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement:
      a. Temporary Asphalt Paving Repair: measure by the linear foot.
   2. Payment: Contract unit price bid for the work performed and all materials
      furnished. No payment for repairs of damage to adjacent pavement caused by
      Contractor.

1.3 REFERENCES

A. Definitions
   1. H.M.A.C. – Hot Mix Asphalt Concrete

1.4 ADMINISTRATIVE REQUIREMENTS

A. Permitting
   1. Obtain Street Use Permit to make utility cuts in the street from the Transportation
      and Public Works Department in conformance with current ordinances.
   2. The Transportation and Public Works Department will inspect the paving repair
      after construction.
1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS
   A. Asphalt Pavement Mix Design: submit for approval. Section 32 12 16.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS
   A. Weather Conditions: Place mixture when the roadway surface temperature is 40 degrees F or higher and rising unless otherwise approved.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [NOT USED]

2.2 MATERIALS
   A. Backfill: see Section 33 05 10.
   B. Base Material:
      1. Flexible Base: Use existing base and add new flexible base as required in accordance with Section 32 11 23.
   C. Asphalt Concrete: See Section 32 12 16.
      1. H.M.A.C. paving: Type D.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION
   A. Removal:
      1. Use an approved method that produces a neat edge.
      2. Use care to prevent fracturing existing pavement structure adjacent to the repair area.
B. Base
   1. Install flexible base material per detail.
   2. See Section 32 11 23.
C. Asphalt Paving
   1. H.M.A.C. placement: in accordance with Section 32 12 16.
   2. Type D surface mix.
3.5 [REPAIR][RESTORATION] [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 32 01 29
CONCRETE PAVING REPAIR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete pavement repair to include but not limited to:
   1. Utility cuts (water, sanitary sewer, drainage, etc.).
   2. Warranty work.
   3. Repairs of damage caused by CONTRACTOR.
   4. Any other concrete pavement repair needed during the course of construction.

B. Deviations from City of Fort Worth Standards
   1. None.

C. Related Specification Sections include but are not necessarily limited to
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 32 01 18 - Temporary Asphalt Paving Repair.
   4. Section 32 12 16 - Asphalt Paving.
   5. Section 32 13 13 - Concrete Paving.
   6. Section 33 05 10 - Utility Trench Excavation, Embedment and Backfill.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:
   1. Measurement:
      a. Concrete Pavement Repair: measure by the square yard per thickness and type.
      a) Limits of repair based on the time of service of the existing pavement as determined by ENGINEER.
      (1) 10 years or less: repair entire panel.
      (2) Greater than 10 years: repair to limits per plans.
   2. Payment: contract unit price bid for the work performed and all materials including base material.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS

A. Permitting:
   1. Obtain Street Use Permit to make utility cuts in the street from the Transportation and Public Works Department in conformance with current ordinances.
   2. Transportation and Public Works Department will inspect paving repair after construction.
1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS
   A. Concrete Mix Design: submit for approval. Section 32 13 13.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS
   A. Weather Conditions: Place concrete as specified in Section 32 13 13.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS
   A. Embedment and Backfill: see Section 33 05 10.
   B. Base material: Concrete base: see Section 32 13 13.
   C. Concrete: see Section 32 13 13.
      1. Concrete paving: Class P or Class HES.
      2. Replace concrete to the specified thickness.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION
   A. Replace a continuous section if multiple repairs are closer than 10 feet apart from edge
      of one repair to the edge of a second repair.
   B. If the cut is to be covered, use steel plates of sufficient strength and thickness to support
      traffic.
      1. Construct a transition of hot-mix or cold-mix asphalt from the top of the steel plate
         to the existing pavement to create a smooth riding surface.
         a. Hot-mix or cold-mix asphalt: conform to the requirements of Section 32 12 16.
3.4 INSTALLATION

A. Sawing:
   1. General:
      a. Saw cut perpendicular to the surface to full pavement depth.
      b. Saw cut the edges of pavement and appurtenances damaged subsequent to
         sawing to remove damaged areas.
      c. Such saw cuts shall be parallel to the original saw cut and to neat straight lines.
   2. Sawing equipment:
      a. Power-driven.
      b. Manufactured for the purpose of sawing pavement.
      c. In good operating condition.
      d. Shall not spall or facture concrete adjacent to the repair area.
   3. Repairs: In true and straight lines to dimensions shown on the plans.
   4. Utility Cuts:
      a. In a true and straight line on both sides of the trench.
      b. Minimum of 12 inches outside the trench walls.
   5. Prevent dust and residues from sawing from entering the atmosphere or drainage
      facilities.

B. Removal:
   1. Use care in removing concrete to be repaired to prevent spalling or fracturing
      concrete adjacent to the repair area.

C. Base: per detail.

D. Concrete Paving:
   1. Concrete placement: in accordance with Section 32 13 13.
   2. Reinforce concrete replacement: per detail.

3.5 [REPAIR]/[RESTORATION] [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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## Revision Log

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1
SECTION 32 11 23
FLEXIBLE BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
1. Foundation course for surface course or for other base course composed of flexible
base constructed in one or more courses in conformity with the typical section.
B. Deviations from City of Fort Worth Standards
1. None
C. Related Specification Sections include but are not necessarily limited to
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the
 Contract
2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
1. Measurement: measured by the square yard of the required depth per plan of
 completed flexible base course by type and gradation.
2. Payment: based on the work performed and materials placed and includes full
 compensation for:
 a. preparation and correction of subgrade
 b. furnishing of material
 c. hauling
 d. blading
 e. sprinkling
 f. compacting
 g. and furnishing all labor and equipment necessary to complete the work.

1.3 REFERENCES
A. Definitions
1. RAP – Recycled Asphalt Pavement.

B. Reference Standards
1. Reference standards cited in this specification refer to the current reference standard
 published at the time of the latest revision date logged at the end of this
 specification, unless a date is specifically cited.
2. ASTM International (ASTM):
 a. D698, Standard Test Methods for Laboratory Compaction Characteristics of
 Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
3. Texas Department of Transportation (TXDOT):
 a. Tex-104-E, Determining Liquid Limits of Soils
 b. Tex-106-E, Calculating the Plasticity Index of Soils
 c. Tex-107-E, Determining the Bar Linear Shrinkage of Soils
 d. Tex-110-E, Particle Size Analysis of Soils
e. Tex-116-E, Ball Mill Method for Determining the Disintegration of Flexible 
   Base Material
f. Tex-117-E, Triaxial Compression for Disturbed Soils and Base Materials
g. Tex-411-A, Soundness of Aggregate Using Sodium Sulfate or Magnesium 
   Sulfate
h. Tex-413-A, Determining Deleterious Material in Mineral Aggregate

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 ACTION SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. General

1. Furnish uncontaminated materials of uniform quality that meet the requirements of 
   the plans and specifications.

2. Obtain materials from approved sources.

3. Notify City of changes to material sources.

4. The City may sample and test project materials at any time before compaction 
   throughout the duration of the project to assure specification compliance.

B. Aggregate

1. Furnish aggregate of the type and grade shown on the plans and conforming to the 
   requirements of Table 1.

2. Each source must meet Table 1 requirements for liquid limit, plastiCity index, and 
   wet ball mill for the grade specified.

3. Do not use additives such as but not limited to lime, cement, or fly ash to modify 
   aggregates to meet the requirements of Table 1, unless shown on the plans.
4. Material Tolerances:
   a) The City may accept material if no more than 1 of the 5 most recent gradation tests has an individual sieve outside the specified limits of the gradation.
   b) When target grading is required by the plans, no single failing test may exceed the master grading by more than 5 percentage points on sieves No. 4 and larger or 3 percentage points on sieves smaller than No. 4.
   c) The City may accept material if no more than 1 of the 5 most recent plasticity index tests is outside the specified limit. No single failing test may exceed the allowable limit by more than 2 points.

5. Material Types
   a) Do not use fillers or binders unless approved.
   b) Furnish the type specified on the plans in accordance with the following:
      1) Type A
         a) Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source.
         b) Do not use gravel or multiple sources.
      2) Type B
         a) Only for use as base material for temporary pavement repairs.
         b) Do not exceed 20% RAP by weight unless shown on plans.
      3) Type D
         a) Type A material or crushed concrete.
         b) Crushed concrete containing gravel will be considered Type D material.
c) The City may require separate dedicated stockpiles in order to verify compliance.

d) Crushed concrete must meet the following requirements:
   (1) Table 1 for the grade specified.
   (2) Recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5 percent deleterious material when tested in accordance with TEX-413-A.

C. Water
1. Furnish water free of industrial wastes and other objectionable matter.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. General
1. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

2. When new base is required to be mixed with existing base:
   a. Deliver, place, and spread the new flexible base in the required amount.
   b. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

B. Subgrade Compaction
1. Proof roll the roadbed before pulverizing or scarifying in accordance with the following:
   a. Proof Rolling
      1) City Project Representative must be on-site during proof rolling operations.
      2) Use equipment that will apply sufficient load to identify soft spots that rut or pump.
         (1) Acceptable equipment includes fully loaded single-axle water truck with a 1500 gallon capacity.
         3) Make at least 2 passes with the proof roller (down and back = 1 pass).
         4) Offset each trip by at most 1 tire width.
         5) If an unstable or non-uniform area is found, correct the area.
   b. Correct
      1) Soft spots that rut or pump greater than 3/4 inch.
      2) Areas that are unstable or non-uniform.

2. Installation of base material cannot proceed until compacted subgrade approved by the Engineer.

3.4 INSTALLATION

A. General
1. Construct each layer uniformly, free of loose or segregated areas, and with the
   required density and moisture content.
2. Provide a smooth surface that conforms to the typical sections, lines, and grades
   shown on the plans or as directed.
3. Haul approved flexible base in clean, covered trucks.

B. Equipment
1. General: Provide machinery, tools, and equipment necessary for proper execution
   of the work.
2. Rollers:
   a. The CONTRACTOR may use any type of roller to meet the production rates
      and quality requirements of the Contract unless otherwise shown on the plans
      or directed.
   b. When specific types of equipment are required, use equipment that meets the
      specified requirements.
   c. Alternate Equipment.
      1) Instead of the specified equipment, the CONTRACTOR may, as approved,
         operate other compaction equipment that produces equivalent results.
      2) Discontinue the use of the alternate equipment and furnish the specified
         equipment if the desired results are not achieved.
   d. City may require CONTRACTOR to substitute equipment if production rate
      and quality requirements of the Contract are not met.

C. Placing
1. Spread and shape flexible base into a uniform layer by approved means the same
   day as delivered unless otherwise approved.
2. Place material such that it is mixed to minimize segregation.
3. Construct layers to the thickness shown on the plans, while maintaining the shape
   of the course.
4. Where subbase or base course exceeds 6 inches in thickness, construct in two or
   more courses of equal thickness.
5. Minimum lift depth: 3 inches.
6. Control dust by sprinkling.
7. Correct or replace segregated areas as directed.
8. Place successive base courses and finish courses using the same construction
   methods required for the first course.

D. Compaction
1. General:
   a. Compact using density control unless otherwise shown on the plans.
   b. Multiple lifts are permitted when shown on the plans or approved.
   c. Bring each layer to the moisture content directed. When necessary, sprinkle the
      material to the extent necessary to provide not less than the required density.
   d. Compact the full depth of the subbase or base to the extent necessary to remain
      firm and stable under construction equipment.
2. Rolling:
   a. Begin rolling longitudinally at the sides and proceed towards the center,
      overlapping on successive trips by at least 1/2 the width of the roller unit.
b. On superelevated curves, begin rolling at the low side and progress toward the high side.

c. Offset alternate trips of the roller.

d. Operate rollers at a speed between 2 and 6 mph as directed.

e. Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted.

f. Continue work until specification requirements are met.

g. Proof roll the compacted flexible base in accordance with the following:

1) Proof Rolling
   a) City Project Representative must be on-site during proof rolling operations.
   b) Use equipment that will apply sufficient load to identify soft spots that rut or pump.
      (1) Acceptable equipment includes fully loaded single-axle water truck with a 1500 gallon capacity.
   c) Make at least 2 passes with the proof roller (down and back = 1 pass).
   d) Offset each trip by at most 1 tire width.
   e) If an unstable or non-uniform area is found, correct the area.

2) Correct
   a) Soft spots that rut or pump greater than 3/4 inch.
   b) Areas that are unstable or non-uniform.

3. Tolerances
   a. Maintain the shape of the course by blading.
   b. Completed surface shall be smooth and in conformity with the typical sections shown on the plans to the established lines and grades.
   c. For subgrade beneath paving surfaces, correct any deviation in excess of 1/4 inch in cross section in length greater than 16 feet measured longitudinally by loosening, adding or removing material. Reshape and recompact by sprinkling and rolling.
   d. Correct all fractures, settlement or segregation immediately by scarifying the areas affected, adding suitable material as required. Reshape and recompact by sprinkling and rolling.
   e. Should the subbase or base course, due to any reason, lose the required stability, density and finish before the surfacing is complete, it shall be recompacted at the sole expense of the CONTRACTOR.

4. Density Control
   a. Minimum Density: 95 percent compaction as determined by ASTM D698.
   b. Moisture content: minus 2 to plus 4 of optimum.

E. Finishing
   1. After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately 1/4 inch.
   2. Remove loosened material and dispose of it at an approved location.
   3. Seal the clipped surface immediately by rolling with an appropriate size pneumatic tire roller until a smooth surface is attained.
   4. Add small increments of water as needed during rolling.
   5. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.
6. In areas where surfacing is to be placed, correct grade deviations greater than 1/4 inch in 16 feet measured longitudinally or greater than 1/4 inch over the entire width of the cross-section.

7. Correct by loosening, adding, or removing material.

8. Reshape and recompact in accordance with 3.4.C.

3.5 [REPAIR]/[RESTORATION] [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 QUALITY CONTROL

A. Density Test

   1. City to measure density of flexible base course.
      a. Notify City Project Representative when flexible base ready for density testing.
      b. Spacing directed by City (1 per block minimum).
      c. City Project Representative determines location of density testing.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

Revision Log

<table>
<thead>
<tr>
<th>DATE</th>
<th>NAME</th>
<th>SUMMARY OF CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

END OF PAGE
SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY
A. Construct a pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder for surface or base courses.
B. Standard Detail
1. H.M.A.C. Pavement Construction Details
C. Deviations from City of Fort Worth Standards
1. None
D. Related Specification Sections include but are not necessarily limited to
1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 - General Requirements
3. Section 32 01 17 - Permanent Asphalt Paving Repair

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
1. Measurement
a. Asphalt Pavement: measure by the square yard of completed and accepted asphalt pavement in its final position for various thicknesses and types.
b. H.M.A.C. Transition: measure by the ton of composite hot mix.
c. Asphalt Base Course: measure by the square yard of completed and accepted in its final position for various thicknesses.
d. H.M.A.C. Pavement Level Up: measure by the ton of completed and accepted in its final position.
e. H.M.A.C. Speed Cushion: measure by each completed and accepted in its final position.
2. Payment: Based on the work performed and all materials furnished and subsidiary work and materials include:
a. shaping and fine grading the roadbed
b. furnishing, loading and unloading, storing, hauling and handling all materials including all freight and royalty
c. traffic control for all testing
d. asphalt, aggregate, and additive
e. materials and work needed for corrective action,
f. equipment, labor, tools
g. trial batches,
h. tack coat,
i. removal and/or sweeping excess material.

1.3 REFERENCES
A. Abbreviations and Acronyms
1. RAP (reclaimed asphalt pavement)
2. SAC (surface aggregate classification)
3. BRSQC (Bituminous Rated Source Quality Catalog)
4. AQMP (Aggregate Quality Monitoring Program)
5. H.M.A.C. (Hot Mix Asphalt Concrete)
6. WMA (Warm Mix Asphalt)

B. Reference Standards
1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
2. National Institute of Standards and Technology (NIST)
3. ASTM International (ASTM):
4. American Association of State Highway and Transportation Officials
   a. MP2 Standard Specification for Superpave Volumetric Mix Design
   b. PP28 Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
   c. T 201, Kinematic Viscosity of Asphalts (Bitumens)
   d. T 202 Standard Method of Test for Viscosity of Asphalts by Vacuum Capillary Viscometer
   e. T 316 Standard Method of Test for Viscosity Determination of Asphalt Binder Using Rotational Viscometer
   f. TP 1-93 Test Method for Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
5. Texas Department of Transportation
   a. Bituminous Rated Source Quality Catalog (BRSQC)
   b. TEX 100-E, Surveying and Sampling Soils for Highways
   c. Tex 106-E, Calculating the Plasticity Index of Soils
   d. Tex 107-E, Determining the Bar Linear Shrinkage of Soils
   e. Tex 200-F, Sieve Analysis of Fine and Coarse Aggregates
   f. Tex 203-F, Sand Equivalent Test
   g. Tex-204-F, Design of Bituminous Mixtures
   h. Tex-207-F, Determining Density of Compacted Bituminous Mixtures
   i. Tex 217-F, Determining Deleterious Material and Decantation Test for Coarse Aggregates
   j. Tex-226-F, Indirect Tensile Strength Test
   k. Tex-227-F, Theoretical Maximum Specific Gravity of Bituminous Mixtures
   l. Tex-243-F, Tack Coat Adhesion
   m. Tex-244-F, Thermal profile of Hot Mix Asphalt
   n. Tex 280-F, Determination of Flat and Elongated Particles
   o. Tex 406-A, Material Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates (Decantation Test for Concrete Aggregates)
   p. Tex 408-A, Organic Impurities in Fine Aggregate for Concrete
   q. Tex 410-A, Abrasion of Coarse Aggregate using the Los Angeles Machine
r. Tex 411-A, Soundness of Aggregate by Using Sodium Sulfate or Magnesium
s. Tex 460-A, Determining Crushed Face Particle Count
t. Tex 461-A, Degradation of Coarse Aggregate by Micro-Deval Abrasion
t. Sulfate
v. Tex-530-C, Effect of Water on Bituminous Paving Mixtures
w. Tex-540-C, Measurement of Polymer Separation on Heating in Modified
Asphalt Systems
x. Tex-541-C, Rolling Thin Film Oven Test for Asphalt Binders
y. Tex-920-K, Verifying the Accuracy of Drum Mix Plant Belt Scales
z. Tex-921-K, Verifying the Accuracy of Hot Mix Plant Asphalt Meters
aa. Tex 923-K, Verifying the Accuracy of Liquid Additive Metering Systems

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 ACTION SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Asphalt Paving Mix Design: Submit for approval. See 2.2.B.1.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS

A. Weather Conditions
   1. Place mixture when the roadway surface temperature is equal to or higher than the
      temperatures listed in Table 1.

**Table 1**

<table>
<thead>
<tr>
<th>Originally Specified High</th>
<th>Minimum Pavement Surface Temperatures in Degrees Fahrenheit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Binder Grade</td>
<td>Subsurface Layers or Night Paving Operations</td>
</tr>
<tr>
<td>PG64 or lower</td>
<td>45</td>
</tr>
<tr>
<td>PG 70</td>
<td>55(^1)</td>
</tr>
<tr>
<td>PG 76 or higher</td>
<td>60(^1)</td>
</tr>
</tbody>
</table>

\(^1\)Contractors may pave at temperatures 10°F lower than the values shown in Table 1 when utilizing a paving process including WMA or equipment that eliminates thermal segregation. In such cases, the contractor must use either a hand held thermal camera or a hand held infrared thermometer operated in accordance with Tex-244-F to demonstrate to the satisfaction of the City that the uncompacted mat has no more than 10° F of thermal segregation.
2. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the City.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. General:

1. Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.
2. Notify the City of all material sources.
3. Notify the City before changing any material source or formulation.
4. When the CONTRACTOR makes a source or formulation change, the City will verify that the requirements of this specification are met and may require a new laboratory mixture design, trial batch, or both.
5. The City may sample and test project materials at any time during the project to verify compliance.
6. The depth of the compacted lift should be at least two times the nominal maximum aggregate size.

B. Aggregate.

1. General:
   a. Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this Section, unless otherwise shown on the plans.
   b. Provide aggregate stockpiles that meet the definition in this Section for either coarse aggregate or fine aggregate.
   c. When reclaimed asphalt pavement (RAP) is allowed by plan note, provide RAP stockpiles in accordance with this Section.
   d. Aggregate from RAP is not required to meet Table 2 requirements unless otherwise shown on the plans.
   e. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex 100 E.
   f. Samples must be from materials produced for the project.
   g. The City will establish the surface aggregate classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests.
   h. Perform all other aggregate quality tests listed in Table 2.
   i. Document all test results on the mixture design report.
   j. The City may perform tests on independent or split samples to verify CONTRACTOR test results.
   k. Stockpile aggregates for each source and type separately and designate for the City.
   l. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex 200 F, Part II.
Table 2
Aggregate Quality Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAC</td>
<td>AQMP</td>
<td>As shown on plans</td>
</tr>
<tr>
<td>Deleterious material, percent, max</td>
<td>Tex-217-F, Part I</td>
<td>1.5</td>
</tr>
<tr>
<td>Decantation, percent, max</td>
<td>Tex-217-F, Part II</td>
<td>1.5</td>
</tr>
<tr>
<td>Micro-Deval abrasion, percent, max</td>
<td>Tex-461-A</td>
<td>Note 1</td>
</tr>
<tr>
<td>Los Angeles abrasion, percent, max</td>
<td>Tex-410-A</td>
<td>40</td>
</tr>
<tr>
<td>Magnesium sulfate soundness, 5 cycles, percent, max</td>
<td>Tex-411-A</td>
<td>30\textsuperscript{2}</td>
</tr>
<tr>
<td>Coarse aggregate angularity, 2 crushed faces, percent, min</td>
<td>Tex 460-A, Part I</td>
<td>85\textsuperscript{3}</td>
</tr>
<tr>
<td>Flat and elongated particles @ 5:1, percent, max</td>
<td>Tex-280-F</td>
<td>10</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear shrinkage, percent, max</td>
<td>Tex-107-E</td>
<td>3</td>
</tr>
<tr>
<td>Combined Aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand equivalent, percent, min</td>
<td>Tex-203-F</td>
<td>45</td>
</tr>
</tbody>
</table>

1. Not used for acceptance purposes. Used by the City as an indicator of the need for further investigation.
2. Unless otherwise shown on the plans.
3. Unless otherwise shown on the plans. Only applies to crushed gravel.

m. Coarse Aggregate.

1) Coarse aggregate stockpiles must have no more than 20 percent material passing the No. 8 sieve.
2) Maximum aggregate size should not be over half of the proposed lift depth to prevent particle on particle contact issues.
3) Provide aggregates from sources listed in the BRSQC.
4) Provide aggregate from nonlisted sources only when tested by the City and/or approved before use.
5) Allow 30 calendar days for the City to sample, test, and report results for nonlisted sources.
6) Class B aggregate meeting all other requirements in Table 2 may be blended with a Class A aggregate in order to meet requirements for Class A materials.
7) When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50 percent by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source.
8) Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300.
9) When blending, do not use Class C or D aggregates.
10) For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.
11) Provide coarse aggregate with at least the minimum SAC shown on the plans.
12) SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans.

n. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement.
1) No RAP permitted for TYPE D H.M.A.C.
2) Use no more than 20 percent RAP on TYPE B H.M.A.C. unless otherwise shown on the plans.
3) Crush or break RAP so that 100 percent of the particles pass the 2 inch sieve.
4) RAP from either CONTRACTOR or City, including RAP generated during the project, is permitted only when shown on the plans.
5) City-owned RAP, if allowed for use, will be available at the location shown on the plans.
6) When RAP is used, determine asphalt content and gradation for mixture design purposes.
7) Perform other tests on RAP when shown on the plans.
8) When RAP is allowed by plan note, use no more than 30 percent RAP in Type A or B mixtures unless otherwise shown on the plans.
9) Do not use RAP contaminated with dirt or other objectionable materials.
10) Do not use the RAP if the decantation value exceeds 5 percent and the plasticity index is greater than 8.
11) Test the stockpiled RAP for decantation in accordance with the laboratory method given in Tex-406-A, Part I.
12) Determine the plasticity index using Tex-106-E if the decantation value exceeds 5 percent.
13) The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction.
14) Do not intermingle CONTRACTOR-owned RAP stockpiles with City-owned RAP stockpiles.
15) Remove unused CONTRACTOR-owned RAP material from the project site upon completion of the project.
16) Return unused City-owned RAP to the designated stockpile location.

o. Fine Aggregate.
1) Fine aggregates consist of manufactured sands, screenings, and field sands.
2) Fine aggregate stockpiles must meet the gradation requirements in Table 3.
3) Supply fine aggregates that are free from organic impurities.
4) The City may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities.
5) At most 15 percent of the total aggregate may be field sand or other uncrushed fine aggregate.
6) With the exception of field sand, use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 2, unless otherwise approved.
7) If 10 percent or more of the stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (Tex-460-A) and flat and elongated particles (Tex-280-F).
Table 3
Gradation Requirements for Fine Aggregate

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>percent Passing by Weight or Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>#8</td>
<td>70–100</td>
</tr>
<tr>
<td>#200</td>
<td>0–30</td>
</tr>
</tbody>
</table>

2. Mineral Filler. Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2 percent hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:
   a. is sufficiently dry, free-flowing, and free from clumps and foreign matter;
   b. does not exceed 3 percent linear shrinkage when tested in accordance with Tex-107-E; and meets the gradation requirements in Table 4.

Table 4
Gradation Requirements for Mineral Filler

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>percent Passing by Weight or Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>#8</td>
<td>100</td>
</tr>
<tr>
<td>#200</td>
<td>55–100</td>
</tr>
</tbody>
</table>

3. Baghouse Fines. Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

4. Asphalt Binder. Furnish the type and grade of performance-graded (PG) asphalt binder specified as follows:
   a. Performance-Graded Binders. PG binders must be smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet Table 5 requirements.
# Table 5
Performance-Graded Binders

<table>
<thead>
<tr>
<th>Property and Test Method</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 max pavement design temperature, °C¹</td>
<td>&lt; 58</td>
<td>&lt; 64</td>
<td>&lt; 70</td>
<td>&lt; 76</td>
<td>&lt; 82</td>
</tr>
<tr>
<td>Min pavement design temperature, °C¹</td>
<td>&gt;-</td>
<td>&gt;-</td>
<td>&gt;-</td>
<td>&gt;-</td>
<td>&gt;-</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>28</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
</tbody>
</table>

**ORIGINAL BINDER**

<table>
<thead>
<tr>
<th>Property and Test Method</th>
<th>Performance Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash point, T 48, Min, °C</td>
<td>230</td>
</tr>
<tr>
<td>Viscosity, T 316.² ³</td>
<td></td>
</tr>
<tr>
<td>Max, 3.0 Ppas, test temperature, °C</td>
<td>135</td>
</tr>
<tr>
<td>Dynamic shear, T 315.⁴</td>
<td></td>
</tr>
<tr>
<td>G*/sin(d), Min, 1.00 kPa</td>
<td></td>
</tr>
<tr>
<td>Test temperature @ 10 rad/sec., °C</td>
<td>58 64 70 76 82</td>
</tr>
<tr>
<td>Elastic recovery, D 6084, 50°F, percent</td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>– – – – 30 – – 30 50 – 30 50 60 30 50 60 70 50 60 70</td>
</tr>
</tbody>
</table>

**ROLLING THIN-FILM OVEN (Tex-541-C)**

<table>
<thead>
<tr>
<th>Property and Test Method</th>
<th>Performance Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass loss, Tex-541-C, Max, percent</td>
<td>1</td>
</tr>
<tr>
<td>Dynamic shear, T 315:</td>
<td></td>
</tr>
<tr>
<td>G*/sin(d), Min, 2.20 kPa</td>
<td></td>
</tr>
<tr>
<td>Test temperature @ 10 rad/sec., °C</td>
<td>58 64 70 76 82</td>
</tr>
</tbody>
</table>
5. If creep stiffness is below 300 MPa, a direct tension test is not required. If creep stiffness is between 300 and 500 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

### Table 5 (continued)

<table>
<thead>
<tr>
<th>Property and Test Method</th>
<th>Performance-Graded Binders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Performance Grade</td>
</tr>
<tr>
<td></td>
<td>PG 58</td>
</tr>
<tr>
<td></td>
<td>PG 64</td>
</tr>
<tr>
<td></td>
<td>PG 70</td>
</tr>
<tr>
<td></td>
<td>PG 76</td>
</tr>
<tr>
<td></td>
<td>PG 82</td>
</tr>
<tr>
<td></td>
<td>Direct tension, T = 314°F</td>
</tr>
<tr>
<td></td>
<td>10% Failure strain, min.</td>
</tr>
<tr>
<td></td>
<td>Test temperature @ 0.5 sec.</td>
</tr>
<tr>
<td></td>
<td>G' (dyn/cm²)</td>
</tr>
<tr>
<td></td>
<td>G' (rad/s)</td>
</tr>
<tr>
<td></td>
<td>Test temperature @ 10 rad/sec.</td>
</tr>
<tr>
<td></td>
<td>m value, min. 0.300</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
5. Tack Coat:
   a. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Section 2.2.A.5.

6. Additives.
   a. General:
      1) When shown on the plans, use the type and rate of additive specified.
      2) Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved.
   b. Liquid Antistripping Agent.
      1) Furnish and incorporate all required asphalt antistripping agents in asphalt concrete paving mixtures and asphalt-stabilized base mixtures to meet moisture resistance testing requirements.
      2) Provide a liquid antistripping agent that is uniform and shows no evidence of crystallization, settling, or separation.
      3) Ensure that all liquid antistripping agents arrive in:
         a) properly labeled and unopened containers, as shipped from the manufacturer, or
         b) sealed tank trucks with an invoice to show contents and quantities.
         c) Provide product information to the City including:
            (1) Material safety data sheet
            (2) Specific gravity of the agent at the manufacturer’s recommended addition temperature,
            (3) Manufacturer’s recommended dosage range, and
            (4) Handling and storage instructions.
      4) Addition of lime or a liquid antistripping agent at the Mix Plant, incorporate into the binder as follows:
         a) Handle in accordance with the manufacturer’s recommendations.
         b) Add at the manufacturer’s recommended addition temperature.
         c) Add into the asphalt line by means of an in-line-metering device.
   c. Liquid Asphalt Additive Meters.
      1) Provide a means to check the accuracy of meter output for asphalt primer, fluxing material, and liquid additives.
      2) Furnish a meter that reads in increments of 0.1 gal. or less.
      3) Verify accuracy of the meter in accordance with Tex-923-K.
      4) Ensure the accuracy of the meter within 5.0 percent.

7. Mixes
   a. Design Requirements:
      1) Unless otherwise shown on the plans, use the typical weight design example given in Tex-204-F, Part I, to design a mixture meeting the requirements listed in Tables 2 through 8.
2) Furnish the City with representative samples of all materials used in the mixture design.
3) The City will verify the mixture design.
4) If the design cannot be verified by the City, furnish another mixture design.

### Table 6
Master Gradation Bands (percent Passing by Weight or Volume)
and Volumetric Properties

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>B Fine Base</th>
<th>C Coarse Surface</th>
<th>D Fine Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot;</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1&quot;</td>
<td>98.0–100.0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>84.0–98.0</td>
<td>95.0–100.0</td>
<td>–</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>–</td>
<td>–</td>
<td>98.0–100.0</td>
</tr>
<tr>
<td>3/8&quot;</td>
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<td>70.0–85.0</td>
<td>85.0–100.0</td>
</tr>
<tr>
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<td>50.0–70.0</td>
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<tr>
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<td>32.0–44.0</td>
<td>35.0–46.0</td>
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<tr>
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<td>14.0–28.0</td>
<td>15.0–29.0</td>
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<tr>
<td>#50</td>
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<td>7.0–21.0</td>
<td>7.0–20.0</td>
</tr>
<tr>
<td>#200</td>
<td>2.0–7.0</td>
<td>2.0–7.0</td>
<td>2.0–7.0</td>
</tr>
</tbody>
</table>

**Design VMA¹, percent Minimum**

| – | 13.0 | 14.0 | 15.0 |

**Plant-Produced VMA, percent Minimum**

| – | 12.0 | 13.0 | 14.0 |


### Table 7
Laboratory Mixture Design Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target laboratory-molded density, percent</td>
<td>Tex-207-F</td>
<td>96.0¹</td>
</tr>
<tr>
<td>Tensile strength (dry), psi (molded to 93 percent ±1 percent density)</td>
<td>Tex-226-F</td>
<td>85–200²</td>
</tr>
<tr>
<td>Boil test³</td>
<td>Tex-530-C</td>
<td>–</td>
</tr>
</tbody>
</table>

1. Unless otherwise shown on the plans.
2. May exceed 200 psi when approved and may be waived when approved.
3. Used to establish baseline for comparison to production results. May be waived when approved.

8. Warm Mix Asphalt (WMA)
   a. WMA is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed.
   b. WMA is allowed for use at the CONTRACTOR’s option unless otherwise shown on the plans.
   c. Produce an asphalt mixture within the temperature range of 215 degrees F and 275 degrees F.
d. When WMA is not required as shown on plans, produce an asphalt mixture within the temperature range of 215 degrees F and 275 degrees

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Hauling Operations
   1. Before use, clean all truck beds to ensure mixture is not contaminated.
   2. When a release agent is necessary to coat truck beds, use a release agent approved by the Engineer.
   3. Petroleum based products, such as diesel fuel, should not be used.
   4. If wind, rain, temperature or haul distance impacts cooling, insulate truck beds or cover the truck bed with tarpaulin.
   5. If haul time in project is to be greater than 30 minutes, insulate truck beds or cover the truck bed with tarpaulin.

3.4 INSTALLATION

A. Equipment.
   1. General:
      a. Provide required or necessary equipment to produce, haul, place, compact, and core asphalt concrete pavement.
      b. Ensure weighing and measuring equipment complies with specification.
      c. Synchronize equipment to produce a mixture meeting the required proportions.
   2. Production Equipment:
      a. Provide:
         1) drum-mix type, weigh-batch, or modified weigh-batch mixing plants that ensure a uniform, continuous production;
         2) automatic proportioning and measuring devices with interlock cut-off circuits that stop operations if the control system malfunctions;
         3) visible readouts indicating the weight or volume of asphalt and aggregate proportions;
         4) safe and accurate means to take required samples by inspection forces;
         5) permanent means to check the output of metering devices and to perform calibration and weight checks;
         6) additive-feed systems to ensure a uniform, continuous material flow in the desired proportion.

      a. General.
         1) Provide weighing and measuring equipment for materials measured or proportioned by weight or volume.
2) Provide certified scales, scale installations, and measuring equipment
   meeting the requirements of NIST Handbook 44, except that the required
   accuracy must be 0.4 percent of the material being weighed or measured.
3) Furnish leak-free weighing containers large enough to hold a complete
   batch of the material being measured.

b. Truck Scales.
   1) Furnish platform truck scales capable of weighing the entire truck or truck–
      trailer combination in a single draft.

c. Aggregate Batching Scales.
   1) Equip scales used for weighing aggregate with a quick adjustment at zero
      that provides for any change in tare.
   2) Provide a visual means that indicates the required weight for each
      aggregate.

d. Suspended Hopper.
   1) Provide a means for the addition or the removal of small amounts of
      material to adjust the quantity to the exact weight per batch.
   2) Ensure the scale equipment is level.

e. Belt Scales.
   1) Use belt scales for proportioning aggregate that are accurate to within 1.0
      percent based on the average of 3 test runs, where no individual test run
      exceeds 2.0 percent when checked in accordance with Tex-920-K.

f. Asphalt Material Meter.
   1) Provide an asphalt material meter with an automatic digital display of the
      volume or weight of asphalt material.
   2) Verify the accuracy of the meter in accordance with Tex-921-K.
   3) When using the asphalt meter for payment purposes, ensure the accuracy of
      the meter is within 0.4 percent.
   4) When used to measure component materials only and not for payment,
      ensure the accuracy of the meter is within 1.0 percent.

g. Liquid Asphalt Additive Meters.
   1) Provide a means to check the accuracy of meter output for asphalt primer,
      fluxing material, and liquid additives.
   2) Furnish a meter that reads in increments of 0.1 gallon or less.
   3) Verify accuracy of the meter in accordance with Tex-923-K.
   4) Ensure the accuracy of the meter within 5.0 percent.

4. Drum-Mix Plants. Provide a mixing plant that complies with the requirements
   below.
   a. Aggregate Feed System.
      1) Provide:
         a) a minimum of 1 cold aggregate bin for each stockpile of individual
            materials used to produce the mix;
         b) bins designed to prevent overflow of material;
         c) scalping screens or other approved methods to remove any oversized
            material, roots, or other objectionable materials;
         d) a feed system to ensure a uniform, continuous material flow in the
            desired proportion to the dryer;
         e) an integrated means for moisture compensation;
         f) belt scales, weigh box, or other approved devices to measure the weight
            of the combined aggregate; and
4 g) cold aggregate bin flow indicators that automatically signal interrupted material flow.

b. Reclaimed Asphalt Pavement (RAP) Feed System.
   1) Provide a separate system to weigh and feed RAP into the hot mix plant.

c. Mineral Filler Feed System.
   1) Provide a closed system for mineral filler that maintains a constant supply with minimal loss of material through the exhaust system.
   2) Interlock the measuring device into the automatic plant controls to automatically adjust the supply of mineral filler to plant production and provide a consistent percentage to the mixture.

d. Heating, Drying, and Mixing Systems.
   1) Provide:
      a) a dryer or mixing system to agitate the aggregate during heating;
      b) a heating system that controls the temperature during production to prevent aggregate and asphalt binder damage;
      c) a heating system that completely burns fuel and leaves no residue; and
      d) a recording thermometer that continuously measures and records the mixture discharge temperature.
      e) Dust collection system to collect excess dust escaping from the drum.

e. Asphalt Binder Equipment.
   1) Supply equipment to heat binder to the required temperature.
   2) Equip the heating apparatus with a continuously recording thermometer located at the highest temperature point.
   3) Produce a 24 hour chart of the recorded temperature.
   4) Place a device with automatic temperature compensation that accurately meters the binder in the line leading to the mixer.
   5) Furnish a sampling port on the line between the storage tank and mixer.
      Supply an additional sampling port between any additive blending device and mixer.

f. Mixture Storage and Discharge.
   1) Provide a surge-storage system to minimize interruptions during operations unless otherwise approved.
   2) Furnish a gob hopper or other device to minimize segregation in the bin.
   3) Provide an automated system that weighs the mixture upon discharge and produces a ticket showing:
      a) date,
      b) project identification number,
      c) plant identification,
      d) mix identification,
      e) vehicle identification,
      f) total weight of the load,
      g) tare weight of the vehicle,
      h) weight of mixture in each load, and
      i) load number or sequential ticket number for the day.

g. Truck Scales.
   1) Provide standard platform scales at an approved location.

5. Weigh-Batch Plants. Provide a mixing plant that complies with Section 2.2.B.4 “Drum-Mix Plants,” except as required below.
   a. Screening and Proportioning.
1) Provide enough hot bins to separate the aggregate and to control proportioning of the mixture type specified.
   a) Supply bins that discard excessive and oversized material through overflow chutes.
   b) Provide safe access for inspectors to obtain samples from the hot bins.
2. Aggregate Weigh Box and Batching Scales.
   1) Provide a weigh box and batching scales to hold and weigh a complete batch of aggregate.
   2) Provide an automatic proportioning system with low bin indicators that automatically stop when material level in any bin is not sufficient to complete the batch.
   1) Provide bucket and scales of sufficient capacity to hold and weigh binder for 1 batch.
   1) Equipment mixers with an adjustable automatic timer that controls the dry and wet mixing period and locks the discharge doors for the required mixing period.
   2) Furnish a pug mill with a mixing chamber large enough to prevent spillage.
   a. Aggregate Feeds.
      1) Aggregate control is required at the cold feeds. Hot bin screens are not required.
   b. Surge Bins.
      1) Provide 1 or more bins large enough to produce 1 complete batch of mixture.
   c. Hauling Equipment.
      1) Provide trucks with enclosed sides to prevent asphalt mixture loss.
      2) Cover each load of mixture with waterproof tarpaulins.
      3) Before use, clean all truck beds to ensure the mixture is not contaminated.
      4) When necessary, coat the inside truck beds with an approved release agent from the City.
   d. Placement and Compaction Equipment.
      1) Provide equipment that does not damage underlying pavement.
      2) Comply with laws and regulations concerning overweight vehicles.
      3) When permitted, other equipment that will consistently produce satisfactory results may be used.
7. Asphalt Paver.
   a. General:
      1) Furnish a paver that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements.
      2) Ensure the paver does not support the weight of any portion of hauling equipment other than the connection.
      3) Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affect the finished pavement quality.
      4) Equip the paver with an automatic, dual, longitudinal-grade control system and an automatic, transverse-grade control system.
   b. Tractor Unit.
1) Supply a tractor unit that can push or propel vehicles, dumping directly into
the finishing machine to obtain the desired lines and grades to eliminate any
hand finishing.

2) Equip the unit with a hitch sufficient to maintain contact between the
hauling equipment’s rear wheels and the finishing machine’s pusher rollers
while mixture is unloaded.

c. Screed.
   1) Provide a heated compacting screed that will produce a finished surface
that meets longitudinal and transverse profile, typical section, and
placement requirements.
   2) Screed extensions must provide the same compacting action and heating as
the main unit unless otherwise approved.

d. Grade Reference.
   1) Provide a grade reference with enough support that the maximum
deflection does not exceed 1/16 inch between supports.
   2) Ensure that the longitudinal controls can operate from any longitudinal
grade reference including a string line, ski, mobile string line, or matching
shoes.
   3) Furnish paver skis or mobile string line at least 40 feet long unless
otherwise approved.

8. Material Transfer Devices.
   a. Provide the specified type of device when shown on the plans.
   b. Ensure the devices provide a continuous, uniform mixture flow to the asphalt
paver.
   c. When used, provide windrow pick-up equipment constructed to pick up
substantially all roadway mixture placed in the windrow.

9. Remixing Equipment.
   a. When required, provide equipment that includes a pug mill, variable pitch
augers, or variable diameter augers operating under a storage unit with a
minimum capacity of 8 tons.

    a. When allowed, provide a self-propelled grader with a blade length of at least 12
feet and a wheelbase of at least 16 feet.

11. Handheld Infrared Thermometer.
    a. Provide a handheld infrared thermometer meeting the requirements of
Tex-244-F.

12. Rollers.
    a. The CONTRACTOR may use any type of roller to meet the production rates
and quality requirements of the Contract unless otherwise shown on the plans
or directed.
    b. When specific types of equipment are required, use equipment that meets the
specified requirements.
    c. Alternate Equipment.
       1) Instead of the specified equipment, the CONTRACTOR may, as approved,
operate other compaction equipment that produces equivalent results.
       2) Discontinue the use of the alternate equipment and furnish the specified
equipment if the desired results are not achieved.
    d. City may require CONTRACTOR to substitute equipment if production rate
and quality requirements of the Contract are not met.
13. Straightedges and Templates. Furnish 10 foot straightedges and other templates as
required or approved.

   a. Furnish vehicle that can achieve a uniform tack coat placement.
   b. The nozzle patterns, spray bar height and distribution pressure must work
together to produce uniform application.
   c. The vehicle should be set to provide a “double lap” or “triple lap” coverage.
   d. Nozzle spray patterns should be identical to one another along the distributor
   spray bar.
   e. Spray bar height should remain constant.
   f. Pressure within the distributor must be capable of forcing the tack coat material
   out of spray nozzles at a constant rate.

15. Coring Equipment.
   a. When coring is required, provide equipment suitable to obtain a pavement
   specimen meeting the dimensions for testing.

B. Construction.
   1. Design, produce, store, transport, place, and compact the specified paving mixture
   in accordance with the requirements of this Section.
   2. Unless otherwise shown on the plans, provide the mix design.
   3. The City will perform quality assurance (QA) testing.
   4. Provide quality control (QC) testing as needed to meet the requirements of this
   Section.

C. Production Operations.
   1. General.
      a. The City may suspend production for noncompliance with this Section.
      b. Take corrective action and obtain approval to proceed after any production
      suspension for noncompliance.
   2. Operational Tolerances.
      a. Stop production if testing indicates tolerances are exceeded on:
         1) 3 consecutive tests on any individual sieve,
         2) 4 consecutive tests on any of the sieves, or
         3) 2 consecutive tests on asphalt content.
      b. Begin production only when test results or other information indicate, to the
      satisfaction of the City, that the next mixture produced will be within Table 9
      tolerances.
      a. Do not heat the asphalt binder above the temperatures specified in Section
      2.2.A. or outside the manufacturer’s recommended values.
      b. On a daily basis, provide the City with the records of asphalt binder and hot-
      mix asphalt discharge temperatures in accordance with Table 10.
      c. Unless otherwise approved, do not store mixture for a period long enough to
      affect the quality of the mixture, nor in any case longer than 12 hours.
      a. Notify the City of the target discharge temperature and produce the mixture
      within 25 degrees F of the target.
b. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350 degrees F. The City will not pay for or allow placement of any mixture produced at more than 350 degrees F.

c. Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant.

D. Placement Operations.

1. Place the mixture to meet the typical section requirements and produce a smooth, finished surface or base course with a uniform appearance and texture.

2. Offset longitudinal joints of successive courses of hot mix by at least 6 inches.

3. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly.

4. When End Dump Trucks are used, ensure the bed does not contact the paver when raised.

5. Placement can be performed by hand in situations where the paver cannot place it adequately due to space restrictions.

6. Hand-placing should be minimized to prevent aggregate segregation and surface texture issues.

7. All hand placement shall be checked with a straightedge or template before rolling to ensure uniformity.

8. Place mixture within the compacted lift thickness shown in Table 9, unless otherwise shown on the plans or allowed.

<table>
<thead>
<tr>
<th>Table 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compacted Lift Thickness and Required Core Height</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mixture Type</th>
<th>Minimum (in.)</th>
<th>Maximum (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>C</td>
<td>2.00</td>
<td>2.50</td>
</tr>
<tr>
<td>D</td>
<td>1.50</td>
<td>2.00</td>
</tr>
</tbody>
</table>


a. Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the City.

b. The City will set the rate between 0.04 and 0.10 gallons of residual asphalt per square yard of surface area.

c. Apply a thin, uniform tack coat to all contact surfaces of curbs, structures, and all joints.

d. Prevent splattering of tack coat when placed adjacent to curb, gutter, metal beam guard fence and structures.

e. Roll the tack coat with a pneumatic-tire roller when directed.

f. The City may use Tex-243-F to verify that the tack coat has adequate adhesive properties.

g. The City may suspend paving operations until there is adequate adhesion.

h. The tack coat should be placed with enough time to break or set before applying hot mix asphalt layers.

i. Traffic should not be allowed on tack coats.
j. When a tacked road surface must be opened to traffic, they should be covered with sand to provide friction and prevent pick-up.

k. A typical rate for applying a sand cover is 4 to 8 lbs/square yard.

10. General placement requirements.
   a. Material should be delivered to maintain a relatively constant head of material in front of the screed.
   b. The hopper should never be allowed to empty during paving.
   c. Dumping wings between trucks not allowed. Dispose of at end of days production.

E. Lay-Down Operations.
   1. Minimum Mixture Placement Temperatures. Use Table 10 for minimum mixture placement temperatures.
   2. Windrow Operations. When hot mix is placed in windrows, operate windrow pickup equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

<table>
<thead>
<tr>
<th>Suggested Minimum Mixture Placement Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-Temperature Binder Grade</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>PG 64 or lower</td>
</tr>
<tr>
<td>PG 70</td>
</tr>
<tr>
<td>PG 76</td>
</tr>
<tr>
<td>PG 82 or higher</td>
</tr>
</tbody>
</table>

F. Compaction.
   1. Use air void control unless ordinary compaction control is specified on the plans.
   2. Avoid displacement of the mixture. If displacement occurs, correct to the satisfaction of the City.
   3. Ensure pavement is fully compacted before allowing rollers to stand on the pavement.
   4. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment.
   5. Keep diesel, gasoline, oil, grease, and other foreign matter off the mixture.
   6. Unless otherwise directed, operate vibratory rollers in static mode when not compacting, when changing directions, or when the plan depth of the pavement mat is less than 1-1/2 inches.
   7. Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with the rollers.
   8. The City may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.
   9. Allow the compacted pavement to cool to 160 degrees F or lower before opening to traffic unless otherwise directed.
   10. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.
11. Air Void Control.
   a. General.
      1) Compact dense-graded hot-mix asphalt to contain from 5 percent to 9 percent in-place air voids.
      2) Do not increase the asphalt content of the mixture to reduce pavement air voids.
   b. Rollers.
      1) Furnish the type, size, and number of rollers required for compaction, as approved.
      2) Use a pneumatic-tire roller to seal the surface, unless otherwise shown on the plans.
      3) Use additional rollers as required to remove any roller marks.
   c. Air Void Determination.
      1) Unless otherwise shown on the plans, obtain 2 roadway specimens at each location selected by the City for in-place air void determination.
      2) The City will measure air voids in accordance with Tex-207-F and Tex-227-F.
      3) Before drying to a constant weight, cores may be predried using a Corelok or similar vacuum device to remove excess moisture.
      4) The City will use the average air void content of the 2 cores to calculate the in-place air voids at the selected location.
   d. Air Voids Out of Range.
      1) If the in-place air void content in the compacted mixture is below 5 percent or greater than 9 percent, change the production and placement operations to bring the in-place air void content within requirements.
   e. Test Section.
      1) Construct a test section of 1 lane-width and at most 0.2 mi. in length to demonstrate that compaction to between 5 percent and 9 percent in-place air voids can be obtained.
      2) Continue this procedure until a test section with 5 percent to 9 percent in-place air voids can be produced.
      3) The City will allow only 2 test sections per day.
      4) When a test section producing satisfactory in-place air void content is placed, resume full production.

12. Ordinary Compaction Control.
   a. Furnish the type, size, and number of rollers required for compaction, as approved. Furnish at least 1 medium pneumatic-tire roller (minimum 12-ton weight).
   b. Use the control strip method given in Tex-207-F, Part IV, to establish rolling patterns that achieve maximum compaction.
   c. Follow the selected rolling pattern unless changes that affect compaction occur in the mixture or placement conditions.
   d. When such changes occur, establish a new rolling pattern.
   e. Compact the pavement to meet the requirements of the plans and specifications.
   f. When rolling with the 3-wheel, tandem or vibratory rollers, start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides.
   g. Proceed toward the center of the pavement, overlapping on successive trips by at least 1 ft., unless otherwise directed.
   h. Make alternate trips of the roller slightly different in length.
i. On superelevated curves, begin rolling at the low side and progress toward the high side unless otherwise directed.

G. Irregularities.

1. Identify and correct irregularities including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles.

2. The City may also identify irregularities, and in such cases, the City shall promptly notify the CONTRACTOR.

3. If the City determines that the irregularity will adversely affect pavement performance, the City may require the CONTRACTOR to remove and replace (at the CONTRACTOR’S expense) areas of the pavement that contain the irregularities and areas where the mixture does not bond to the existing pavement.

4. If irregularities are detected, the City may require the CONTRACTOR to immediately suspend operations or may allow the CONTRACTOR to continue operations for no more than 1 day while the CONTRACTOR is taking appropriate corrective action.

5. The City may suspend production or placement operations until the problem is corrected.

6. At the expense of the CONTRACTOR and to the satisfaction of the City, remove and replace any mixture that does not bond to the existing pavement or that has other surface irregularities identified above.

3.5 REPAIR

A. See Section 32 01 17.

3.6 QUALITY CONTROL

A. Production Testing

1. Perform production tests to verify asphalt paving meets the performance standard required in the plans and specifications.

2. City to measure density of asphalt paving with nuclear gauge.

3. City to core asphalt paving from the normal thickness of section once acceptable density achieved. City identifies location of cores.

   a. Minimum core diameter: 4 inches

   b. Minimum spacing: 200 feet

   c. Minimum of one core every block

   d. Alternate lanes between core

4. City to use cores to determine pavement thickness and calculate theoretical density.

   a. City to perform theoretical density test a minimum of one per day per street.

B. Density Test

1. The average measured density of asphalt paving must meet specified density.

2. Average of measurements per street not meeting the minimum specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR’S expense as show in Table 11.
Table 11
Density Payment Schedule

<table>
<thead>
<tr>
<th>Percent Rice</th>
<th>Percent of Contract Price Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>89 and lower</td>
<td>remove and replace at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
<tr>
<td>90</td>
<td>75-percent</td>
</tr>
<tr>
<td>91-93</td>
<td>100-percent</td>
</tr>
<tr>
<td>94</td>
<td>90-percent</td>
</tr>
<tr>
<td>95</td>
<td>75-percent</td>
</tr>
<tr>
<td>Over 95</td>
<td>remove and replace at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
</tbody>
</table>

3. The amount of penalty shall be deducted from payment due to CONTRACTOR.
4. These requirements are in addition to the requirements of Section 1.2 Measurement and Payment.

C. Pavement Thickness Test.
1. City measure each core thickness by averaging at least three measurements.
2. 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.
3. In the event a deficiency in the thickness of pavement is revealed during production testing, subsequent tests necessary to isolate the deficiency shall be at the CONTRACTOR’S expense.
4. The cost for additional coring test shall be at the same rate charged by commercial laboratories.
5. Where the average thickness of pavement in the area found to be deficient, payment shall be made at an adjusted price as specified in Table 12.

Table 12
Thickness Deficiency Penalties

<table>
<thead>
<tr>
<th>Deficiency in Thickness Determined by Cores</th>
<th>Proportional Part Of Contract Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Than 0 percent - Not More than 10 percent</td>
<td>90 percent</td>
</tr>
<tr>
<td>Greater Than 10 percent - Not More than 15 percent</td>
<td>80 percent</td>
</tr>
<tr>
<td>Greater Than 15 percent</td>
<td>remove and replace at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
</tbody>
</table>

6. 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 asphalt paving of the thickness shown on the plans.
7. No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by the plans.
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

<table>
<thead>
<tr>
<th>DATE</th>
<th>NAME</th>
<th>SUMMARY OF CHANGE</th>
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<tbody>
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SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes finished pavement constructed of portland cement concrete including monolithically poured curb on the prepared subgrade or other base course.
B. Standard Details.
  1. Reinforced Concrete Pavement Construction Details.
C. Deviations from City of Fort Worth Standards.
  1. None.
D. Related Specification Sections include but are not necessarily limited to
  1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
  2. Division 1 - General Requirements.
  3. Section 32 01 29 - Concrete Paving Repair.
  4. Section 32 13 73 - Concrete Paving Joint Sealants.

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment.
  1. Measurement: measured by the square yard of completed and accepted pavement in its final position and measured from back of curb for various classes and thicknesses.
  2. Payment: based on the work performed and all materials furnished for concrete paving. Subsidiary work and materials include:
     a. shaping and fine grading the roadbed
     b. furnishing and applying all water required
     c. furnishing, loading and unloading, storing, hauling and handling all concrete ingredients including all freight and royalty involved
     d. mixing, placing, finishing and curing all concrete
     e. furnishing and installing all reinforcing steel
     f. furnishing all materials and placing longitudinal, warping, expansion, and contraction joints, including all steel dowels, dowel caps and load transmission units required, wire and devices for placing, holding and supporting the steel bar, load transmission units, and joint filler material in the proper position; for coating steel bars where required by the plans
     g. sealing joints
     h. monolithically poured curb
     i. all manipulations, labor, equipment, appliances, tools, and incidental necessary to complete the work.

1.3 REFERENCES
A. Reference Standards.
1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.

2. ASTM International (ASTM):
   a. A615/A615M, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field
   c. C33, Concrete Aggregates
   d. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   e. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   f. C94/C94M, Standard Specifications for Ready-Mixed Concrete
   g. C150, Portland Cement
   h. C156, Water Retention by Concrete Curing Materials
   i. C172, Standard Practice for Sampling Freshly Mixed Concrete
   j. C260, Air Entraining Admixtures for Concrete
   k. C309, Liquid Membrane-Forming Compounds for Curing Concrete, Type 2
   l. C494, Chemical Admixtures for Concrete, Types “A”, “D”, “F” and “G”
   m. C618, Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Concrete
   o. C1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
   q. D698, Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

3. American Concrete Institute (ACI):
   a. ACI 305.1-06 Specification for Hot Weather Concreting
   b. ACI 306.1-90, Standard Specification for Cold Weather Concreting
   c. ACI 318

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Mix Design: submit for approval. See Item 2.4.A.
1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS

A. Weather Conditions.
   1. Place concrete when concrete temperature is between 40 and 100 degrees when measured in accordance with ASTM C1064 at point of placement.
   2. Hot Weather Concreting
      a. Take immediate corrective action or cease paving when the ambient temperature exceeds 95 degrees.
      b. Concrete paving operations shall be approved by the Engineer when the concrete temperature exceeds 100 degrees. See Standard Specification for Hot Weather Concreting (ACI 305.1-06).
   3. Cold Weather Concreting
      a. Do not place when ambient temp in shade is below 40 degrees and falling.
      b. Concrete may be placed when ambient temp is above 35 degrees and rising or above 40 degrees.
      b. Concrete paving operations shall be approved by the Engineer when ambient temperature is below 40 degrees. See Standard Specification for Cold Weather Concreting (ACI 306.1-90).

B. Time: Place concrete after sunrise and no later than shall permit the finishing of the pavement in natural light, or as directed by the Engineer.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Cementitious Material: ASTM C150.

B. Aggregates: ASTM C33.

C. Water: ASTM C1602.

D. Admixtures: When admixtures are used, conform to the appropriate specification:
   3. Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete: ASTM C618.

E. Steel Reinforcement: ASTM A615.

F. Steel Wire Reinforcement: Not used for concrete pavement.
G. Dowels and Tie Bars.
   1. Dowel and tie bars: ASTM A615.
   2. Dowel Caps.
      a. Provide dowel caps with enough range of movement to allow complete closure
         of the expansion joint.
      b. Caps for 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.
      c. In no case shall the internal diameter exceed the bar diameter by more 1/8 inch,
         and one end of the cap shall be rightly closed.
      a. See following table for approved producers of epoxies and adhesives

<table>
<thead>
<tr>
<th>Pre-Qualified Producers of Epoxies and Adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Name</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Concreseive 1420</td>
</tr>
<tr>
<td>HTE-50</td>
</tr>
<tr>
<td>T 308 +</td>
</tr>
<tr>
<td>P E 1000+</td>
</tr>
<tr>
<td>C-6</td>
</tr>
<tr>
<td>Epcon G-5</td>
</tr>
<tr>
<td>Pro-Poxy-300 Fast Tube</td>
</tr>
<tr>
<td>Shep-Poxy TxIII</td>
</tr>
<tr>
<td>Ultrabond 1300 Tubes</td>
</tr>
<tr>
<td>Ultrabone 2300 N.S. A-22-2300 Slow Set</td>
</tr>
<tr>
<td>Dynapoxy EP-430</td>
</tr>
<tr>
<td>EDOT</td>
</tr>
<tr>
<td>ET22</td>
</tr>
<tr>
<td>SET 22</td>
</tr>
<tr>
<td>SpecPoxy 3000FS</td>
</tr>
</tbody>
</table>

b. Epoxy Use, Storage and Handling.
   1) Package components in airtight containers and protect from light and
      moisture.
   2) Include detailed instructions for the application of the material and all
      safety information and warnings regarding contact with the components.
   3) Epoxy label requirements
      a) Resin or hardener components;
      b) Brand name;
      c) Name of manufacturer;
      d) Lot or batch number;
      e) Temperature range for storage;
      f) Date of manufacture
g) Expiration date; and
h) Quantity contained
4) Store epoxy and adhesive components at temperatures recommended by the manufacturer.
5) Do not use damaged or previously opened containers and any material that shows evidence of crystallization, lumps skinning, extreme thickening, or settling of pigments that cannot be readily dispersed with normal agitation.
6) Follow sound environmental practices when disposing of epoxy and adhesive wastes.
7) Dispose of all empty containers separately.
8) Dispose of epoxy by completely emptying and mixing the epoxy before disposal.

H. Reinforcement Bar Chairs.
1. Reinforcement bar chairs or supports shall be of adequate strength 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.
2. Bar chairs may be made of metal (free of rust), precast mortar or concrete blocks or plastic.
3. 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.
4. Bar chairs may be rejected for failure to meet any of the requirements of this specification.

I. Joint Filler.
1. Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete.
2. Wood Boards: Used as joint filler for concrete paving.
   a. Boards for expansion joint filler shall be of the required size, shape and type indicated on the plans or required in the specifications.
      1) Boards shall be of selected stock of redwood or cypress. The boards shall be sound heartwood and shall be free from sapwood, knots, clustered birdseyes, checks and splits.
      2) Joint filler, boards, shall be smooth, flat and straight throughout, and shall be sufficiently rigid to permit ease of installation.
      3) 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.
3. Dimensions. The thickness of the expansion joint filler shall be shown on the plans; the width shall be not less than that shown on the plans, providing for the top seal space.
4. Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

J. Joint Sealants. Provide Joint Sealants in accordance with Section 32 13 73.

K. Curing Materials.
1. Membrane-Forming Compounds.
a. Conform to the requirements of ASTM C309, Type 2, white pigmented
  compound and be of such nature that it shall not produce permanent
  discoloration of concrete surfaces nor react deleteriously with the concrete.
b. The compound shall produce a firm, continuous uniform moisture-impermeable
  film free from pinholes and shall adhere satisfactorily to the surfaces of damp
  concrete.
c. It shall, when applied to the damp concrete surface at the specified rate of
  coverage, dry to touch in 1 hour and dry through in not more than 4 hours under
  normal conditions suitable for concrete operations.
d. It shall adhere in a tenacious film without running off or appreciably sagging.
e. It shall not disintegrate, check, peel or crack during the required curing period.
f. The compound shall not peel or pick up under traffic and shall disappear from
  the surface of the concrete by gradual disintegration.
g. 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.
h. 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 0.01-oz.-per-2 inches of surface.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

  A. Mix Design

  1. Concrete Mix Design and Control.
    a. At least 10 calendar days prior to the start of concrete paving operations, the
       CONTRACTOR shall submit a design of the concrete mix it proposes to use
       and a full description of the source of supply of each material component.
    b. The design of the concrete mix shall produce a quality concrete complying with
       these specifications and 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.
       6) Design water/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.
    c. Once mix design approved by the Engineer, maintain intent of mix design and maximum
       water to cement ratio.
    d. No concrete may be placed on the job site until the mix design has been
       approved by the the Engineer.

  2. Quality of Concrete.
a. Consistency.
   1) In general, the consistency of concrete mixtures shall be such that:
      a) mortar shall cling to the coarse aggregate,
      b) aggregate shall not segregate in concrete when it is transported to the
         place of deposit,
      c) 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,
      d) concrete and mortar shall show no free water when removed from the
         mixer,
      e) concrete shall slide and not flow into place when transported in metal
         chutes at an angle of 30 degrees with the horizontal, and
      f) surface of the finished concrete shall be free from a surface film or
         laitance.
   2) 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 hand sprayer only and be held to a minimum
      amount.
   3) 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.
   4) Excessive bleeding shall be avoided.
   5) 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 Engineer 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.
   6) 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.
   7) The CONTRACTOR is solely responsible for the quality of the concrete
      produced.
   8) 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.

b. Standard Class.
   1) Unless otherwise shown on the plans or detailed specifications, the standard
      class for concrete paving for streets and alleys is shown in the following
      table.
Standard Classes of Pavement Concrete

<table>
<thead>
<tr>
<th>Class of Concrete¹</th>
<th>Minimum Cementitious, Lb./CY</th>
<th>28 Day Min. Compressive Strength² psi</th>
<th>Maximum Water/Cementitious Ratio</th>
<th>Course Aggregate Maximum Size inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>517</td>
<td>3600</td>
<td>0.49</td>
<td>1-1/2</td>
</tr>
<tr>
<td>H</td>
<td>564</td>
<td>4500</td>
<td>0.45</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

1. All exposed horizontal concrete shall have entrained-air.
2. Minimum Compressive Strength Required.

2) Machine-Laid concrete: Class P
3) Hand-Laid concrete: Class H.

C. High Early Strength Concrete (HES).
1) When shown on the plans or allowed, provide Class HES concrete for very early opening of pavements area or leaveouts to traffic.
2) Design class HES to meet the requirements of class specified for concrete pavement and a minimum compressive strength of 2,600 psi in 24 hours, unless other early strength and time requirements are shown on the plans allowed.
3) No strength overdesign is required.

Standard Classes of Pavement Concrete

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<tr>
<td>HES</td>
<td>564</td>
<td>4500</td>
<td>0.45</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

d. Slump.
1) Slump requirements for pavement and related concrete shall be as specified in the following table.

Concrete Pavement Slump Requirements

<table>
<thead>
<tr>
<th>Concrete Use</th>
<th>Recommended Design and Placement Slump, inch</th>
<th>Maximum Acceptable Placement Slump, inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip-Form/Form-Riding Paving</td>
<td>1-1/2</td>
<td>3</td>
</tr>
<tr>
<td>Hand Formed Paving</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sidewalk, Curb and Gutter, Concrete Valley Gutter and Other Miscellaneous Concrete</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

2) No concrete shall be permitted with slump in excess of the maximums shown.
3) 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.

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Equipment

1. All equipment necessary for the construction of this item shall be on the project.

2. The equipment shall include spreading devices (augers), internal vibration,
tamping, and surface floating necessary to finish the freshly placed concrete in such
a manner as to provide a dense and homogeneous pavement.

3. Machine-Laid Concrete Pavement

a. Fixed-Form Paver. Fixed-form paving equipment shall be provided with forms
that are uniformly supported on a very firm subbase to prevent sagging under
the weight of machine.

b. Slip-Form Paver.

1) 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.

2) City may reject use of Slip-Form Paver if paver requires over-digging and
impacts trees, mailboxes or other improvements.

4. Hand-Laid Concrete Pavement

a. Machines that do not incorporate these features, such as roller screeds or
vibrating screeds, shall be considered tools to be used in hand-laid concrete
construction, as slumps, spreading methods, vibration, and other procedures are
more common to hand methods than to machine methods.

5. City may reject equipment and stop operation if equipment does not meet
requirements.

B. Concrete Mixing and Delivery

1. Transit Batching: shall not be used – onsite mixing not permitted

2. Ready Mixed Concrete

a. The concrete shall be produced in an approved method conforming to the
requirements of this specification and ASTM C94/C94M. City shall have access
ready mix to get samples of materials.

b. City shall have access to ready mix plant to obtain material samples.

c. When ready-mix concrete is used, sample concrete per ASTM C94 Alternate
Procedure 2:

1) As the mixer is being emptied, individual samples shall be taken after the
discharge of approximately 15% and 85% of the load.
2) The method of sampling shall provide that the samples are representative of widely separated portions, but not from the very ends of the batch.
   d. 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.
   e. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.
   f. Retempering or remixing shall not be permitted.

3. Delivery.
   a. Deliver concrete at an interval not exceeding 30 minutes or as determined by City to prevent cold joint.

4. Delivery Tickets.
   a. For all 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:
      1) Name of concrete supplier.
      2) Serial number of ticket.
      3) Date.
      4) Truck number.
      5) Name of purchaser.
      6) Specific designation of job (name and location).
      7) Specific class, design identification and designation of the concrete in conformance with that employed in job specifications.
      8) Amount of concrete in cubic yards.
      9) Time loaded or of first mixing of cement and aggregates.
      10) Water added by receiver of concrete.
      11) Type and amount of admixtures.

C. Subgrade
   1. 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.
   2. 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.
   3. All holes, ruts and depressions shall be filled and compacted with suitable material and, if required, the subgrade shall be thoroughly wetted and reshaped.
   4. Irregularities of more than 1/2 inch., as shown by straightedge or template, shall be corrected.
   5. The subgrade shall be uniformly compacted to at least 95 percent of the maximum density as determined by ASTM D698.
   6. Moisture content shall be within minus 2 percent to plus 4 percent of optimum.
   7. The prepared subgrade shall be wetted down sufficiently in advance of placing the pavement to ensure its being in a firm and moist condition.
   8. Sufficient subgrade shall be prepared in advance to ensure satisfactory prosecution of the work.
9. The CONTRACTOR shall notify the City at least 24 hours in advance of its intention to place concrete pavement.

10. After the specified moisture and density are achieved, the CONTRACTOR shall maintain the subgrade moisture and density in accordance with this Section.

11. 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.

D. Placing and Removing Forms

1. Placing Forms
   a. Forms for machine-laid concrete
      1) The side forms shall be metal, of approved cross section and bracing, of a height no less than the prescribed edge thickness of the concrete section, and a minimum of 10 feet in length for each individual form.
      2) Forms shall be of ample strength and staked with adequate number of pins 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, settling or deflection.
      3) The forms shall be free from warps, bends or kinks and shall show no variation from the true plane for face or top.
      4) Forms shall be jointed neatly and tightly and set with exactness to the established grade and alignment.
      5) Forms shall be set to line and grade at least 200 feet, where practicable, in advance of the paving operations.
      6) In no case shall the base width be less than 8 inches for a form 8 inches or more in height.
      7) Forms must be in firm contact with the subgrade throughout their length and base width.
      8) If the subgrade becomes unstable, forms shall be reset, using heavy stakes or other additional supports may be necessary to provide the required stability.
   b. Forms for hand-laid concrete
      1) Forms shall extend the full depth of concrete and be a minimum of 1-1/2 inches 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.
      2) For curves with a radius of less than 250 feet, acceptable flexible metal or wood forms shall be used.
      3) All forms showing a deviation of 1/8 inch in 10 feet from a straight line shall be rejected.

2. Settling. When forms settle over 1/8 inch 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.

3. Cleaning. Forms shall be thoroughly cleaned after each use.

4. Removal.
   a. Forms shall remain in place until the concrete has taken its final set.
   b. Avoid damage to the edge of the pavement when removing forms.
   c. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hours after form removal unless otherwise approved.
d. Clean joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed unless otherwise approved.

e. When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.

E. Placing Reinforcing Steel, Tie, and Dowel Bars

1. General.
   a. When reinforcing steel tie bars, dowels, etc., are required they shall be placed as shown on the plans.
   b. All reinforcing steel 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.
   c. Reinforcing bars shall be securely wired together at the alternate intersections and all splices and shall be securely wired at each intersection dowel and load-transmission unit intersected.
   d. All bars shall be installed in their required position as shown on the plans.
   e. 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.

2. Splices.
   a. Provide standard reinforcement splices by lapping and tying ends.
   b. Comply with ACI 318 for minimum lap of spliced bars where not specified on the documents.

3. Installation of Reinforcing Steel
   a. 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.
   b. Chairs Assembly. The chair assembly shall be similar and equal to that shown on the plans and shall be approved by the Engineer prior to extensive fabrication.
   c. After the reinforcing steel is securely installed above the subgrade as specified in plans and as herein prescribed, no loading shall be imposed upon the bar mats or individual bars before or during the placing or finishing of the concrete.

4. Installation of Dowel Bars
   a. Install through the predrilled joint filler and rigidly support in true horizontal and vertical positions by an assembly of bar chairs and dowel baskets.
   b. Dowel Baskets.
      1) The dowels shall be held in position exactly parallel to surface and centerline of the slab, by a dowel basket that is left in the pavement.
      2) The dowel basket shall hold each dowel in exactly the correct position so firmly that the dowel’s position cannot be altered by concreting operations.
   c. Dowel Caps.
      1) Install cap to allow the bar to move not less than 1-1/4 inch in either direction.

5. Tie Bar and Dowel Placement.
   a. Place at mid-depth of the pavement slab, parallel to the surface.
   b. Place as shown on the plans.

6. Epoxy for Tie and Dowel Bar Installation
   1) Epoxy bars as shown on the plans.
2) Use only drilling operations that do not damage the surrounding operations.
3) Blow out drilled holes with compressed air.
4) Completely fill the drilled hole with approved epoxy before inserting the tie bar into the hole.
5) Install epoxy grout and bar at least 6 inches embedded into concrete.

F. Joints
1. Joints shall be placed where shown on the plans or where directed by the City.
2. The plane of all joints shall make a right angle with the surface of the pavement.
3. No joints shall have an error in alignment of more than 1/2 inch at any point.
   a. The width of the joint shall be shown on the plans, creating the joint sealant reservoir.
   b. The depth of the joint shall be shown on the plans.
   c. Dimensions of the sealant reservoir shall be in accordance with manufacturer’s recommendations.
   d. After curing, the joint sealant shall be 1/8 inch to 1/4 inch below the pavement surface at the center of the joint.
5. Transverse Expansion Joints.
   a. Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the plans, or as approved by the Engineer.
   b. Joints shall be of the design width, and spacing shown on the plans, or as approved by the Engineer.
   c. Dowel bars, shall be of the size and type shown on the plans, or as approved by the Engineer, and shall be installed at the specified spacing.
   d. Support dowel bars with dowel baskets.
   e. Dowels shall restrict the free opening and closing of the expansion joint and shall not make planes of weaknesses in the pavement.
   f. Greased Dowels for Expansion Joints.
      1) Coat dowels with a thin film of grease or other approved de-bonding material.
      2) Provide dowel caps on the lubricated end of each dowel bar.
   g. Proximity to Existing Structures. When the pavement is adjacent to or around existing structures, expansions joints shall be constructed in accordance with the details shown on the plans.
6. Transverse Contraction Joints.
   a. Contraction or dummy joints shall be installed at the locations and at the intervals shown on the plans.
   b. Joints shall be of the design width, and spacing shown on the plans, or as approved by the Engineer.
   c. Dowel bars, shall be of the size and type shown on the plans, or as approved by the Engineer, and shall be installed at the specified spacing.
   d. Joints shall be sawed into the completed pavement surface as soon after initial concrete set as possible so that some raveling of the concrete is observed in order for the sawing process to prevent uncontrolled shrinkage cracking.
   e. The joints shall be constructed by sawing to a 1/4 inch width and to a depth of 1/3 inch (1/4 inch permitted if limestone aggregate used) of the actual pavement thickness, or deeper if so indicated on the plans.
f. Complete sawing as soon as possible in hot weather conditions and within a maximum of 24 hours after saw cutting begins under cool weather conditions.

g. If sharp edge joints are being obtained, the sawing process shall be sped up to the point where some raveling is observed.

h. Damage by blade action to the slab surface and to the concrete immediately adjacent to the joint shall be minimized.

i. Any portion of the curing membrane which has been disturbed by sawing operations shall be restored by spraying the areas with additional curing compound.

   a. 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.
   b. Wooden bulkheads shall have a thickness of not less than 2-inch stock material.
   c. 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.
   d. Edges shall be rounded to 1/4 inch radius.
   e. Any surplus concrete on the subgrade shall be removed upon the resumption of the work.

8. Longitudinal Construction Joints.
   a. Longitudinal construction joints shall be of the type shown on the plans.

   a. Joint filler shall be as specified in 2.2.1 of the size and shape shown on the plans.
   b. Redwood Board joints shall be used for all pavement joints except for expansion joints that are coincident with a butt joint against existing pavements.
   c. Boards with less than 25-percent of moisture at the time of installation shall be thoroughly wetted on the job.
   d. Green lumber of much higher moisture content is desirable and acceptable.
   e. The joint filler shall be appropriately drilled to admit the dowel bars when required.
   f. The bottom edge of the filler shall extend to or slightly below the bottom of the slab. The top edge shall be held approximately 1/2 inch below the finished surface of the pavement in order to allow the finishing operations to be continuous.
   g. The joint filler may be composed of more than one length of board in the length of joint, but no board of a length less than 6 foot may be used unless otherwise shown on the plans.
   h. 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.

10. Joint Sealing. Routine pavement joints shall be filled consistent with paving details and as specified in Section 32 13 73. Materials shall generally be handled and applied according to the manufacturer’s recommendations as specified in Section 32 13 73.

G. Placing Concrete
1. Unless otherwise specified in the plans, the finished pavement shall be constructed monolithically and constructed by machined laid method unless impractical.

2. 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.

3. Any concrete not placed as herein prescribed within the time limits in the following table will be rejected. Time begins when the water is added to the mixer.

Temperature – Time Requirements

<table>
<thead>
<tr>
<th>Concrete Temperature (at point of placement)</th>
<th>Max Time – minutes (no retarding agent)</th>
<th>Max Time – minutes (with retarding agent)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>All temperatures</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Agitated Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 90°F</td>
<td>Time may be reduced by City</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>60</td>
<td>120</td>
</tr>
</tbody>
</table>

¹ Normal dosage of retarder.

4. Rakes shall not be used in handling concrete.

5. At the end of the day, or in case of unavoidable interruption or delay of more than 30 minutes or longer to prevent cold joints, a transverse construction joint shall be placed in accordance with 3.4.F.7 of this Section.

6. Honeycombing.
   a. 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.
   b. 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.

H. Finishing

   a. Tolerance Limits.
      1) While the concrete is still workable, it shall be tested for irregularities with a 10 foot straightedge placed parallel to the centerline of the pavement so as to bridge depressions and to touch all high spots.
      2) Ordinates measured from the face of the straightedge to the surface of the pavement shall at no place exceed 1/16 inch-per-foot from the nearest point of contact.
      3) In no case shall the maximum ordinate to a 10 foot straightedge be greater than 1/8 inch.
      4) Any surface not within the tolerance limits shall be reworked and refinished.
b. Edging,
   1) 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 non-workable.
   2) All such work shall be left smooth and true to lines.

2. Hand,
   a. Hand finishing permitted only in intersections and areas inaccessible to a
      finishing machine.
   b. 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
      with a screed bar 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.
   c. A slight excess of material shall be kept in front of the cutting edge at all times.
   d. The straightedge and joint finishing shall be as prescribed herein.

I. Curing
   1. The curing of concrete pavement shall be thorough and continuous throughout the
      entire curing period.
   2. Failure to provide proper curing as herein prescribed shall be considered as
      sufficient cause for immediate suspension of the paving operations.
   3. The curing method as herein specified does not preclude the use of any of the other
      commonly used methods of curing, and the Engineer may approve another method of
      curing if so requested by the CONTRACTOR.
   4. 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.
   5. After removal of the side forms, the sides of the slab shall receive a like coating
      before earth is banked against them.
   6. 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.
   7. The rate of application shall be such as to ensure complete coverage and shall not
      exceed 20-square-yards-per-gallon of curing compound.
   8. 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.
   9. If for any reason the seal is broken during the curing period, it shall be immediately
      repaired with additional sealing solution.
   10. 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 the following.
   11. CONTRACTOR shall maintain and properly repair damage to curing materials on
       exposed surfaces of concrete pavement continuously for a least 72 hours.

J. Monolithic Curbs
   1. 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.
2. After the concrete has been struck off and sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden flat.

3. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans.

4. All exposed surfaces of curb shall be brushed to a smooth and uniform surface.

K. Alley Paving

1. Alley paving shall be constructed in accordance with the specifications for concrete paving hereinbefore described, in accordance with the details shown on the plans, and with the following additional provisions:
   a. Alley paving shall be constructed to the typical cross sections shown on the plans.
   b. 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 feet.
   c. Transverse contraction and dummy joints shall be placed at the spacing shown on the plans.
   d. Contraction and dummy joints shall be formed in such a manner that the required joints shall be produced to the satisfaction of the City.
   e. All joints shall be constructed in accordance with this specification and filled in accordance with the requirement of Section 32 13 73.

L. Pavement Leaveouts

1. 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.

2. 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.

3.5 REPAIR

A. Repair of concrete pavement concrete shall be consistent with paving details and as specified in Section 32 01 29.

3.6 RE-INSTALLATION [NOT USED]

3.7 SITE QUALITY CONTROL

A. Concrete Placement

1. Place concrete using a fully automated paving machine. Hand paving only permitted in areas such as intersections where use of paving machine is not practical
   a. All concrete pavement not placed by hand shall be placed using a fully automated paving machine as approved by the Engineer.
   b. Screeds will not be allowed except if approved by the Engineer.

B. Testing of Materials.

1. 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.
2. 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.

3. All testing shall be in accordance with applicable ASTM Standards and concrete testing technician must be ACI certified or equivalent.

C. Pavement Thickness Test.

1. Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the City.

2. 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.

3. The cost for the initial pavement thickness test shall be the expense of the City.

4. 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.

5. The cost for additional coring test shall be at the same rate charged by commercial laboratories.

6. Where the average thickness of pavement in the area found to be deficient in thickness by more than 0.20 inch, but not more than 0.50 inch, payment shall be made at an adjusted price as specified in the following table.

<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></td>
</tr>
<tr>
<td>0.00 – 0.20</td>
<td>100 percent</td>
</tr>
<tr>
<td>0.21 – 0.30</td>
<td>80 percent</td>
</tr>
<tr>
<td>0.31 – 0.40</td>
<td>70 percent</td>
</tr>
<tr>
<td>0.41 – 0.50</td>
<td>60 percent</td>
</tr>
</tbody>
</table>

7. Any area of pavement found deficient in thickness by more than 0.50 inch but not more than 0.75 inch or 1/10 of the plan thickness, whichever is greater, shall be evaluated by the City.

8. 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.

9. 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.

10. Any area of pavement found deficient in thickness by more than 0.75 inch or more than 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.

11. No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by the plans.

D. Pavement Strength Test.
1. During the progress of the work the City shall provide trained technicians to cast
test cylinders for conforming to ASTM C31, to maintain a check on the
compressive strengths of the concrete being placed.

2. 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.

3. 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.

4. 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 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.

5. Cylinders and/or cores must meet minimum specified strength. If cylinders do not
meet minimum specified strength, additional cores shall be taken to identify the
limits of deficient concrete pavement at the expense of the CONTRACTOR.

6. 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 placement at the CONTRACTOR’S expense as show in the following
table.

<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 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>0-percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by City</td>
</tr>
</tbody>
</table>

7. The amount of penalty shall be deducted from payment due to CONTRACTOR;
such as penalty deducted is to defray the cost of extra maintenance.

8. The strength requirements for structures and other concrete work are not altered by
the special provision.

9. No additional payment over the contract unit price shall be made for any pavement
of strength exceeding that required by the plans and/or specifications.

E. Cracked Concrete Acceptance Policy.

1. If cracks exist in concrete pavement upon completion of the project, the Project
Inspector shall make a determination as to the need for action to address the
cracking as to its cause and recommended remedial work.

2. If the recommended remedial work is routing and sealing of the cracks to protect
the subgrade, the Inspector shall make the determination as to whether to rout and
seal the cracks at the time of final inspection and acceptance or at any time prior to
the end of the project maintenance period. The CONTRACTOR shall perform the
routing and sealing work as directed by the Project Inspector, at no cost to the City,
regardless of the cause of the cracking.
3. If remedial work beyond routing and sealing is determined to be necessary, the Inspector and the CONTRACTOR will attempt to agree on the cause of the cracking. If agreement is reached that the cracking is due to deficient materials or workmanship, the CONTRACTOR shall perform the remedial work at no cost to the City. Remedial work in this case shall be limited to removing and replacing the deficient work with new material and workmanship that meets the requirements of the contract.

4. If remedial work beyond routing and sealing is determined to be necessary, and the Inspector and the CONTRACTOR agree that the cause of the cracking is not deficient materials or workmanship, the City may request the CONTRACTOR to provide an estimate of the cost of the necessary remedial work and/or additional work to address the cause of the cracking, and the CONTRACTOR will perform that work at the agreed-upon price if the City elects to do so.

5. If remedial work is necessary, and the Inspector and the CONTRACTOR cannot agree on the cause of the cracking, the City may hire an independent geotechnical engineer to perform testing and analysis to determine the cause of the cracking. The contractor will escrow 50% of the proposed costs of the geotechnical contract with the City. The CONTRACTOR and the City shall use the services of a geotechnical firm acceptable to both parties.

6. If the geotechnical engineer determines that the primary cause of the cracking is the CONTRACTOR’S deficient material or workmanship, the remedial work will be performed at the CONTRACTOR’S entire expense and the CONTRACTOR will also reimburse the City for the balance of the cost of the geotechnical investigation over and above the amount that has previously been escrowed. Remedial work in this case shall be limited to removing and replacing the deficient work with new material and workmanship that meets the requirements of the contract.

7. If the geotechnical engineer determines that the primary cause of the cracking is not the CONTRACTOR’S deficient material or workmanship, the City will return the escrowed funds to the CONTRACTOR. The Contractor, on request, will provide the City an estimate of the costs of the necessary remedial work and/or additional work and will perform the work at the agreed-upon price as directed by the City.

3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION
<table>
<thead>
<tr>
<th>DATE</th>
<th>NAME</th>
<th>SUMMARY OF CHANGE</th>
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SECTION 32 13 20

CONCRETE SIDEWALKS, DRIVEWAYS AND BARRIER FREE RAMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Concrete sidewalks
   2. Driveways
   3. Barrier free ramps

B. Deviations from City of Fort Worth Standards
   1. None

C. Related Specification Sections include but are not necessarily limited to
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 02 41 13 - Selective Site Demolition
   4. Section 32 13 13 - Concrete Paving
   5. Section 32 13 73 - Concrete Paving Joint Sealants

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. Concrete sidewalk: measure by the square foot of completed and accepted sidewalk in its final position by thickness and type.
      b. Driveway: measure by the square foot of completed and accepted driveway in its final position by thickness and type.
         1) From back of projected curb, including the area of the curb radii and extend to the limits specified in plans.
         2) Sidewalk portion of drive included in driveway measurement
         3) Curb on driveways included in driveway measurement.
      c. Barrier free ramps: measure by each unit of completed and accepted barrier free ramp per type by width of connecting sidewalk including:
         1) curb ramp
         2) landing and detectable warning surface as shown on the plans.
         3) adjacent flares or side curb
   2. Payment: contract unit price bid for the work performed and all materials furnished.
      Subsidiary work and materials include:
      a. excavating and preparing the subgrade
      b. furnishing and placing all materials
      c. manipulation, labor, tools, equipment and incidentals necessary to complete the work.

1.3 REFERENCES

A. Abbreviations and Acronyms
1. TAS – Texas Accessibility Standards
2. TDLR – Texas Department of Licensing and Regulation

B. Reference Standards
1. American Society for Testing and Materials (ASTM)
   a. D545, Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Non-extruding and Resilient Types)
   b. D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS
1. Mix Design: submit for approval. Section 32 13 13.
2. Product Data: submit product data and sample for pre-cast detectable warning for barrier free ramp.

1.7 CLOSEOUT SUBMITTALS

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 EQUIPMENT AND MATERIALS
1. Forms: wood or metal straight, free from warp and of a depth equal to the thickness of the finished work.
2. Concrete: see Section 32 13 13.
   a. Unless otherwise shown on the plans or detailed specifications, the standard class for concrete sidewalks, driveways and barrier free ramps is shown in the following table.

<table>
<thead>
<tr>
<th>Class of Concrete¹</th>
<th>Minimum Cementitious, Lb./CY</th>
<th>28 Day Min. Compressive Strength² psi</th>
<th>Maximum Water/Cementitious Ratio</th>
<th>Course Aggregate Maximum Size, inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>470</td>
<td>3000</td>
<td>0.58</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

C. Reinforcement: see Section 32 13 13.
1. Sidewalk, driveway and barrier free ramp reinforcing steel shall be #3 deformed bars at 18 inches on-center-both-ways at the center plane of all slabs.

D. Joint Filler.
1. Wood Filler: see Section 32 13 13.
2. Pre-Molded Asphalt Board Filler:
   a. Use only in areas where not practical for wood boards.
   b. Pre-molded asphalt board filler: ASTM D545.
   c. Install the required size and uniform thickness and as specified in plans.
   d. Include two liners of 0.016 asphalt impregnated kraft paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler.

E. Expansion Joint Sealant: see Section 32 13 73 where shown on the plans.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Surface Preparation
1. Excavation: Excavation required for the construction of sidewalks, driveways and barrier free ramps shall be to the lines and grades as shown on the plans or as established by the City.

2. Fine Grading
   a. 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.
   b. Moisture content shall be within minus 2 to plus 4 of optimum.
   c. Any over-excavation shall be repaired to the satisfaction of the City.

B. Demolition / Removal
1. Sidewalk, Driveway and/or Barrier Free Ramp Removal: see Section 02 41 13.

3.4 INSTALLATION

A. General
1. Concrete sidewalks shall have a minimum thickness of 4 inches.
2. 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.
3. Driveways shall have a minimum thickness of 6 inches. Standard cross-slopes for walks shall be 2 percent max in accordance with current TAS/TDLR guidelines. The construction of the driveway approach shall include the variable height radius curb in accordance with the plans and details.
4. All pedestrian facilities shall comply with provisions of TAS including location, slope, width, shapes, texture and coloring. Pedestrian facilities installed by the CONTRACTOR and not meeting TAS must be removed and replaced to meet TAS (no separate pay).

B. Forms: Forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

C. Reinforcement: see Section 32 13 13.

D. Concrete Placement: see Section 32 13 13.

E. Finishing

1. Concrete sidewalks, driveways and barrier free ramps shall be finished to a true, even surface.

2. Trowel and then brush transversely to obtain a smooth uniform brush finish.

3. Provide exposed aggregate finish if specified.

4. Edge joints and sides shall with suitable tools.

F. Joints

1. Expansion joints for sidewalks, driveways and barrier free ramps shall be formed using redwood.

2. Expansion joints shall be placed at 40 foot intervals for 4 foot wide sidewalk and 50 foot intervals for 5 foot wide and greater sidewalk.

3. Expansion joints shall also be placed at all intersections, sidewalks with concrete driveways, curbs, and other sidewalks and other adjacent old concrete work. Similar material shall be placed around all obstructions protruding into or through sidewalks or driveways.

4. All expansion joints shall be 1/2 inch in thickness.

5. Edges of all construction and expansion joints and outer edges of all sidewalks shall be finished to approximately a 1/2 inch radius with a suitable finishing tool.

6. Sidewalks shall be marked at intervals equal to the width of the walk with a marking tool.

7. When sidewalk is against the curb, expansion joints shall match those in the curb.

G. Barrier Free Ramp

1. Furnish and install brick red color pre-cast detectable warning Dome-Tile, manufactured by StrongGo Industries or approved equal by the Engineer.

2. Detectable warning surface shall be a minimum of 24-inch in depth in the direction of pedestrian travel, and extend to a minimum of 48-inch along the curb ramp or landing where the pedestrian access route enters the street.

3. Locate detectable warning surface so that the edge nearest the curb line is a minimum of 6-inch and maximum of 8-inch from the extension of the face of the curb.

4. Detectable warning Dome-Tile surface may be curved along the corner radius.

5. Install detectable warning surface according to manufacturer’s instructions.
### END OF SECTION

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</tbody>
</table>

3.5 [REPAIR]/[RESTORATION] [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]
SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

B. Standard Detail
   1. Typical Street Construction Details

C. Deviations from City of Fort Worth Standards
   1. None

D. Related Specification Sections include but are not necessarily limited to
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the
      Contract.
   2. Division 1 - General Requirements.
   3. Section 32 13 13 - Concrete Paving.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment.
   1. Measurement: when specified in the plans to be a pay item, measure by the linear
      foot of completed and accepted joint sealant.
   2. Payment: Unless otherwise specified on plans, the work performed and materials
      furnished as required in this Section will not be paid for directly but will be
      subsidiary to other bid items.

1.3 REFERENCES

A. Reference Standards
   1. ASTM International (ASTM):
      a. D5893, Standard Specification for Cold Applied, Single Component,
         Chemically Curing Silicone Joint Sealant for Portland Cement Concrete
         Pavements

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 ACTION SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports
   1. Prior to installation, furnish certification by an independent testing laboratory that
      the silicone joint sealant meets the requirements of this Section.
2. Submit verifiable documentation that the manufacturer of the silicone joint sealant has a minimum two-year demonstrated, documented successful field performance with concrete pavement silicone joint sealant systems.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD CONDITIONS

A. Do not apply joint sealant when the air and pavement temperature is less than 35°F
B. Concrete surface must be clean, dry and frost free.
C. Do not place sealant in an expansion-type joint if surface temperature is below 35°F or above 90°F.

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS & EQUIPMENT

A. Materials
2. Joint Filler, Backer Rod and Breaker Tape
   a. The joint filler sop shall be of a closed cell expanded polyethylene foam backer rod and polyethylene bond breaker tape of sufficient size to provide a tight seal.
   b. The back rod and breaker tape shall be installed in the saw-cut joint to prevent the joint sealant from flowing to the bottom of the joint.
   c. The backer rod and breaker tape shall be compatible with the silicone joint sealant and no bond or reaction shall occur between them.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General.
1. The silicone sealant shall be cold applied.
2. Allow concrete to cure for a minimum of 7 days to ensure it has sufficient strength prior to sealing joints.
3. Perform joint reservoir saw cutting, cleaning, bond breaker installation, and joint sealant placement in a continuous sequence of operations.
4. See plans for the various joint details with their respective dimensions.

B. Equipment
1. Provide all necessary equipment and keep equipment in a satisfactory working condition.
2. Equipment shall be inspected by the OWNER prior to the beginning of the work.
3. The minimum requirements for construction equipment shall be as follows:
   a. Concrete Saw. The sawing equipment shall be adequate in size and power to complete the joint sawing to the required dimensions.
   b. Air Compressors. The delivered compressed air shall have a pressure in excess of 90 psi and shall be suitable for the removal of all free water and oil from the compressed air.
   c. Extrusion Pump. The output shall be capable of supplying a sufficient volume of sealant to the joint.
   d. Injection Tool. This mechanical device shall apply the sealant uniformly into the joint.
   e. Sandblaster. The design shall be for commercial use with air compressors as specified in this Section.
   f. Backer Rod Roller and Tooling Instrument. These devices shall be clean and free of contamination. They shall be compatible with the joint depth and width requirements.

C. Sawing Joints: see Section 32 13 13.

D. Cleaning joints
1. Dry saw in one direction with reverse cutting blade then sand blast.
2. Use compressed air to remove the resulting dust from the joint.
3. Sandblast joints after complete drying.
   a. Attach nozzle to a mechanical aiming device so that the sand blast will be directed at an angle of 45 degrees and at a distance of 1 to 2 inches from the face of the joint.
   b. Sandblast both joint faces sandblasted in separate, one directional passes.
   c. When sandblasting is complete, blow-out using compressed air.
   d. The blow tube shall fit into the joints.
4. Check the blown joint for residual dust or other contamination.
   a. If any dust or contamination is found, repeat sandblasting and blowing until the joint is cleaned.
   b. Do not use solvents to remove stains and contamination.
5. Place the bond breaker and sealant in the joint immediately upon cleaning.
6. Bond Breaker Rod and Tape: install in the cleaned joint prior to the application of the joint sealant.
7. Do not leave open, cleaned joints unsealed overnight.

E. Joint Sealant
1. Apply the joint sealant upon placement of the bond breaker rod and tape, using the mechanical injection tool.
2. Do not seal joints unless they are clean and dry.
3. Remove and discard excess sealant left on the pavement surface.
   a. Do not excess use to seal the joints.
4. The pavement surface shall present a clean final condition as determined by City.
5. Do not allow traffic on the fresh sealant until it becomes tack-free.

F. Approval of Joints
1. The City may request a representative of the sealant manufacturer to be present at the job site at the beginning of the final cleaning and sealing of joints.
   a. The representative shall demonstrate to the CONTRACTOR and the City the acceptable method for sealant installation.
   b. The representative shall approve the clean, dry joints before the sealing operation commences.

3.5 [REPAIR]/[RESTORATION] [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

Revision Log

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END
SECTION 32 16 13
CONCRETE CURB AND GUTTERS AND VALLEY GUTTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Concrete Curbs and Gutters
   2. Concrete Valley Gutters

B. Standard Detail
   1. Typical Street Construction Details

C. Deviations from City of Fort Worth Standards
   1. None

D. Related Specification Sections include but are not necessarily limited to
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 - General Requirements
   3. Section 02 41 13 - Selective Site Demolition
   4. Section 32 13 13 - Concrete Paving
   5. Section 32 13 73 - Concrete Paving Joint Sealants

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. Concrete Curb and Gutter: measure by the linear foot of the height specified complete and in place.
      b. Concrete Valley Gutter: measure by the square yard per thickness complete and in place.
   2. Payment: contract unit price bid for the work performed and all materials furnished.
      a. Subsidiary work and materials include:
         1) preparing the subgrade
         2) furnishing and placing all materials, including foundation course, reinforcing steel, and expansion material
         3) all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.
1.3 REFERENCES [NOT USED]
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]
1.5 ACTION SUBMITTALS [NOT USED]
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
1.7 CLOSEOUT SUBMITTALS [NOT USED]
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD CONDITIONS
  A. Weather Conditions: see Section 32 13 13.
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS [NOT USED]

2.2 EQUIPMENT AND MATERIALS

  A. Forms: see Section 32 13 13.
  B. Concrete: see Section 32 13 13.
  C. Reinforcement: see Section 32 13 13.
  D. Joint Filler.
    1. Wood Filler: see Section 32 13 13.
    2. Pre-Molded Asphalt Board Filler:
       a. Use only in areas where not practical for wood boards.
       b. Pre-molded asphalt board filler: ASTM D545.
       c. Install the required size and uniform thickness and as specified in plans.
       d. Include two liners of 0.016 asphalt impregnated kraft paper filled with a mastic
          mixture of asphalt and vegetable fiber and/or mineral filler.
  E. Expansion Joint Sealant: see Section 32 13 73.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Demolition / Removal: See Section 02 41 13.

3.4 INSTALLATION

A. Forms

1. Extend forms the full depth of concrete.
2. Wood forms: minimum of 1-1/2 inches in thickness.
3. Metal Forms: a gauge that shall provide equivalent rigidity and strength.
4. Use acceptable wood or metal forms for curves with a radius of less than 250 feet.
5. All forms showing a deviation of 1/8 inch in 10 feet from a straight line shall be rejected.

B. Reinforcing Steel.

1. Place all necessary reinforcement for the Engineer approval prior to depositing concrete.
2. All steel must be free from paint and oil and all loose scale, rust, dirt and other foreign substances.
3. Remove foreign substances from steel before placing.
4. Wire all bars at their intersections and at all laps or splices.
5. Lap all bar splices a minimum of 20 diameters of the bar or 12 inches, whichever is greater.

C. Concrete Placement

1. Deposit concrete to maintain a horizontal surface.
2. Work concrete into all spaces and around any reinforcement to form a dense mass free from voids.
3. Work coarse aggregate away from contact with the forms
   a. Shape and compact subgrade to the lines, grades and cross section shown on the plans.
   b. Lightly sprinkle subgrade material immediately before concrete placement.
   c. Deposit concrete into forms.
   d. Strike off with a template 1/4 to 3/8 inch less than the dimensions of the finished curb unless otherwise approved.
   a. Hand-tamp and sprinkle subgrade material before concrete placement.
   b. Provide clean surfaces for concrete placement.
   c. Place the concrete with approved self-propelled equipment.
1) The forming tube of the extrusion machine or the form of the slipform machine must easily be adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

d. Attach a pointer or gauge to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline.

e. Brush finish surfaces immediately after extrusion or slipforming.

6. Hand-Laid Concrete – Concrete Valley Gutter: see Section 32 13 13.

7. Expansion joints

a. Place expansion joints in the curb and gutter at 200-foot intervals and at intersection returns and other rigid structures.
b. Place tooled joints at 15-foot intervals or matching abutting sidewalk joints and pavement joints to a depth of 1 1/2 inches.
c. Place expansion joints at all intersections with concrete driveways, curbs, buildings and other curb and gutters.
d. Make expansion joints no less than 1/2 inch in thickness, extending the full depth of the concrete.
e. Make expansion joints perpendicular and at right angles to the face of the curb.
f. Neatly trim any expansion material extending above the finished to the surface of the finished work.
g. Make expansion joints in the curb and gutter coincide with the concrete expansion joints.
h. Longitudinal dowels across the expansion joints in the curb and gutter are required.
i. Install 3 No. 4 round, smooth bars, 24 inches in length, for dowels at each expansion joint.
j. Coat 1/2 of the dowel with a bond breaker and terminate with a dowel cap that provides a minimum of 1 inch free expansion.
k. Support dowels by an approved method.

D. Curing: see Section 32 13 13.

3.5 [REPAIR]/[RESTORATION] [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pavement Markings
      a. Thermoplastic, hot-applied, spray (HAS) pavement markings
      b. Thermoplastic, hot-applied, extruded (HAE) pavement markings
      c. Preformed polymer tape
      d. Preformed heat-activated thermoplastic tape
      e. Painted markings
   2. Raised markers
   3. Work zone markings
   4. Removal of pavement markings and markers

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Pavement Markings
      a. Measurement
         1) Measurement for this Item shall be per linear foot of material placed.
      b. Payment
         1) The work performed and materials furnished in accordance with this Item
            and measured as provided under “Measurement” shall be paid for at the
            unit price bid per linear foot of “Pvmt Marking” installed for:
            a) Various Widths
            b) Various Types
            c) Various Materials
            d) Various Colors
         2) The price bid shall include:
            1) Installation of Pavement Marking
            2) Glass beads, when required
            3) Surface preparation
            4) Clean-up
            5) Testing (when required)
   2. Legends
      a. Measurement
         1) Measurement for this Item shall be per each Legend installed.
b. Payment
   1) The work performed and materials furnished in accordance with this Item
   shall be paid for at the unit price bid per each “Legend” installed for:
      a) Various types
      b) Various applications
   c. The price bid shall include:
      1) Installation of Pavement Marking
      2) Glass beads, when required
      3) Surface preparation
      4) Clean-up
      5) Testing

3. Raised Markers
   a. Measurement
      1) Measurement for this Item shall be per each Raised Marker installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
      shall be paid for at the unit price bid per each “Raised Marker” installed
      for:
         a) Various types
   c. The price bid shall include:
      1) Installation of Raised Markers
      2) Surface preparation
      3) Clean-up
      4) Testing

4. Work Zone Tab Markers
   a. Measurement
      1) Measurement for this Item shall be per each Tab Marker installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
      shall be paid for at the unit price bid per each “Tab Marker” installed for:
         a) Various types
   c. The price bid shall include:
      1) Installation of Tab Work Zone Markers

5. Fire Lane Markings
   a. Measurement
      1) Measurement for this Item shall be per the linear foot.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
      and measured as provided under “Measurement” shall be paid for at the
      unit price bid per linear foot of “Fire Lane Marking” installed.
   c. The price bid shall include:
      1) Surface preparation
      2) Clean-up
      3) Testing

6. Pavement Marking Removal
   a. Measurement
      1) Measure for this Item shall be per linear foot.
   b. Payment
1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot of “Remove Pvmnt Marking” performed for:

   a) Various widths

c. The price bid shall include:

   1) Removal of Pavement Markings
   2) Clean-up

7. Raised Marker Removal

   a. Measurement

   1) Measurement for this Item shall be per each Pavement Marker removed.

   b. Payment

   1) The work performed and materials furnished in accordance with this Item shall be paid for at the unit price bid per each “Remove Raised Marker” performed for:

      a) Various types

   c. The price bid shall include:

      1) Removal of each Marker
      2) Disposal of removed materials
      3) Clean-up

8. Legend Removal

   a. Measurement

   1) Measure for this Item shall be per each Legend removed.

   b. Payment

   1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot of “Remove Legend” performed for:

      a) Various types
      b) Various applications

   c. The price bid shall include:

      1) Removal of Pavement Markings
      2) Clean-up

1.3 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.


   a. Part 3, Markings

3. American Association of State Highway and Transportation Officials (AASHTO)

   a. Standard Specification for Glass Beads Used in Pavement Markings, M 247-09

4. Federal Highway Administration (FHWA)

   a. 23 CFR Part 655, FHWA Docket No. FHWA-2009-0139

5. Texas Department of Transportation (TxDOT)

   a. DMS-4200, Pavement Markers (Reflectorized)
   b. DMS-4300, Traffic Buttons
   c. DMS-8220, Hot Applied Thermoplastic
   d. DMS-8240, Permanent Prefabricated Pavement Markings
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. The Contractor shall secure and maintain a location to store the material in accordance with Section 01 50 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-SUPPLIED PRODUCTS

A. New Products

1. Refer to Drawings to determine if there are owner-supplied products for the Project.

2.2 MATERIALS

A. Manufacturers

1. Only the manufacturers as listed in the City’s Standard Products List will be considered as shown in Section 01 60 00.

a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Materials

1. Pavement Markings

a. Thermoplastic, hot applied, spray

1) Refer to Drawings and City Standard Detail Drawings for width of longitudinal lines.

2) Product shall be especially compounded for traffic markings.
3) When placed on the roadway, the markings shall not be slippery when wet, lift from pavement under normal weather conditions nor exhibit a tacky exposed surface.

4) Cold ductility of the material shall permit normal road surface expansion and contraction without chipping or cracking.

5) The markings shall retain their original color, dimensions and placement under normal traffic conditions at road surface temperatures of 158 degrees Fahrenheit and below.

6) Markings shall have uniform cross-section, clean edges, square ends and no evidence of tracking.

7) The density and quality of the material shall be uniform throughout the markings.

8) The thickness shall be uniform throughout the length and width of the markings.

9) The markings shall be 95 percent free of holes and voids, and free of blisters for a minimum of 60 days after application.

10) The material shall not deteriorate by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice or because of the oil content of pavement markings or from oil droppings or other effects of traffic.

11) The material shall not prohibit adhesion of other thermoplastic markings if, at some future time, new markings are placed over existing material.

a) New material shall bond itself to the old line in such a manner that no splitting or separation takes place.

12) The markings placed on the roadway shall be completely retroreflective both internally and externally with traffic beads and shall exhibit uniform retro-directive reflectance.

13) Traffic beads

a) Manufactured from glass
b) Spherical in shape
c) Essentially free of sharp angular particles
d) Essentially free of particles showing cloudiness, surface scoring or surface scratching
e) Water white in color
f) Applied at a uniform rate
g) Meet or exceed Specifications shown in AASHTO Standard Specification for Glass Beads Used in Pavement Markings, AASHTO Designation: M 247-09.

b. Thermoplastic, hot applied, extruded

1) Product shall be especially compounded for traffic markings
2) When placed on the roadway, the markings shall not be slippery when wet, lift from pavement under normal weather conditions nor exhibit a tacky exposed surface.

3) Cold ductility of the material shall permit normal road surface expansion and contraction without chipping or cracking.

4) The markings shall retain their original color, dimensions and placement under normal traffic conditions at road surface temperatures of 158 degrees Fahrenheit and below.

5) Markings shall have uniform cross-section, clean edges, square ends and no evidence of tracking.
6) The density and quality of the material shall be uniform throughout the 
markings.
7) The thickness shall be uniform throughout the length and width of the 
markings.
8) The markings shall be 95 percent free of holes and voids, and free of 
blisters for a minimum of 60 days after application.
9) The minimum thickness of the marking, as measured above the plane 
formed by the pavement surface, shall not be less than 1/8 inch in the center 
of the marking and 3/32 inch at a distance of 1/2 inch from the edge.
10) Maximum thickness shall be 3/16 inch.
11) The material shall not deteriorate by contact with sodium chloride, calcium 
chloride or other chemicals used to prevent roadway ice or because of the 
oil content of pavement markings or from oil droppings or other effects of 
traffic.
12) The material shall not prohibit adhesion of other thermoplastic markings if, 
at some future time, new markings are placed over existing material. New 
material shall bond itself to the old line in such a manner that no splitting or 
separation takes place.
13) The markings placed on the roadway shall be completely retroreflective 
both internally and externally with traffic beads and shall exhibit uniform 
retro-directive reflectance.
14) Traffic beads
   a) Manufactured from glass
   b) Spherical in shape
   c) Essentially free of sharp angular particles
   d) Essentially free of particles showing cloudiness, surface scoring or 
surface scratching
   e) Water white in color
   f) Applied at a uniform rate
   g) Meet or exceed Specifications shown in AASHTO Standard 
      Specification for Glass Beads Used in Pavement Markings, AASHTO 
      Designation: M 247-09.
   c. Preformed Polymer Tape
      1) Material shall meet or exceed the Specifications for SWARCO Director 35, 
         3M High Performance Tape Series 3801 ES, or approved equal.
   d. Preformed Heat-Activated Thermoplastic Tape
      1) Material shall meet or exceed the Specifications for HOT Tape Brand 0.125 
         mil preformed thermoplastic or approved equal.
   e. Traffic Paint
      1) Materials shall meet or exceed the TxDOT Specification DMS-8200.
2. Raised Markers
   a. Markers shall meet the requirements of the Texas Manual on Uniform Traffic 
      Control Devices.
   b. Non-reflective markers shall be Type Y (yellow body) and Type W (white 
      body) round ceramic markers and shall meet or exceed the TxDOT 
      Specification DMS-4300.
   c. The reflective markers shall be plastic, meet or exceed the TxDOT 
      Specification DMS-4200 for high-volume retroreflective raised markers and be 
      available in the following types:
         1) Type I-C, white body, 1 face reflects white
2) Type II-A-A, yellow body, 2 faces reflect amber
3) Type II-C-R, white body, 1 face reflects white, the other red

3. Work Zone Markings
   a. Tabs
      1) Temporary flexible-reflective roadway marker tabs shall meet requirements of TxDOT DMS-8242, “Temporary Flexible-Reflective Road Marker Tabs.”
      2) Removable markings shall not be used to simulate edge lines.
      3) No segment of roadway open to traffic shall remain without permanent pavement markings for a period greater than 14 calendar days.
   b. Raised Markers
      1) All raised pavement markers shall meet the requirements of DMS-4200.
   c. Striping
      1) Work Zone striping shall meet or exceed the TxDOT Specification DMS-820.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

A. Performance
   1. Minimum maintained retroreflectivity levels for longitudinal markings shall meet the requirements detailed in the table below for a minimum of 30 calendar days.

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<td>2-lane roads with centerline markings only (1)</td>
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<tr>
<td>All other roads (2)</td>
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(1) Measured at standard 30-m geometry in units of mcd/m²/lux.
(2) Exceptions:
   A. When raised reflective pavement markings (RRPMs) supplement or substitute for a longitudinal line, minimum pavement marking retroreflectivity levels are not applicable as long as the RRPMs are maintained so that at least 3 are visible from any position along that line during nighttime conditions.
   B. When continuous roadway lighting assures that the markings are visible, minimum pavement marking retroreflectivity levels are not applicable.

PART 3 - EXECUTION

3.1 EXAMINATION [NOT USED]

3.2 PREPARATION

A. Pavement Conditions
   1. Roadway surfaces shall be free of dirt, grease, loose and/or flaking existing markings and other forms of contamination.
   2. New Portland cement concrete surfaces shall be cleaned sufficiently to remove the curing membrane.
   3. Pavement to which material is to be applied shall be completely dry.
4. Pavement shall be considered dry, if, on a sunny day after observation for 15 minutes, no condensation develops on the underside of a 1 square foot piece of clear plastic that has been placed on the pavement and weighted on the edges.

5. Equipment and methods used for surface preparation shall not damage the pavement or present a hazard to motorists or pedestrians.

3.3 INSTALLATION

A. General

1. The materials shall be applied according to the manufacturer’s recommendations.

2. Markings and markers shall be applied within temperature limits recommended by the material manufacturer, and shall be applied on clean, dry pavement having a surface temperature above 50 degrees Fahrenheit.

3. Markings that are not properly applied due to faulty application methods or being placed in the wrong position or alignment shall be removed and replaced by the Contractor at the Contractor’s expense. If the mistake is such that it would be confusing or hazardous to motorists, it shall be remedied the same day of notification. Notification will be made by phone and confirmed by fax. Other mistakes shall be remedied within 5 days of written notification.

4. When markings are applied on roadways open to traffic, care will be taken to ensure that proper safety precautions are followed, including the use of signs, cones, barricades, flaggers, etc.

5. Freshly applied markings shall be protected from traffic damage and disfigurement.

6. Temperature of the material must be equal to the temperature of the road surface before allowing traffic to travel on it.

B. Pavement Markings

1. Thermoplastic, hot applied, spray
   a. This method shall be used to install and replace long lines – centerlines, lane lines, edge lines, turn lanes, and dots.
   b. Markings shall be applied at a 110 mil thickness.
   c. Markings shall be applied at a 90 mil thickness when placed over existing markings.
   d. Typical setting time shall be between 4 minutes and 10 minutes depending upon the roadway surface temperature and the humidity factor.
   e. Retroreflective raised markers shall be used to supplement the centerlines, lane lines, and turn lanes. Refer to City Standard Detail Drawings for placement.
   f. Minimum retroreflectivity of markings shall meet or exceed values shown in subparagraph 2.4.A.1 of this Specification.

2. Thermoplastic, hot applied, extruded
   a. This method shall be used to install and replace crosswalks and stop-lines.
   b. Markings shall be applied at a 125 mil thickness.
   c. Minimum retroreflectivity of markings shall meet or exceed values shown in this Specification.

3. Preformed Polymer Tape
   a. This method shall be used to install and replace crosswalks, stop-lines, and legends.
   b. The applied marking shall adhere to the pavement surface with no slippage or lifting and have square ends, straight lines and clean edges.
c. Minimum retroreflectivity of markings shall meet or exceed values shown in this Specification.

4. Preformed Heat-Activated Thermoplastic Tape
   a. This method shall be used to install and replace crosswalks, stop-lines, and legends.
   b. The applied marking shall adhere to the pavement surface with no slippage or lifting and have square ends, straight lines and clean edges.
   c. Minimum retroreflectivity of markings shall meet or exceed values shown in this Specification.

5. Traffic Paint
   a. This method shall be used to install Work Zone Markings, Parking Lot Markings and any other temporary marking application.
   b. The applied marking shall adhere to the pavement surface with no slippage or lifting and have square ends, straight lines and clean edges.
   c. Minimum retroreflectivity of markings shall meet or exceed values shown in this Specification.

C. Raised Markers
   1. All permanent raised pavement markers on Portland Cement roadways shall be installed with epoxy adhesive. Bituminous adhesive is not acceptable.
   2. All permanent raised pavement markers on new asphalt roadways may be installed with epoxy or bituminous adhesive.
   3. A chalk line, chain or equivalent shall be used during layout to ensure that individual markers are properly aligned. All markers shall be placed uniformly along the line to achieve a smooth continuous appearance.

D. Work Zone Markings
   1. Work shall be performed with as little disruption to traffic as possible.
   2. Install longitudinal markings on pavement surfaces before opening to traffic.
   3. Maintain lane alignment traffic control devices and operations until markings are installed.
   4. Install markings in proper alignment in accordance with the Texas MUTCD and as shown on the Drawings.
   5. Place standard longitudinal lines no sooner than 3 calendar days after the placement of a surface treatment, unless otherwise shown on the Drawings.
   6. Place markings in proper alignment with the location of the final pavement markings.
   7. Do not use raised pavement markers for words, symbols, shapes, or diagonal or transverse lines.
   8. All markings shall be visible from a distance of 300 feet in daylight conditions and from a distance of at least 160 feet in nighttime conditions, illuminated by low-beam automobile headlight.
   9. The daytime and nighttime reflected color of the markings must be distinctly white or yellow.
   10. The markings must exhibit uniform retroreflective characteristics.
   11. Epoxy adhesives shall not be used to work zone markings.
3.4 REMOVALS

1. Pavement Marking and Marker Removal
   a. The industry’s best practice shall be used to remove existing pavement
      markings and markers.
   b. If the roadway is being damaged during the marker removal, Work shall be
      halted until consultation with the City.
   c. Removals shall be done in such a matter that color and texture contrast of the
      pavement surface will be held to a minimum.
   d. Repair damage to asphaltic surfaces, such as spalling, shelling, etc., greater than
      ¼ inch in depth resulting from the removal of pavement markings and markers.
      Driveway patch asphalt emulsion may be broom applied to reseal damage to
      asphaltic surfaces.
   e. Dispose of markers in accordance with federal, state, and local regulations.
   f. Use any of the following methods unless otherwise shown on the Drawings.
      1) Surface Treatment Method
         a) Apply surface treatment at rates shown on the Drawings or as directed.
            Place a surface treatment a minimum of 2 feet wide to cover the
            existing marking.
         b) Place a surface treatment, thin overlay, or microsurfacing a minimum
            of 1 lane in width in areas where directional changes of traffic are
            involved or in other areas as directed by the City.
      2) Burn Method
         a) Use an approved burning method.
         b) For thermoplastic pavement markings or prefabricated pavement
            markings, heat may be applied to remove the bulk of the marking
            material prior to blast cleaning.
         c) When using heat, avoid spalling pavement surfaces.
         d) Sweeping or light blast cleaning may be used to remove minor residue.
      3) Blasting Method
         a) Use a blasting method such as water blasting, abrasive blasting, water
            abrasive blasting, shot blasting, slurry blasting, water-injected abrasive
            blasting, or brush blasting as approved.
         b) Remove pavement markings on concrete surfaces by a blasting method
            only.
      4) Mechanical Method
         a) Use any mechanical method except grinding.
         b) Flail milling is acceptable in the removal of markings on asphalt and
            concrete surfaces.
   2. If a location is to be paved over, no additional compensation will be allowed for
      marking or marker removal.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. All lines must have clean edges, square ends, and be uniform cross-section.
B. The density and quality of markings shall be uniform throughout their thickness.
C. The applied markings shall have no more than 5 percent, by area, of holes or voids and shall be free of blisters.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Contractor shall clean up and remove all loose material resulting from construction operations.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log
SECTION 329213

HYDROMULCHING, SEEDING AND SODDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Furnishing and installing grass sod and permanent seeding as shown on plans, or as directed.

B. Deviations from City of Fort Worth Standards

1. None

C. Related Specification Sections include but are not necessarily limited to

1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 1 - General Requirements.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Measurement

a. Block Sod Placement: measure by the square yard.

b. Seeding: measure by the square yard by the installation method.

c. Mowing: measure by each.

2. Payment

a. Block Sod Placement: contract unit price and total compensation for furnishing and placing all sod, rolling and tamping, watering (until established), disposal of all surplus materials, and material, labor, equipment, tools and incidentals necessary to complete the work.

b. Seeding: contract unit price and total compensation for furnishing all materials including water for seed-fertilizer, slurry and hydraulic mulching, water and mowing (until established), fertilizer, and material, labor, equipment, tools and incidentals necessary to complete the work.

c. Mowing: contract unit price and total compensation for material, labor, equipment, tools and incidentals necessary to complete the work.

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 ACTION SUBMITTALS [NOT USED]

1.6 INFORMATIONAL SUBMITTALS

A. Seed

1. Vendors’ certification that seeds meet Texas State seed law including:


b. Name and type of seed.

2. All seed shall be tested in a laboratory with certified results presented to the City in writing, prior to planting.
3. All seed to be of the previous season’s crop and the date on the container shall be within twelve months of the seeding date.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Block Sod
   1. Protect from exposure to wind, sun and freezing.
   2. Keep stacked sod moist.

B. Seed
   1. If using native grass or wildflower seed, seed must have been harvested within one hundred (100) miles of the construction site.
   2. Each species of seed shall be supplied in a separate, labeled container for acceptance by the City.

C. Fertilizer
   1. Provide fertilizer labeled with the analysis.
   2. Conform to Texas fertilizer law.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS AND EQUIPMENT

A. Materials
   1. Block Sod
      a. Sod Varieties (match existing if applicable)
         1) "Stenotaphrum secundatum" (St. Augustine grass),
         2) "Cynodon dactylon" (Common Bermudagrass),
         3) "Buchloe dactyloides" (Buffalograss),
         4) an approved hybrid of Common Bermudagrass,
         5) or an approved Zoysiagrass.
      b. Sod must contain stolons, leaf blades, rhizomes and roots.
      c. Sod shall be alive, healthy and free of insects, disease, stones, undesirable foreign materials and weeds and grasses deleterious to its growth or which might affect its subsistence or hardiness when transplanted.
      d. Minimum sod thickness: 3/4 inch
      e. Maximum grass height: 2 inches
      f. Acceptable growing beds:
         1) St. Augustine grass sod: clay or clay loam topsoil,
         2) Bermuda grasses and zoysia grasses: sand or sandy loam soils.
      g. Dimensions.
         1) Machine cut to uniform soil thickness.
2) Sod shall be of equal width and of a size that permits the sod to be lifted, handled and rolled without breaking.

h. Broken or torn sod or sod with uneven ends shall be rejected.

2. Seed

a. General
1) Plant all seed at rates based on pure live seed (PLS)
   a) Pure Live Seed (PLS) determined using the formula:
      (1) Percent Pure Live Seed = Percent Purity x [(Percent Germination + Percent Firm or Hard Seed) + 100]

2) Availability of Seed
   a) Substitution of individual seed types due to lack of availability may be permitted by the City at the time of planting.
   b) Notify the City prior to bidding of difficulties locating certain species.

3) Weed seed
   a) not exceed ten percent by weight of the total of pure live seed (PLS) and other material in the mixture.
   b) Seed not allowed:
      (1) Johnsongrass
      (2) nutgrass seed

4) Harvest seed within 1-year prior to planting

b. Non-native Grass Seed
1) Plant between April 15 and September 10

<table>
<thead>
<tr>
<th>Lbs. PLS/Acre</th>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Purity (percent)</th>
<th>Germination (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Bermuda (unhulled)</td>
<td>cynodon dactylon</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>75</td>
<td>Bermuda (hulled)</td>
<td>cynodon dactylon</td>
<td>95</td>
<td>90</td>
</tr>
</tbody>
</table>

2) Plant between September 10 and April 15

<table>
<thead>
<tr>
<th>Lbs. PLS/Acre</th>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Purity (percent)</th>
<th>Germination (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>Rye Grass</td>
<td>lolium multiflorum</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>75</td>
<td>Bermuda (unhulled)</td>
<td>cynodon dactylon</td>
<td>95</td>
<td>90</td>
</tr>
</tbody>
</table>

c. Native Grass Seed
1) Plant between February 1 and October 1.

<table>
<thead>
<tr>
<th>Lbs. PLS/Acre</th>
<th>Common Name</th>
<th>Botanical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>Green Sprangletop</td>
<td>Leptochloa dubia</td>
</tr>
<tr>
<td>5.5</td>
<td>Sideoats Grama*</td>
<td>Bouteloua curtipendula</td>
</tr>
<tr>
<td>3.7</td>
<td>Little Bluestem*</td>
<td>Schizachyrium scoparium</td>
</tr>
<tr>
<td>17.0</td>
<td>Buffalograss</td>
<td>Buchloe dactyloides</td>
</tr>
<tr>
<td>1.8</td>
<td>Indian Grass*</td>
<td>Sorghastrum nutans</td>
</tr>
<tr>
<td>0.5</td>
<td>Sand Lovegrass*</td>
<td>Eragrostis trichodes</td>
</tr>
<tr>
<td>6.0</td>
<td>Big Bluestem</td>
<td>Andropogon gerardii</td>
</tr>
<tr>
<td>8.0</td>
<td>Eastern Grama</td>
<td>Tripsacum dactyloides</td>
</tr>
<tr>
<td>1.2</td>
<td>Blue Grama</td>
<td>Bouteloua gracilis</td>
</tr>
<tr>
<td>1.8</td>
<td>Switchgrass</td>
<td>Panicum virgatum</td>
</tr>
<tr>
<td>10.0</td>
<td>Prairie Wildrye*</td>
<td>Elymus canadensis</td>
</tr>
</tbody>
</table>
d. Wildflower Seed
   1) Plant between the following:
      a) March 5 and May 31
      b) September 1 and December 1

<table>
<thead>
<tr>
<th>Lbs. PLS/Acre</th>
<th>Common Name</th>
<th>Botanical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>Bush Sunflower</td>
<td>Sinsia calva</td>
</tr>
<tr>
<td>5.0</td>
<td>Butterfly Weed</td>
<td>Asclepias tuberosa</td>
</tr>
<tr>
<td>2.0</td>
<td>Clasping Coneflower*</td>
<td>Rudbeckia amplexicaulis</td>
</tr>
<tr>
<td>3.0</td>
<td>Golden - Wave</td>
<td>Coreopsis basalis</td>
</tr>
<tr>
<td>13.4</td>
<td>Illinois Bundleflower</td>
<td>Desmanthus illinoensis</td>
</tr>
<tr>
<td>13.6</td>
<td>Partridge Pea</td>
<td>Cassia fasciculata</td>
</tr>
<tr>
<td>2.0</td>
<td>Prairie Verbena</td>
<td>Verbena bipinnatifida</td>
</tr>
<tr>
<td>8.0</td>
<td>Texas Yellow Star</td>
<td>Lindheimeri texana</td>
</tr>
<tr>
<td>8.0</td>
<td>Winecup</td>
<td>Callirhoe involcrata</td>
</tr>
<tr>
<td>2.0</td>
<td>Black-eyed Susan</td>
<td>Rudbeckia hirta</td>
</tr>
<tr>
<td>18.0</td>
<td>Cutleaf Daisy</td>
<td>Engelmannia pinnatifida</td>
</tr>
<tr>
<td>2.0</td>
<td>Obedient Plant</td>
<td>Physostegia intermedia</td>
</tr>
<tr>
<td>3.0</td>
<td>Pitcher Sage</td>
<td>Salvia azurea</td>
</tr>
<tr>
<td>2.0</td>
<td>Plains Coreopsis</td>
<td>Coreopsis tinctoria</td>
</tr>
<tr>
<td>8.0</td>
<td>Scarlet Sage</td>
<td>Salvia coccinea</td>
</tr>
</tbody>
</table>

*not to be planted within ten feet of a walkway

e. Temporary Erosion Control Seed
   1) Consist of the sowing of cool season plant seeds.

3. Mulch
   a. For use with conventional mechanical or hydraulic planting of seed.
   b. Wood cellulose fiber produced from virgin wood or recycled paper-by-products
      (waste products from paper mills or recycled newspaper).
   c. No growth or germination inhibiting factors.
   d. No more than ten percent moisture, air dry weight basis.
   e. Additives: binder in powder form.
   f. Form a strong moisture retaining mat.

4. Fertilizer
   a. acceptable condition for distribution
   b. applied uniformly over the planted area.
   c. Analysis
      1) 16-20-0
      2) 16-8-8
   d. Fertilizer rate:
      1) Not required for wildflower seeding.
      2) Newly established seeding areas - 100 pounds of nitrogen per acre.
      3) Established seeding areas - 150 pounds of nitrogen per acre.

5. Topsoil: See Section 32 91 19.

6. Water: clean and free of industrial wastes or other substances harmful to the
   germination of the seed or to the growth of the vegetation.

7. Soil Retention Blanket
   a. "Curlex I" from American Excelsior, 900 Ave. H East, Post Office Box 5624,
      Arlington, Texas 76001, 1-800-777-SOIL or approved equal.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION [NOT USED]

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Surface Preparation: clear surface of all material including:
   1. Stumps, stones, and other objects larger than one inch.
   2. Roots, brush, wire, stakes, etc.
   3. Any objects that may interfere with seeding or maintenance.

B. Tilling
   1. Compacted areas: till one inch deep.
   2. Areas sloped greater than 3:1: run a tractor parallel to slope to provide less
      seed/water run-off.
   3. Areas near trees: Do not till deeper than one half inch inside "drip line" of trees.

3.4 INSTALLATION

A. Block Sodding
   1. General:
      a. Place sod between curb and walk and on terraces that is the same type grass as
         adjacent grass or existing lawn.
      b. Plant between the average last freeze date in the spring and 6 weeks prior to the
         average first freeze in the fall.
   2. Installation
      a. Plant sod specified after the area has been completed to the lines and grades
         shown on the plans with 6 inches of topsoil.
      b. Use care to retain native soil on the roots of the sod during the process of
         excavating, hauling and planting.
      c. Keep sod material moist from the time it is dug until planted.
      d. Place sod so that the entire area designated for sodding is covered.
      e. Fill voids left in the solid sodding with additional sod and tamp.
      f. Roll and tamp sod so that sod is in complete contact with topsoil at a uniform
         slope.
      g. Peg sod with wooden pegs (or wire staple) driven through the sod block to the
         firm earth in areas that may slide due to the height or slope of the surface or
         nature of the soil.
   3. Watering and Finishing
      a. Furnish water as an ancillary cost to CONTRACTOR by means of temporary
         metering / irrigation, water truck or by any other method necessary to achieve
         an acceptable stand of turf as defined in 3.13.B.
      b. Thoroughly water sod immediately after planted.
      c. Water until established.
d. Generally, an amount of water that is equal to the average amount of rainfall plus one half inch per week should be applied until accepted. If applicable, plant large areas by irrigation zones to ensure areas are watered as soon as they are planted.

B. Seeding

1. General
   a. Seed only those areas indicated on the plans and areas disturbed by construction.
   b. Mark each area to be seeded in the field prior to seeding for the Engineer approval.

2. Broadcast Seeding
   a. Broadcast seed in two directions at right angles to each other.
   b. Harrow or rake lightly to cover seed.
   c. Never cover seed with more soil than twice its diameter.
   d. For wildflower plantings:
      1) scalp existing grasses to one inch.
      2) remove grass clippings, so seed can make contact with the soil.

3. Mechanically Seeding (Drilling):
   a. Uniformly distribute seed over the areas shown on the plans or as directed.
   b. All varieties of seed and fertilizer may be distributed at the same time provided that each component is uniformly applied at the specified rate.
   c. Drill seed at a depth of 1/4 inch to 3/8 inch utilizing a pasture or rangeland type drill.
   d. Drill on the contour of slopes
   e. After planting roll with a roller integral to the seed drill, or a corrugated roller of the "Cultipacker" type.
   f. Roll slope areas on the contour.

4. Hydromulching
   a. Mixing: Seed, mulch, fertilizer and water may be mixed provided that:
      1) Mixture is uniformly suspended to form a homogenous slurry.
      2) Mixture forms a blotter-like ground cover impregnated uniformly with grass seed.
      3) Mixture is applied within thirty (30) minutes after placed in the equipment.
   b. Placing
      1) Uniformly distribute in the quantity specified over the areas shown on the plans or as directed.

5. Fertilizing: uniformly apply fertilizer over seeded area.

6. Watering
   a. Furnish water by means of temporary metering / irrigation, water truck or by any other method necessary to achieve an acceptable stand of turf as defined in 3.13.B.
   b. Water soil to a minimum depth of 4 inches within forty eight hours of seeding.
   c. Water as direct by the City at least twice daily for 14 days after seeding in such a manner as to prevent washing of the slopes or dislodgement of the seed.
   d. Water until final acceptance.
   e. Generally, an amount of water that is equal to the average amount of rainfall plus one half inch per week should be applied until accepted.
3.5 [REPAIR]/[RESTORATION] [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE
   A. Block Sodding
      1. Water and mow sod until completion and final acceptance of the Project or as
directed by the City.
      2. Sod shall not be considered finally accepted until the sod has started to peg down
(root growing into the soil) and is free from dead blocks of sod.
   B. Seeding
      1. Water and mow sod until completion and final acceptance of the Project or as
directed by the City.
      2. Maintain the seeded area until each of the following is achieved:
         a. Vegetation is evenly distributed.
         b. Vegetation is free from bare areas.
      3. Turf will be accepted once fully established.
         a. Seeded area must have 100 percent growth to a height of three inches with one
mow cycle performed by the CONTRACTOR prior to consideration of
acceptance by the City.
   C. Rejection
      1. City may reject block sod or seeded area on the basis of weed populations.
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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SECTION 33 01 30
SEWER AND MANHOLE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing for sanitary sewer pipe and manholes prior to placing in service
      a. Low Pressure Air Test and Deflection (Mandrel) Test
         1) Excludes pipe with flow
         2) Hydrostatic Testing is not allowed.
      b. Vacuum Testing for sanitary sewer manholes
   2. Before any newly constructed sanitary sewer pipe and manholes are placed into
      service it shall be cleaned and tested.
   3. Pipe testing will include low pressure air test and deflection (mandrel) test for 36-
      inch pipe and smaller.
   4. Hydrostatic testing is not allowed.
   5. Manhole testing will include vacuum test.

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the
      Contract
   2. Division 1 – General Requirements
   3. Section 03 80 00 – Modifications to Existing Concrete
   4. Section 33 04 50 – Cleaning of Sewer Mains

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Pipe Testing
      a. Measurement
         1) This Item is considered subsidiary to the sanitary sewer main (pipe)
            completed in place.
      b. Payment
         1) The work performed and the materials furnishing in accordance with this
            Item are subsidiary to the unit price bid per linear foot of sanitary sewer
            main (pipe) complete in place, and no other compensation will be allowed.
   2. Manhole Testing
      a. Measurement
         1) Measurement for testing manholes shall be per each vacuum test.
      b. Payment
         1) The work performed and the materials furnished in accordance with this
            Item shall be paid for at the unit price bid per each vacuum test completed.
c. The price bid shall include:
   1) Mobilization
   2) Plugs
   3) Clean-up

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS

A. Test and Evaluation Reports
   1. All test reports generated during testing (pass and fail)

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Certifications
   1. Mandrel Equipment
      a. If requested by City, provide Quality Assurance certification that the equipment
         used has been designed and manufactured in accordance to the required
         specifications.

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Low Pressure Air Test (Pipe)
   1. Clean the sewer main before testing, as outlined in Section 33 04 50.
   2. Plug ends of all branches, laterals, tees, wyes, and stubs to be included in test.
B. Deflection (mandrel) test (Pipe)
   1. Perform as last work item before final inspection.
2. Clean the sewer main and inspect for offset and obstruction prior to testing.

3. Materials
   a. Mandrel used for deflection test
      1) Use of an uncertified mandrel or a mandrel altered or modified after certification will invalidate the deflection test.
      2) Mandrel requirements
         a) Odd number of legs with 9 legs minimum
         b) Effective length not less than its nominal diameter
         c) Fabricated of rigid and nonadjustable steel
         d) Fitted with pulling rings and each end
         e) Stamped or engraved on some segment other than a runner indicating the following:
            (1) Pipe material specification
            (2) Nominal size
            (3) Mandrel outside diameter (OD)
      f) Mandrel diameter must be 95 percent of inside diameter (ID) of pipe.

C. Vacuum test (Manhole)
   1. Plug lifting holes and exterior joints.
   2. Plug pipes and stubouts entering the manhole.
   3. Secure stubouts, manhole boots, and pipe plugs to prevent movement while vacuum is drawn.
   4. Plug pipes with drop connections beyond drop.
   5. Place test head inside the frame at the top of the manhole.

3.4 INSTALLATION

A. Low pressure air test (Pipe)
   1. Install plug with inlet tap.
   2. Connect air hose to inlet tap and a portable air control source.
   3. After the stabilization period (3.5 psig minimum pressure) start the stop watch.
   4. Determine time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding time per diameter per length of pipe is computed from the following equation:

\[
T = \frac{(0.0850\ast D\ast K)}{Q}
\]

Where:
T = shortest time, seconds, allowed for air pressure to drop to 1.0 psig
K = 0.000419\ast D\ast L, but not less than 1.0
D = nominal pipe diameter, inches
L = length of pipe being tested (by pipe size), feet
Q = 0.0015, cubic feet per minute per square foot of internal surface

5. UNI-B-6, Table 1 provides required time for given lengths of pipe for sizes 4-inch through 60-inch based on the equation above.

6. Stop test if no pressure loss has occurred during the first 25 percent of the calculated testing time.

B. Deflection (mandrel) test (Pipe)
1. For pipe 36 inches and smaller, the mandrel is pulled through the pipe by hand to ensure that maximum allowable deflection is not exceeded.

2. Maximum percent deflection by pipe size is as follows:

<table>
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<tr>
<th>Nominal Pipe Size</th>
<th>Percent Deflection Allowed</th>
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<tr>
<td>12 and smaller</td>
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<td>15 through 30</td>
<td>4.0</td>
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<tr>
<td>Greater than 30</td>
<td>3.0</td>
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</table>

C. Vacuum test (Manhole)

1. Draw a vacuum of 10 inches of mercury and turn off the pump.

2. With the valve closed, read the level vacuum level after the required test time.

3. Minimum time required for vacuum drop of 1 inch of mercury is as follows:

<table>
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<tr>
<th>Depth of Manhole, feet</th>
<th>4-foot Dia Seconds</th>
<th>5-foot Dia Seconds</th>
<th>6-foot Dia Seconds</th>
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<td>59</td>
<td>73</td>
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<tr>
<td>**</td>
<td>T=5</td>
<td>T=6.5</td>
<td>T=8</td>
</tr>
</tbody>
</table>

** For manholes over 18 feet deep, add “T” seconds as shown for each respective diameter for each 2 feet of additional depth of manhole to the time shown for 18 foot depth. (Example: A 30 foot deep, 4-foot diameter. Total test time would be 70 seconds. 40+6(5)=70 seconds)

4. Manhole vacuum levels observed to drop greater than 1 inch of mercury will have failed the test.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Non-Conforming Work

1. Low pressure air test
   a. Should the air test fail, find and repair leak(s) and retest.

2. Deflection (mandrel) test (Pipe)
   a. Should the mandrel fail to pass, the pipe is considered overdeflected.
   b. Uncover overdeflected pipe. Reinstall if not damaged.
   c. If damaged, remove and replace.
3. Vacuum test (Manhole)
   a. Should the vacuum test fail, repair suspect area and retest.
      1) External repairs required for leaks at pipe connection to manhole.
      a) Shall be in accordance with Section 03 80 00.
      2) Leaks within the manhole structure may be repaired internally or
         externally.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log
SECTION 33 01 30
SEWER AND MANHOLE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing for sanitary sewer pipe and manholes prior to placing in service
   a. Low Pressure Air Test and Deflection (Mandrel) Test
      1) Excludes pipe with flow
      2) Hydrostatic Testing is not allowed.
   b. Vacuum Testing for sanitary sewer manholes

2. Before any newly constructed sanitary sewer pipe and manholes are placed into
   service it shall be cleaned and tested.

3. Pipe testing will include low pressure air test and deflection (mandrel) test for 36-
   inch pipe and smaller.

4. Hydrostatic testing is not allowed.

5. Manhole testing will include vacuum test.

B. Deviations from this City of Fort Worth Standard Specification

1. None.

C. Related Specification Sections include, but are not necessarily limited to:

1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the
   Contract

2. Division 1 – General Requirements

3. Section 03 80 00 – Modifications to Existing Concrete

4. Section 33 04 50 – Cleaning of Sewer Mains

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Pipe Testing
   a. Measurement
      1) This Item is considered subsidiary to the sanitary sewer main (pipe)
         completed in place.
   b. Payment
      1) The work performed and the materials furnishing in accordance with this
         Item are subsidiary to the unit price bid per linear foot of sanitary sewer
         main (pipe) complete in place, and no other compensation will be allowed.

2. Manhole Testing
   a. Measurement
      1) Measurement for testing manholes shall be per each vacuum test.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item shall be paid for at the unit price bid per each vacuum test completed.
c. The price bid shall include:
   1) Mobilization
   2) Plugs
   3) Clean-up

1.3 REFERENCES [NOT USED]

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS

A. Test and Evaluation Reports
   1. All test reports generated during testing (pass and fail)

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Certifications
   1. Mandrel Equipment
      a. If requested by City, provide Quality Assurance certification that the equipment
         used has been designed and manufactured in accordance to the required
         specifications.

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Low Pressure Air Test (Pipe)
   1. Clean the sewer main before testing, as outlined in Section 33 04 50.
   2. Plug ends of all branches, laterals, tees, wyes, and stubs to be included in test.
B. Deflection (mandrel) test (Pipe)
   1. Perform as last work item before final inspection.
2. Clean the sewer main and inspect for offset and obstruction prior to testing.

3. Materials
   a. Mandrel used for deflection test
      1) Use of an uncertified mandrel or a mandrel altered or modified after certification will invalidate the deflection test.
      2) Mandrel requirements
         a) Odd number of legs with 9 legs minimum
         b) Effective length not less than its nominal diameter
         c) Fabricated of rigid and nonadjustable steel
         d) Fitted with pulling rings and each end
         e) Stamped or engraved on some segment other than a runner indicating the following:
            (1) Pipe material specification
            (2) Nominal size
            (3) Mandrel outside diameter (OD)
      f) Mandrel diameter must be 95 percent of inside diameter (ID) of pipe.

C. Vacuum test (Manhole)
   1. Plug lifting holes and exterior joints.
   2. Plug pipes and stubouts entering the manhole.
   3. Secure stubouts, manhole boots, and pipe plugs to prevent movement while vacuum is drawn.
   4. Plug pipes with drop connections beyond drop.
   5. Place test head inside the frame at the top of the manhole.

3.4 INSTALLATION

A. Low pressure air test (Pipe)
   1. Install plug with inlet tap.
   2. Connect air hose to inlet tap and a portable air control source.
   3. After the stabilization period (3.5 psig minimum pressure) start the stop watch.
   4. Determine time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding time per diameter per length of pipe is computed from the following equation:

\[ T = \frac{0.0850*D*K}{Q} \]

Where:
   \( T \) = shortest time, seconds, allowed for air pressure to drop to 1.0 psig
   \( K = 0.000419*D*L, \) but not less than 1.0
   \( D = \) nominal pipe diameter, inches
   \( L = \) length of pipe being tested (by pipe size), feet
   \( Q = 0.0015, \) cubic feet per minute per square foot of internal surface

5. UNI-B-6, Table 1 provides required time for given lengths of pipe for sizes 4-inch through 60-inch based on the equation above.

6. Stop test if no pressure loss has occurred during the first 25 percent of the calculated testing time.

B. Deflection (mandrel) test (Pipe)
1. For pipe 36 inches and smaller, the mandrel is pulled through the pipe by hand to
ensure that maximum allowable deflection is not exceeded.
2. Maximum percent deflection by pipe size is as follows:

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C. Vacuum test (Manhole)
1. Draw a vacuum of 10 inches of mercury and turn off the pump.
2. With the valve closed, read the level vacuum level after the required test time.
3. Minimum time required for vacuum drop of 1 inch of mercury is as follows:

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** For manholes over 18 feet deep, add “T” seconds as shown for each respective
diameter for each 2 feet of additional depth of manhole to the time shown for 18 foot
depth. (Example: A 30 foot deep, 4-foot diameter. Total test time would be 70
seconds. 40+6(5)=70 seconds)
4. Manhole vacuum levels observed to drop greater than 1 inch of mercury will have
failed the test.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL
A. Non-Conforming Work
1. Low pressure air test
   a. Should the air test fail, find and repair leak(s) and retest.
2. Deflection (mandrel) test (Pipe)
   a. Should the mandrel fail to pass, the pipe is considered overdeflected.
   b. Uncover overdeflected pipe. Reinstall if not damaged.
   c. If damaged, remove and replace.
3. Vacuum test (Manhole)
   a. Should the vacuum test fail, repair suspect area and retest.
      1) External repairs required for leaks at pipe connection to manhole.
         a) Shall be in accordance with Section 03 80 00.
      2) Leaks within the manhole structure may be repaired internally or
         externally.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 33 01 31
CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Requirements and procedures for Closed Circuit Television (CCTV) Inspection of sanitary sewer or storm sewer mains
2. Deviations from this City of Fort Worth Standard Specification

B. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. Section 33 03 10 – Bypass Pumping of Existing Sewer Systems
4. Section 33 04 50 – Cleaning of Sewer Mains
5. Section 33 31 20 – Polyvinyl Chloride (PVC) Gravity Sanitary Sewer Pipe
6. Section 33 31 21 – Polyvinyl Chloride (PVC) Closed Profile Gravity Sanitary Sewer Pipe
7. Section 33 31 22 – Sanitary Sewer Slip Lining

1.2 PRICE AND PAYMENT PROCEDURES

A. Pre-CCTV Inspection
1. Measurement
   a. Measurement for this Item will be by the linear foot of line televised for CCTV Inspection performed prior to any line modification or replacement determined from the distance recorded on the video tape log.
2. Payment
   a. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per linear foot for “Pre-CCTV Inspection”.
      1) Contractor will not be paid for unaccepted video.
3. The price bid shall include:
   a. Mobilization
   b. Cleaning
   c. Digital file

B. Post-CCTV Inspection
1. Measurement
   a. Measurement for this Item will be by the linear foot of line televised for CCTV Inspection performed following repair or installation determined from the distance recorded on the video tape log.
2. Payment
   a. The work performed and materials furnished in accordance with this Item and
      measured as provided under “Measurement” will be paid for at the unit price
      bid per linear foot for “Post-CCTV Inspection”.
      1) Contractor will not be paid for unaccepted video.
   3. The price bid shall include:
      a. Mobilization
      b. Cleaning
      c. Digital file

1.3 REFERENCES
   A. Reference Standards
      1. Reference standards cited in this Specification refer to the current reference
         standard published at the time of the latest revision date logged at the end of this
         Specification, unless a date is specifically cited.
   2. City of Fort Worth Water Department
      a. City of Fort Worth Water Department CCTV Inspection and Defect Coding
         Program (CCTV Manual). Contact Field Operations to obtain a copy of the
         CCTV Manual.

1.4 ADMINISTRATIVE REQUIREMENTS
   A. Coordination
      1. Meet with City of Fort Worth Water Department staff to confirm that the
         equipment, software, standard templates, defect codes and defect rankings are being
         used, if required.

1.5 SUBMITTALS
   A. Submittals shall be in accordance with Section 01 33 00.
   B. All submittals shall be approved by the Engineer prior to delivery.

1.6 INFORMATIONAL SUBMITTALS
   A. Pre-CCTV submittals for sanitary sewer lines 24 inches and larger, if required
      1. Project schedule
      2. Listing of cleaning equipment and procedures
      3. Listing of flow diversion procedures
      4. Listing of CCTV equipment
      5. Listing of backup and standby equipment
      6. Listing of safety precautions and traffic control measures

1.7 CLOSEOUT SUBMITTALS
   A. Post-CCTV submittals
      1. 2 copies of CCTV video results on DVD
      2. 2 hard copies of Inspection Report
1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
1.9 QUALITY ASSURANCE [NOT USED]
1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]
1.11 FIELD [SITE] CONDITIONS [NOT USED]
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]
3.2 EXAMINATION [NOT USED]
3.3 PREPARATION

A. CCTV Equipment

1. Use equipment specifically designed and constructed for such inspection.
2. Use equipment designed to operate in 100 percent humidity conditions.
3. Use equipment with a pan (±270 degrees), tilt, and rotates (360 degrees).
4. Use camera with an accurate footage counter that displays on the monitor the distance of the camera (to the nearest 1/10 foot) from the centerline of the starting manhole.
5. Use camera with height adjustment so camera lens is always centered at 1/2 the inside diameter, or higher, in the televised pipe.
6. Provide sufficient lighting to illuminate the entire periphery of the pipe.
7. Provide color video.
8. Use the Fort Worth Water Department standardized inspection and coding program by I.T. software with pre-configured template.

B. Temporary Bypass Pumping – Conform to Section 33 03 10.
C. Cleaning – Conform to Section 33 04 50.

3.4 INSPECTION (CCTV)

A. General

1. Begin inspection immediately after cleaning of the main.
2. Move camera through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the main’s condition.
3. Do not move camera at a speed greater than 30 feet per minute.
4. Use manual winches, power winches, TV cable, and power rewinds that do not obstruct the camera view, allowing for proper evaluation.
5. During investigation stop camera at each defect along the main.
3.1 Record the nature, location and orientation of the defect or infiltration location as specified in the CCTV Manual.

6. Pan and tilt the camera to provide additional detail at:
   a. Manholes
   b. Service connections
   c. Joints
   d. Visible pipe defects such as cracks, broken or deformed pipe, holes, offset joints, obstructions or debris
   e. Infiltration/Inflow locations
   f. Pipe material transitions
   g. Other locations that do not appear to be typical for normal pipe conditions

7. Provide accurate distance measurement.
   a. The meter device is to be accurate to the nearest 1/10 foot.

8. CCTV inspections are to be continuous.
   a. Do not provide a single segment of main on more than 1 DVD.

B. Pre-Installation Inspection for Sewer Mains to be rehabilitated
   1. Perform Pre-CCTV inspection immediately after cleaning of the main and before rehabilitation work.
   2. If, during inspection, the CCTV will not pass through the entire section of main due to blockage or pipe defect, set up so the inspection can be performed from the opposite manhole.
   3. Provisions for repairing or replacing the impassable location are addressed in Section 33 31 20, Section 33 31 21 and Section 33 31 22.

C. Post-Installation Inspection
   1. Complete manhole installation before inspection begins.
   2. Prior to inserting the camera, flush and clean the main in accordance to Section 33 04 50.

D. Documentation of CCTV Inspection
   1. Follow the CCTV Manual for the inspection video, data logging and reporting.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING
   A. See Section 33 04 50.
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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SECTION 33 03 10
BYPASS PUMPING OF EXISTING SEWER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Bypass pumping of the existing sewer system, required on 18-inch and larger sewer lines unless otherwise specified in the Contract Documents
B. Deviations from this City of Fort Worth Standard Specification
   1. None.
C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
   1. Measurement
      a. Measurement for this Item will be by lump sum.
   2. Payment
      a. The work performed and materials furnished in accordance with this Item will be paid for at the lump sum price bid for “Bypass Pumping”.
   3. The price bid shall include:
      a. Mobilization
      b. Development of bypass plans
      c. Transportation and storage
      d. Setup
      e. Confined space entry
      f. Plugging
      g. Pumping
      h. Clean up
      i. Manhole restoration
      j. Surface restoration

1.3 REFERENCES
A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. Occupational Safety and Health Organization (OSHA).

1.4 ADMINISTRATIVE REQUIREMENTS
A. Coordination
1. Schedule meeting with City to review sewer shutdown prior to replacing or
   rehabilitating any facilities.
2. City reserves the right to delay schedule due to weather conditions, or other
   unexpected emergency within the sewer system.
3. Review bypass pumping arrangement or layout in the field with City prior to
   beginning operations. Facilitate preliminary bypass pumping run with City staff
   present to affirm the operation is satisfactory to the City.
4. After replacement or rehabilitation of facilities, coordinate the reestablishment of
   sewer flow with City staff.
5. Provide onsite continuous monitoring during all bypass pumping operations using
   one of the following methods:
   a. Personnel on site
   b. Portable SCADA equipment

1.5 SUBMITTALS
A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS
A. Submit a detailed plan and description outlining all provisions and precautions that will
   be taken with regard to the handling of sewer flows. Submit the plan to the Engineer for
   approval a minimum of 7 days prior to commencing work. Include the following
   details:
   1. Schedule for installation and maintenance of the bypass pumping system
   2. Staging areas for pumps
   3. Pump sizes, capacity, number of each size, and power requirements
   4. Calculations for static lift, friction losses, and velocity
   5. Pump curves showing operating range and system head curves
   6. Sewer plugging methods
   7. Size, length, material, joint type, and method for installation of suction and
      discharge piping
   8. Method of noise control for each pump and/or generator, if required
   9. Standby power generator size and location
  10. Suction and discharge piping plan
  11. Emergency action plan identifying the measures taken in the event of a pump
      failure or sewer spill
  12. Staffing plan for responding to alarm conditions identifying multiple contacts by
      name and phone numbers (office, mobile)
  13. A contingency plan to implement in the event the replacement or rehabilitation has
      unexpected delays or problems
1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT

A. Pumping

1. Provide equipment that will convey 100 percent of wet weather peak flow conditions.

2. Provide fully automatic self-priming pumps. Foot-valves or vacuum pumps are not permitted for priming the system.

3. Pumps must be constructed to allow dry running for periods of time to account for the cyclical nature of sewer flow.

4. Provide 1 stand-by pump for each size to be maintained on site. Place backup pumps on line, isolated from the primary system by valve.

5. If multiple pumps are required to meet the flow requirements, provide the necessary fittings and connections to incorporate multiple discharges.

6. Noise levels of the pumping system must follow the requirements of the City noise ordinance for gas wells.

B. Piping

1. Install pipes with joints which prevent the incident of flow spillage.

C. Plugs or Stop Logs

1. Plugs

   a. Select a plug that is made for the size and potential pressure head that will be experienced.

   b. Provide an additional anchor, support or bracing to secure plug when back pressure is present.

   c. Use accurately calibrated air pressure gauges for monitoring the inflation pressure.

   d. Place inflation gauge at location outside of confined space area. Keep the inflation gauge and valve a safe distance from the plugs.

   e. Never over inflate the plug beyond its pressure rating.

2. Stop Logs

   a. Use stop log devices designed for the manhole or sewer vault structure in use.

   b. If applicable, obtain stop logs from City that may be used on specific structures.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Locate the bypass pipelines in area to minimize disturbance to existing utilities and obtain approval of those locations from the Engineer.

B. Make preparations to comply with OSHA requirements when working in the presence of sewer gases, oxygen-deficient atmospheres and confined spaces.

C. Do not begin bypass preparation and operation until the Engineer approval of the submittals requested per this Specification.

3.4 INSTALLATION

A. Install and operate pumping and piping equipment in accordance to the submittals provided per this Specification.

B. Sewer flow stoppage

1. Plugging
   a. Use confined space procedures and equipment during installation when necessary.
   b. Thoroughly clean the pipe before insertion of the plug.
   c. Insert the plug seal surface completely so it is fully supported by the pipe.
   d. Position the plug where there are not sharp edges or protrusions that may damage the plug.
   e. Use pressure gauges for measuring inflation pressures.
   f. Minimize upstream pressure head before deflating and removing.

C. Sewer flow control and monitoring

1. Take sufficient precautions to ensure sewer flow operations do not cause flooding or damage to public or private property. The Contractor is responsible for any damage resulting from bypass pumping operations.

2. Begin continual monitoring of the sewer system as soon as the sewer is plugged or blocked. Be prepared to immediately start bypass pumping if needed due to surcharge conditions.

3. Sewer discharge may be into another sewer manhole or appropriate vehicle or container only. Do not discharge sewer into an open environment such as an open channel or earthen holding facility.

4. Do not construct bypass facilities where vehicular traffic may travel over the piping.
   a. Provide details in the suction and discharge piping plan that accommodate both the bypass facilities and traffic without disrupting either service.
3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

   A. Field [or] Site Tests and Inspections
      1. Perform leakage and pressure tests of the bypass pumping pipe and equipment
         before actual operation begins. Have City staff on site during tests.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES

   A. Once plugging or blocking is no longer necessary, remove in such a way that permits
      the sewer flow to slowly return to normal – preventing surge, surcharging and major
      downstream disturbance.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log

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CITY OF FORT WORTH
STANDARD CONSTRUCTION SPECIFICATION DOCUMENTS
Revised July 1, 2011
SECTION 33 04 40
CLEANING AND ACCEPTANCE TESTING OF WATER MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. General
1. Before any newly constructed potable water mains will be permitted to be placed into service in the Fort Worth Water Department’s Water Distribution System, it shall be cleaned (purged) and tested, or cleaned, disinfected, and tested until the bacteria count within the water main meets the standards established by the Fort Worth Water Department and the requirements of Chapter 290 of the Texas Administrative Code (TAC) established by the Texas Commission on Environmental Quality (TCEQ).

B. Deviations from this City of Fort Worth Standard Specification
1. None.

C. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. Section 33 01 31 – Closed Circuit Television (CCTV) Inspection

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Measurement
a. This Item is considered subsidiary to the water main being Cleaned and Tested.

2. Payment
a. The work performed and the materials furnished in accordance with this Item are subsidiary to cleaning, disinfection, hydrostatic testing, and bacteriological testing and shall be subsidiary to the unit price bid per linear foot of water pipe complete in place, and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.

2. American Water Works Association/American (AWWA):
   a. C301, Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.
   b. C303, Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.
   c. C651, Disinfecting Water Mains.
1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals

For 24-inch and larger water mains, provide the following:

1. Cleaning Plan – Prior to the start of construction, submit a water main cleaning plan
detailing the methods and schedule, including:
   a. A detailed description of cleaning procedures
   b. Pigging entry and exit ports
   c. Flushing procedures
   d. Plans and hydraulic calculations to demonstrate adequate flushing velocities
   e. Control of water
   f. Disposal

2. Disinfection Plan – prior to the start of construction submit a disinfection plan
including:
   a. The method mixing and introducing chlorine
   b. Flushing
   c. De-chlorination
   d. Sampling

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES

A. Pigs

1. Open cell polyurethane foam body
2. Densities between 2 pounds per cubic foot up to 8 pounds per cubic foot
3. May be wrapped with polyurethane spiral bands
4. Abrasives are not permitted, unless expressly approved by the Engineer in writing for
   the particular application.
5. Must pass through a reduction up to 65 percent of the cross sectional area of the
   nominal pipe diameter
6. Pigs shall be able to traverse standard piping arrangements such as 90 degree bends, tees, crosses, wyes, and gate valves.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 ERECTION/INSTALLATION/APPLICATION [NOT USED]

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. General

1. All water mains shall be cleaned prior to bacteriological testing.
   a. Pig all 36-inch and smaller water mains.
   b. Pig or manually sweep 42-inch and larger mains.
   c. Flushing is only permitted when specially designated in the Drawings, or if pigging is not practical and approved by the Engineer.

B. Pigging Method

1. If the method of pigging is to be used, prepare the main for the installation and removal of a pig, including:
   a. Furnish all equipment, material and labor to satisfactorily expose cleaning wye, remove cleaning wye covers, etc.
   b. Where expulsion of the pig is required through a dead-ended conduit:
      1) Prevent backflow of purged water into the main after passage of the pig.
      2) Install a mechanical joint to provide a riser out of the trench on 12-inch and smaller mains to prevent backwater re-entry into the main.
      3) Additional excavation of the trench may be performed on mains over 12 inches, to prevent backwater re-entry into the main.
      4) Flush any backflow water that inadvertently enters the main.
   c. Flush short dead-end pipe sections not swabbed by a pig.
   d. Once pigging is complete:
      1) Pigging wyes shall remain in place unless otherwise specified in the Contract Documents.
      2) Install cleaning wye, blind flanges or mechanical joint plugs.
3) Plug and place blocking at other openings.
4) Backfill
5) Complete all appurtenant work necessary to secure the system and proceed
   with disinfection.

C. Flushing Method
   1. Prepare the main by installing blow-offs at appropriate locations, of sufficient sizes
      and numbers, and with adequate flushing to achieve a minimum velocity in the
      main of 2.5 feet per second.
      a. Minimum blow-off sizes for various main sizes are as follows:
         1) 4-inch through 8-inch main – ¾-inch blow-off
         2) 10-inch through 12-inch main – 1-inch blow-off
         3) 16-inch and greater main – 2-inch blow-off
      b. Flushing shall be subject to the following limitations:
         1) Limit the volume of water for flushing to 3 times the volume of the water
            main.
         2) Do not unlawfully discharge chlorinated water.
         3) Do not damage private property.
         4) Do not create a traffic hazard.
      c. Once Flushing is complete:
         1) Corporations stops used for flushing shall be plugged.

D. Daily main cleaning
   1. Wipe joints and then inspect for proper installation.
   2. Sweep each joint and keep clean during construction.
   3. Install a temporary plug on all exposed mains at the end of each working day or an
      extended period of work stoppage.

E. Hydrostatic Testing
   1. All water main that is to be under pressure, shall be hydrostatically tested to meet
      the following criteria:
      a. Furnish and install corporations for proper testing of the main.
         1) Furnish adequate and satisfactory equipment and supplies necessary to
            make such hydrostatic tests.
         2) The section of line to be tested shall be gradually filled with water,
            carefully expelling the air and the specified pressure applied.
      b. The City will furnish water required for the testing at its nearest City line.
      c. Expel air from the pipe before applying the required test pressure.
      d. Test Pressure
         1) Test pressures should meet the following criteria:
            a) Not less than 1.25 (187 psi minimum) times the stated working
               pressure of the pipeline measured at the highest elevation along the test
               section.
            b) Not less that 1.5 (225 psi minimum) times the stated working pressure
               at the lowest elevation of the test section.
      e. Test Conditions
         1) Must be at least 2 hour duration
         2) Add water as necessary to sustain the required test pressure.
         3) Test Fire hydrants to the fire hydrant valve.
a) Leave the isolation valve on the fire hydrant lead line open during the hydrostatic testing.

4) Close isolation valves for air release valves.

5) Makeup water must come from a container of fixed 55 gallon container that does not have a water source.

f. Measure all water used in the pressure test through an approved meter, or measure the difference in volume within a 55 gallon container.

1) Do not test against existing water distribution valves unless expressly provided for in the Drawings, or approved by the Engineer.

2) If the City denies approval to test against existing water distribution system valve, then make arrangements to plug and test the pipe at no additional cost.

2. Allowable Leakage

a. No pipe installation should be accepted if the amount of makeup water is greater than that determined using the following formula:

   In inch-pound units,

   \[
   L = \frac{SD \sqrt{P}}{148,000}
   \]

   Where:

   \( L \) = testing allowance (make up water), gallons per hour
   \( S \) = length of pipe tested, ft.
   \( D \) = nominal diameter of pipe, in.
   \( P \) = average test pressure during the hydrostatic test, psi

b. For any pipeline that fails to pass hydrostatic test:

   1) Identify the cause
   
   2) Repair the leak
   
   3) Restore the trench and surface
   
   4) Retest

c. All costs associated with repairing the pipeline to pass the hydrostatic test is the sole responsibility of the Contractor and included in the price per linear foot of pipe.

d. If the City determines that an existing system valve is responsible for the hydrostatic test to fail, the Contractor shall make provisions to test the pipeline without the use of the system valve.

e. There shall be no additional payment to the Contractor if the existing valve is unable to sustain the hydrostatic test and shall be included in the price per linear foot of pipe.

F. Disinfection

1. General

a. Disinfection of the main shall be accomplished by the “continuous feed” method or the “slug” method as determined by the Contractor.

b. The free chlorine amounts shown are minimums. The Contractor may require higher rates.

   1) Calcium hypochlorite granules shall be used as the source of chlorine.

c. Continuous Feed Method

   1) Apply water at a constant rate in the newly laid main.

      a) Use the existing distribution system or other approved source of supply.
2) At a point not more than 10 feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine.
   a) Free chlorine concentration: 50 mg/L minimum, or as required by TCEQ, whichever is greater.
   b) Chlorine applications shall not cease until the entire conduit is filled with heavily chlorinated water.
3) Retain chlorinated water in the main for at least 24 hours.
   a) Operate valves and hydrants in the section treated in order to disinfect the appurtenances.
   b) Prevent the flow of chlorinated water into mains in active service.
   c) Residual at the end of the 24-hour period: 10 mg/L free chlorine, minimum, for the treated water in all portions of the main.
4) Flush the heavily chlorinated water from the main and dispose of in a manner and at a location accepted by the City.
5) Test the chlorine residual prior to flushing operations.
   a) If the chlorine residual exceeds 4 mg/L, the water shall remain in the new main until the chlorine residual is less than 4 mg/L.
   b) The Contractor may choose to evacuate the water into water trucks, or other approved storage facility, and treat the water with Sodium Bisulfate, or another de-chlorination chemical, or method acceptable for potable water and approved by the Engineer until the chlorine residual is reduced to 4 mg/L or less.
   c) After the specified chlorine residual is obtained, the water may then be discharged into the drainage system or utilized by the Contractor.

d. Slug Method
   1) Water from the existing distribution system or other approved source of supply shall be made to flow at a constant rate in the newly laid main.
   2) At a point not more than 10 feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine.
      a) Free chlorine concentration: 100 mg/L minimum, or as required by TCEQ, whichever is greater.
      b) The chlorine shall be applied continuously and for a sufficient time to develop a solid column or “slug” of chlorinated water that shall expose all interior surfaces to the “slug” for at least 3 hours.
   3) Operate the fittings and valves as the chlorinated water flows past to disinfect the appurtenances.
   4) Prevent the flow of chlorinated water into mains in active service.
   5) Flush the heavily chlorinated water from the main and dispose of in a manner and at a location accepted by the Engineer.
   6) Upon completion, test the chlorine residual remaining in the main.
      a) Chlorine levels of 4 mg/L or less should be maintained.

2. Contractor Requirements
   a. Furnish all equipment, material and labor to satisfactorily prepare the main for the disinfection method approved by the Engineer with adequate provisions for sampling.
   b. Make all necessary taps into the main to accomplish chlorination of a new line, unless otherwise specified in the Contract Documents.
c. After satisfactory completion of the disinfection operation, as determined by
the The Engineer, remove surplus pipe at the chlorination and sampling points, plug the
remaining pipe, backfill and complete all appurtenant work necessary to secure
the main.

G. Bacteriological Testing (Water Sampling)

1. General
   a. Notify the City when the main is suitable for sampling.
   b. The City shall then take water samples from a suitable tap for analysis by the
      City’s laboratory, unless otherwise specified in the Contract Documents.
      1) No hose or fire hydrant shall be used in the collection of samples.

2. Water Sampling
   a. Complete microbiological sampling prior to connecting the new main into the
      existing distribution system in accordance with AWWA C651.
   b. Collect samples for bacteriological analysis in sterile bottles treated with
      sodium thiosulfate.
   c. Collect 2 consecutive sets of acceptable samples, taken at least 24 hours apart,
      from the new main.
   d. Collect at least 1 set of samples from every 1,000 linear feet of the new main
      (or at the next available sampling point beyond 1,000 linear feet as designated
      by the City), plus 1 set from the end of the line and at least 1 set from each
      branch.
   e. If trench water has entered the new main during construction or, if in the
      opinion of the City, excessive quantities of dirt or debris have entered the new
      main, obtain bacteriological samples at intervals of approximately 200 linear
      feet.
   f. Obtain samples from water that has stood in the new main for at least 16 hours
      after formal flushing.

3. Repetition of Sampling
   a. Unsatisfactory test results require a repeat of the disinfection process and re-
      sampling as required above until a satisfactory sample is obtained.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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Revision Log

CITY OF FORT WORTH
STANDARD CONSTRUCTION SPECIFICATION DOCUMENTS
Revised July 1, 2011

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SECTION 33 05 10
UTILITY TRENCH EXCAVATION, EMBEDMENT AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, Embedment and Backfill for:
      a. Pressure Applications
         1) Water Distribution or Transmission Main
         2) Wastewater Force Main
         3) Reclaimed Water Main
      b. Gravity Applications
         1) Wastewater Gravity Mains
         2) Storm Sewer Pipe and Culverts
         3) Storm Sewer Precast Box and Culverts
   2. Including:
      a. Excavation of all material encountered, including rock and unsuitable materials
      b. Disposal of excess unsuitable material
      c. Site specific trench safety
      d. Pumping and dewatering
      e. Embedment
      f. Backfill
      g. Compaction

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 02 41 13 – Selective Site Demolition
   4. Section 02 41 15 – Paving Removal
   5. Section 02 41 14 – Utility Removal/Abandonment
   6. Section 03 34 13 – Controlled Low Strength Material (CLSM)
   7. Section 31 10 00 – Site Clearing
   8. Section 31 25 00 – Erosion and Sediment Control
   9. Section 33 05 26 – Utility Markers/Locators
   10. Section 34 71 13 – Traffic Control

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Trench Excavation, Embedment and Backfill associated with the installation of an underground utility or excavation
a. Measurement
   1) This Item is considered subsidiary to the installation of the utility pipe line
      as designated in the Drawings.

b. Payment
   1) The work performed and the materials furnished in accordance with this
      Item are considered subsidiary to the installation of the utility pipe for the
      type of embedment and backfill as indicated on the plans. No other
      compensation will be allowed.

2. Imported Embedment or Backfill
   a. Measurement
      1) Measured by the cubic yard as delivered to the site and recorded by truck
         ticket provided to the City
   b. Payment
      1) Imported fill shall only be paid when using materials for embedment and
         backfill other than those identified in the Drawings. The work performed
         and materials furnished in accordance with pre-bid item and measured as
         provided under “Measurement” will be paid for at the unit price bid per
         cubic yard of “Imported Embedment/Backfill” delivered to the Site for:
         a) Various embedment/backfill materials
         c. The price bid shall include:
            1) Furnishing backfill or embedment as specified by this Specification
            2) Hauling to the site
            3) Placement and compaction of backfill or embedment

3. Ground Water Control
   a. Measurement
      1) Measurement shall be lump sum when a ground water control plan is
         specifically required by the Contract Documents.
   b. Payment
      1) Payment shall be per the lump sum price bid for “Ground Water Control”
         including:
         a) Submittals
         b) Additional Testing
         c) Ground water control system installation
         d) Ground water control system operations and maintenance
         e) Disposal of water
         f) Removal of ground water control system

4. Trench Safety
   a. Measurement
      1) Measured per linear foot of excavation for all trenches that require trench
         safety in accordance with OSHA excavation safety standards (29 CFR Part
         1926 Subpart P Safety and Health regulations for Construction)
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” will be paid for at the unit
         price bid per linear foot of excavation to comply with OSHA excavation
         safety standards (29 CFR Part 1926.650 Subpart P), including, but not
         limited to, all submittals, labor and equipment.
### 1.3 REFERENCES

**A. Definitions**

1. General – Definitions used in this section are in accordance with Terminologies ASTM F412 and ASTM D8 and Terminology ASTM D653, unless otherwise noted.
2. Definitions for trench width, backfill, embedment, initial backfill, pipe zone, haunching bedding, springline, pipe zone and foundation are defined as shown in the following schematic:

![Diagram showing trench width, backfill, embedment, initial backfill, pipe zone, haunching bedding, springline, pipe zone and foundation.]

3. Deleterious materials – Harmful materials such as clay lumps, silts and organic material
4. Excavated Trench Depth – Distance from the surface to the bottom of the bedding or the trench foundation
5. Final Backfill Depth
   a. Unpaved Areas – The depth of the final backfill measured from the top of the initial backfill to the surface
   b. Paved Areas – The depth of the final backfill measured from the top of the initial backfill to bottom of permanent or temporary pavement repair

**B. Reference Standards**
1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.

2. ASTM Standards:
   a. ASTM C33-08 Standard Specifications for Concrete Aggregates
   b. ASTM C88-05 Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
   c. ASTM C136-01 Test Method for Sieve Analysis of Fine and Coarse Aggregate
   d. ASTM D448-08 Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
   e. ASTM C535-09 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   f. ASTM D588 – Standard Test method for Moisture-Density Relations of Soil-Cement Mixture
   g. ASTM D698-07 Test Method for Laboratory Compaction Characteristics of Soil Using Stand Efforts (12,400 ft-lb/ft3 600 Kn-m/M3)).
   h. ASTM 1556 Standard Test Methods for Density and Unit Weight of Soils in Place by Sand Cone Method.
   i. ASTM 2487 – 10 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   j. ASTM 2321-09 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   k. ASTM D2922 – Standard Test Methods for Density of Soils and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
   l. ASTM 3017 - Standard Test Method for Water Content of Soil and Rock in place by Nuclear Methods (Shallow Depth)
   m. ASTM D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density

3. OSHA
   a. Occupational Safety and Health Administration CFR 29, Part 1926-Safety Regulations for Construction, Subpart P - Excavations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. Utility Company Notification
      a. Notify area utility companies at least 48 hours in advance, excluding weekends and holidays, before starting excavation.
      b. Request the location of buried lines and cables in the vicinity of the proposed work.

B. Sequencing
   1. Sequence work for each section of the pipe installed to complete the embedment and backfill placement on the day the pipe foundation is complete.
   2. Sequence work such that proctors are complete in accordance with ASTM D698 prior to commencement of construction activities.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer prior to construction.
1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Shop Drawings
   1. Provide detailed drawings and explanation for ground water and surface water control, if required.
   2. Trench Safety Plan in accordance with Occupational Safety and Health Administration CFR 29, Part 1926-Safety Regulations for Construction, Subpart P - Excavations
   3. Stockpiled excavation and/or backfill material
      a. Provide a description of the storage of the excavated material only if the Contract Documents do not allow storage of materials in the right-of-way of the easement.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage
   1. Within Existing Rights-of-Way (ROW)
      a. Spoil, imported embedment and backfill materials may be stored within existing ROW, easements or temporary construction easements, unless specifically disallowed in the Contract Documents.
      b. Do not block drainage ways, inlets or driveways.
      c. Provide erosion control in accordance with Section 31 25 00.
      d. Store materials only in areas barricaded as provided in the traffic control plans.
      e. In non-paved areas, do not store material on the root zone of any trees or in landscaped areas.
   2. Designated Storage Areas
      a. If the Contract Documents do not allow the storage of spoils, embedment or backfill materials within the ROW, easement or temporary construction easement, then secure and maintain an adequate storage location.
      b. Provide an affidavit that rights have been secured to store the materials on private property.
      c. Provide erosion control in accordance with Section 31 25 00.
      d. Do not block drainage ways.
      e. Only materials used for 1 working day will be allowed to be stored in the work zone.

B. Deliveries and haul-off - Coordinate all deliveries and haul-off.

1.11 FIELD [SITE] CONDITIONS

A. Existing Conditions
   1. Any data which has been or may be provided on subsurface conditions is not intended as a representation or warranty of accuracy or continuity between soils. It is expressly understood that neither the City nor the Engineer will be responsible for interpretations or conclusions drawn there from by the Contractor.
   2. Data is made available for the convenience of the Contractor.
1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS

2.2 MATERIALS

A. Materials

1. Utility Sand
   a. Granular and free flowing
   b. Generally meets or exceeds the limits on deleterious substances per Table 1 for fine aggregate according to ASTM C 33
   c. Reasonably free of organic material
   d. Gradation:

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2. Crushed Rock
   a. Durable crushed rock or recycled concrete
   b. Meets the gradation of ASTM D448 size numbers 56, 57 or 67
   c. May be unwashed
   d. Free from significant silt clay or unsuitable materials
   e. Percentage of wear not more than 40 percent per ASTM C131 or C535
   f. Not more than a 12 percent maximum loss when subjective to 5 cycles of sodium sulfate soundness per ASTM C88

3. Fine Crushed Rock
   a. Durable crushed rock
   b. Meets the gradation of ASTM D448 size numbers 8 or 89
   c. May be unwashed
   d. Free from significant silt clay or unsuitable materials.
   e. Have a percentage of wear not more than 40 percent per ASTM C131 or C535
   f. Not more than a 12 percent maximum loss when subjective to 5 cycles of sodium sulfate soundness per ASTM C88

4. Ballast Stone
   a. Stone ranging from 3 inches to 6 inches in greatest dimension.
   b. May be unwashed
   c. Free from significant silt clay or unsuitable materials
   d. Percentage of wear not more than 40 percent per ASTM C131 or C535
   e. Not more than a 12 percent maximum loss when subjected to 5 cycles of sodium sulfate soundness per ASTM C88

5. Acceptable Backfill Material
   a. In-situ or imported soils classified as CL, CH, SC or GC in accordance with ASTM D2487
   b. Free from deleterious materials, boulders over 6 inches in size and organics
   c. Can be placed free from voids
d. Must have 20 percent passing the number 200 sieve

6. Blended Backfill Material
   a. In-situ soils classified as SP, SM, GP or GM in accordance with ASTM D2487
   b. Blended with in-situ or imported acceptable backfill material to meet the
      requirements of an Acceptable Backfill Material
   c. Free from deleterious materials, boulders over 6 inches in size and organics
   d. Must have 20 percent passing the number 200 sieve

7. Unacceptable Backfill Material
   a. In-situ soils classified as ML, MH, PT, OL or OH in accordance with ASTM
      D2487

8. Select Fill
   a. Classified as SC or CL in accordance with ASTM D2487
   b. Liquid limit less than 35
   c. Plasticity index between 8 and 20

9. Cement Stabilized Sand (CSS)
   a. Sand or silty sand
   b. Free of clay or plastic material
   c. Minimum of 4 percent cement content of Type I/II portland cement
   d. 100 to 150 psi compressive strength at 2 days in accordance with ASTM
      D1633, Method A
   e. 200 to 250 psi compressive strength at 23 days in accordance with ASTM
      D1633, Method A
   f. Mix in a stationary pug mill, weigh-batch or continuous mixing plant

10. Controlled Low Strength Material (CLSM)
    a. Conform to Section 03 34 13

11. Trench Geotextile Fabric
    a. Soils other than ML or OH in accordance with ASTM D2487
       1) Needle punch, nonwoven geotextile composed of polypropylene fibers
       2) Fibers shall retain their relative position
       3) Inert to biological degradation
       4) Resist naturally occurring chemicals
       5) UV Resistant
       6) Mirafi 140N by Tencate, or approved equal
    b. Soils Classified as ML or OH in accordance with ASTM D2487
       1) High-tenacity monofilament polypropylene woven yarn
       2) Percent open area of 8 percent to 10 percent
       3) Fibers shall retain their relative position
       4) Inert to biological degradation
       5) Resist naturally occurring chemicals
       6) UV Resistant
       7) Mirafi FW402 by Tencate, or approved equal
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Verification of Conditions
   1. Review all known, identified or marked utilities, whether public or private, prior to excavation.
   2. Locate and protect all known, identified and marked utilities or underground facilities as excavation progresses.
   3. Notify all utility owners within the project limits 48 hours prior to beginning excavation.
   4. The information and data shown in the Drawings with respect to utilities is approximate and based on record information or on physical appurtenances observed within the project limits.
   5. Coordinate with the Owner(s) of underground facilities.
   6. Immediately notify any utility owner of damages to underground facilities resulting from construction activities.
   7. Repair any damages resulting from the construction activities.

B. Notify the City immediately of any changed condition that impacts excavation and installation of the proposed utility.

3.3 PREPARATION

A. Protection of In-Place Conditions
   1. Pavement
      a. Conduct activities in such a way that does not damage existing pavement that is designated to remain.
      b. Repair or replace any pavement damaged due to the negligence of the contractor outside the limits designated for pavement removal at no additional cost to the City.
   2. Trees
      a. When operating outside of existing ROW, stake permanent and temporary construction easements.
      b. Restrict all construction activities to the designated easements and ROW.
      c. Flag and protect all trees designated to remain in accordance with Section 31 10 00.
      d. Conduct excavation, embedment and backfill in a manner such that there is no damage to the tree canopy.
      e. Prune or trim tree limbs as specifically allowed by the Drawings or as specifically allowed by the City.
         1) Pruning or trimming may only be accomplished with equipments specifically designed for tree pruning or trimming.
f. Remove trees specifically designated to be removed in the Drawings in accordance with Section 31 10 00.

3. Above ground Structures
   a. Protect all above ground structures adjacent to the construction.
   b. Remove above ground structures designated for removal in the Drawings in accordance with Section 02 41 13

4. Traffic
   a. Maintain existing traffic, except as modified by the traffic control plan, and in accordance with Section 34 71 13.
   b. Do not block access to driveways or alleys for extended periods of time unless:
      1) Alternative access has been provided
      2) Proper notification has been provided to the property owner or resident
      3) It is specifically allowed in the traffic control plan
   c. Use traffic rated plates to maintain access until access is restored.

5. Traffic Signal – Poles, Mast Arms, Pull boxes, Detector loops
   a. Notify the City’s Traffic Services Division a minimum of 48 hours prior to any excavation that could impact the operations of an existing traffic signal.
   b. Protect all traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops.
   c. Immediately notify the City’s Traffic Services Division if any damage occurs to any component of the traffic signal due to the contractors activities.
   d. Repair any damage to the traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops as a result of the construction activities.

6. Fences
   a. Protect all fences designated to remain.
   b. Leave fence in the equal or better condition as prior to construction.

3.4 INSTALLATION

A. Excavation
   1. Excavate to a depth indicated on the Drawings.
   2. Trench excavations are defined as unclassified. No additional payment shall be granted for rock or other in-situ materials encountered in the trench.
   3. Excavate to a width sufficient for laying the pipe in accordance with the Drawings and bracing in accordance with the Excavation Safety Plan.
   4. The bottom of the excavation shall be firm and free from standing water.
      a. Notify the City immediately if the water and/or the in-situ soils do not provide for a firm trench bottom.
      b. The The Engineer will determine if any changes are required in the pipe foundation or bedding.
   5. Unless otherwise permitted by the Drawings or by the The Engineer, the limits of the excavation shall not advance beyond the pipe placement so that the trench may be backfilled in the same day.
   6. Over Excavation
      a. Fill over excavated areas with the specified bedding material as specified for the specific pipe to be installed.
      b. No additional payment will be made for over excavation or additional bedding material.
7. Unacceptable Backfill Materials
   a. In-situ soils classified as unacceptable backfill material shall be separated from
      acceptable backfill materials.
   b. If the unacceptable backfill material is to be blended in accordance with this
      Specification, then store material in a suitable location until the material is
      blended.
   c. Remove all unacceptable material from the project site that is not intended to be
      blended or modified.

8. Rock – No additional compensation will be paid for rock excavation or other
   changed field conditions.

B. Shoring, Sheeting and Bracing
   1. Engage a Licensed Professional Engineer in the State of Texas to design a site
      specific excavation safety system in accordance with Federal and State
      requirements.
   2. Excavation protection systems shall be designed according to the space limitations
      as indicated in the Drawings.
   3. Furnish, put in place and maintain a trench safety system in accordance with the
      Excavation Safety Plan and required by Federal, State or local safety requirements.
   4. If soil or water conditions are encountered that are not addressed by the current
      Excavation Safety Plan, engage a Licensed Professional Engineer in the State of
      Texas to modify the Excavation Safety Plan and provide a revised submittal to the
      City.
   5. Do not allow soil, or water containing soil, to migrate through the Excavation
      Safety System in sufficient quantities to adversely affect the suitability of the
      Excavation Protection System. Movable bracing, shoring plates or trench boxes
      used to support the sides of the trench excavation shall not:
      a. Disturb the embedment located in the pipe zone or lower
      b. Alter the pipe’s line and grade after the Excavation Protection System is
         removed
      c. Compromise the compaction of the embedment located below the spring line of
         the pipe and in the haunching

C. Water Control
   1. Surface Water
      a. Furnish all materials and equipment and perform all incidental work required to
         direct surface water away from the excavation.
   2. Ground Water
      a. Furnish all materials and equipment to dewater ground water by a method
         which preserves the undisturbed state of the subgrade soils.
      b. Do not allow the pipe to be submerged within 24 hours after placement.
      c. Do not allow water to flow over concrete until it has sufficiently cured.
      d. Engage a Licensed Engineer in the State of Texas to prepare a Ground Water
         Control Plan if any of the following conditions are encountered:
         1) A Ground Water Control Plan is specifically required by the Contract
            Documents
         2) If in the sole judgment of the The Engineer, ground water is so severe that an
            Engineered Ground Water Control Plan is required to protect the trench or
            the installation of the pipe which may include:
a) Ground water levels in the trench are unable to be maintained below the top of the bedding
b) A firm trench bottom cannot be maintained due to ground water
c) Ground water entering the excavation undermines the stability of the excavation.
d) Ground water entering the excavation is transporting unacceptable quantities of soils through the Excavation Safety System.
e) In the event that there is no bid item for a Ground Water Control and the The Engineer requires an Engineered Ground Water Control Plan due to conditions discovered at the site, the contractor will be eligible to submit a change order.
f) Control of ground water shall be considered subsidiary to the excavation when:
   1) No Ground Water Control Plan is specifically identified and required in the Contract Documents

  g) Ground Water Control Plan installation, operation and maintenance
     1) Furnish all materials and equipment necessary to implement, operate and maintain the Ground Water Control Plan.
     2) Once the excavation is complete, remove all ground water control equipment not called to be incorporated into the work.

  h) Water Disposal
     1) Dispose of ground water in accordance with City policy or Ordinance.
     2) Do not discharge ground water onto or across private property without written permission.
     3) Permission from the City is required prior to disposal into the Sanitary Sewer.
     4) Disposal shall not violate any Federal, State or local regulations.

D. Embedment and Pipe Placement

  1. Water Lines less than, or equal to, 12 inches in diameter:
     a) The entire embedment zone shall be of uniform material.
     b) Utility sand shall be generally used for embedment.
     c) If ground water is in sufficient quantity to cause sand to pump, then use crushed rock as embedment.
        1) If crushed rock is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
     d) Place evenly spread bedding material on a firm trench bottom.
     e) Provide firm, uniform bedding.
     f) Place pipe on the bedding in accordance with the alignment of the Drawings.
     g) In no case shall the top of the pipe be less than 42 inches from the surface of the proposed grade, unless specifically called for in the Drawings.
     h) Place embedment, including initial backfill, to a minimum of 6 inches, but not more than 12 inches, above the pipe.
        i) Where gate valves are present, the initial backfill shall extend to 6 inches above the elevation of the valve nut.
        j) Form all blocking against undisturbed trench wall to the dimensions in the Drawings.
        k) Compact embedment and initial backfill.
        l) Place marker tape on top of the initial trench backfill in accordance with Section 33 05 26.

  2. Water Lines 16-24 inches in Diameter
     a) The entire embedment zone shall be of uniform material.
b. Utility sand may be used for embedment when the excavated trench depth is less than 15 feet deep.

c. Crushed rock or fine crushed rock shall be used for embedment for excavated trench depths greater than 15 feet deep.

d. Crushed rock shall be used for embedment for steel pipe.

e. Provide trench geotextile fabric at any location where crushed rock or fine crushed rock come into contact with utility sand.

f. Place evenly spread bedding material on a firm trench bottom.

g. Provide firm, uniform bedding.
   1) Additional bedding may be required if ground water is present in the trench.
   2) If additional crushed rock is required not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.

h. Place pipe on the bedding according to the alignment shown on the Drawings.
   i. The pipe line shall be within:
      1) ±3 inches of the elevation on the Drawings for 16-inch and 24-inch water lines

j. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer’s recommendations.

k. Place remaining embedment including initial backfill to a minimum of 6 inches, but not more than 12 inches, above the pipe.

l. Where gate valves are present, the initial backfill shall extend up to the valve nut.

m. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.

n. Density test may be performed by City to verify that the compaction of embedment meets requirements.

o. Place trench geotextile fabric on top of the initial backfill.

p. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

3. Water Lines Greater than 24 Inches in Diameter
   a. The entire embedment zone shall be of uniform material.
   b. Crushed rock shall be used for embedment.
   c. Provide trench geotextile fabric at any location where crushed rock or fine crushed rock come into contact with utility sand.
   d. Place evenly spread bedding material on a firm trench bottom.
   e. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
      2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
   f. Place pipe on the bedding according to the alignment shown on the Drawings.
   g. The pipe line shall be within:
      1) ±1 inch of the elevation on the Drawings for 30-inch and larger water lines
   h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer’s recommendations.
   i. For steel pipe greater than 30 inches in diameter, the initial embedment lift shall not exceed the spring line prior to compaction.
j. Place remaining embedment, including initial backfill, to a minimum of 6 inches, but not more than 12 inches, above the pipe.

k. Where gate valves are present, the initial backfill shall extend up to the valve nut.

l. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.

m. Density test may be performed by City to verify that the compaction of embedment meets requirements.

n. Place trench geotextile fabric on top of the initial backfill.

o. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

4. Sanitary Sewer Lines and Storm Sewer Lines (HDPE)
   a. The entire embedment zone shall be of uniform material.
   b. Crushed rock shall be used for embedment.
   c. Place evenly spread bedding material on a firm trench bottom.
   d. Spread bedding so that lines and grades are maintained and that there are no sags in the sanitary sewer pipe line.
   e. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
      2) If additional crushed rock is required which is not specifically identified in the Contract Documents, then crushed rock shall be paid by the pre-bid unit price.
   f. Place pipe on the bedding according to the alignment shown in the Drawings.
   g. The pipe line shall be within ±0.1 inches of the elevation on the Drawings.
   h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer’s recommendations.
   i. For sewer lines greater than 30 inches in diameter, the embedment lift shall not exceed the spring line prior to compaction.
   j. Place remaining embedment including initial backfill to a minimum of 6 inches, but not more than 12 inches, above the pipe.
   k. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.
   l. Density test may be performed by City to verify that the compaction of embedment meets requirements.
   m. Place trench geotextile fabric on top of the initial backfill.
   n. Place marker tape on top of the trench geotextile fabric in accordance with Section 33 05 26.

5. Storm Sewer (RCP)
   a. The bedding and the pipe zone up to the spring line shall be of uniform material.
   b. Crushed rock shall be used for embedment up to the spring line.
   c. The specified backfill material may be used above the spring line.
   d. Place evenly spread bedding material on a firm trench bottom.
   e. Spread bedding so that lines and grades are maintained and that there are no sags in the storm sewer pipe line.
   f. Provide firm, uniform bedding.
      1) Additional bedding may be required if ground water is present in the trench.
2) If additional crushed rock is required which is not specifically identified in
the Contract Documents, then crushed rock shall be paid by the pre-bid unit
price.

g. Place pipe on the bedding according to the alignment of the Drawings.
h. The pipe line shall be within ±0.1 inches of the elevation on the Drawings.
i. Place embedment material up to the spring line.
   1) Place embedment to ensure that adequate support is obtained in the haunch.
j. Compact the embedment and initial backfill to 95 percent Standard Proctor
   ASTM D 698.
k. Density test may be performed by City to verify that the compaction of
   embedment meets requirements.
l. Place trench geotextile fabric on top of pipe and crushed rock.

6. Storm Sewer Reinforced Concrete Box
   a. Crushed rock shall be used for bedding.
b. The pipe zone and the initial backfill shall be:
   1) Crushed rock, or
   2) Acceptable backfill material compacted to 95 percent Standard Proctor
density
   c. Place evenly spread compacted bedding material on a firm trench bottom.
d. Spread bedding so that lines and grades are maintained and that there are no
   sags in the storm sewer pipe line.
e. Provide firm, uniform bedding.
   1) Additional bedding may be required if ground water is present in the
trench.
   2) If additional crushed rock is required which is not specifically identified in
   the Contract Documents, then crushed rock shall be paid by the pre-bid unit
   price.
f. Fill the annular space between multiple boxes with crushed rock, CLSM
   according to 03 34 13 or cement stabilized sand (CSS).
g. Place pipe on the bedding according to the alignment of the Drawings.
h. The pipe shall be within ±0.1 inches of the elevation on the Drawings.
i. Compact the embedment initial backfill to 95 percent Standard Proctor ASTM
   D698.

7. Water Services (Less than 2 Inches in Diameter)
   a. The entire embedment zone shall be of uniform material.
b. Utility sand shall be generally used for embedment.
c. Place evenly spread bedding material on a firm trench bottom.
d. Provide firm, uniform bedding.
e. Place pipe on the bedding according to the alignment of the Plans.
f. Compact the initial backfill to 95 percent Standard Proctor ASTM D698.

8. Sanitary Sewer Services
   a. The entire embedment zone shall be of uniform material.
b. Crushed rock shall be used for embedment.
c. Place evenly spread bedding material on a firm trench bottom.
d. Spread bedding so that lines and grades are maintained and that there are no
   sags in the sanitary sewer pipe line.
e. Provide firm, uniform bedding.
   1) Additional bedding may be required if ground water is present in the
trench.
2) If additional crushed rock is required which is not specifically identified in
the Contract Documents, then crushed rock shall be paid by the pre-bid unit
price.
f. Place pipe on the bedding according to the alignment of the Drawings.
g. Place remaining embedment, including initial backfill, to a minimum of 6
inches, but not more than 12 inches, above the pipe.
h. Compact the initial backfill to 95 percent Standard Proctor ASTM D698.
i. Density test may be required to verify that the compaction meets the density
requirements.

E. Trench Backfill

1. At a minimum, place backfill in such a manner that the required in-place density
and moisture content is obtained, and so that there will be no damage to the surface,
pavement or structures due to any trench settlement or trench movement.
a. Meeting the requirement herein does not relieve the responsibility to damages
associated with the Work.

2. Backfill Material
a. Final backfill depth less than 15 feet
   1) Backfill with:
      a) Acceptable backfill material
      b) Blended backfill material, or
      c) Select backfill material, CSS, or CLSM when specifically required
b. Final backfill depth greater than 15 feet and under pavement or future pavement
   1) Backfill depth from 0-15 feet deep
      a) Backfill with:
         (1) Acceptable backfill material
         (2) Blended backfill material, or
         (3) Select backfill material, CSS, or CLSM when specifically required
   2) Backfill depth greater than 15 feet deep
      a) Backfill with:
         (1) Select Fill
         (2) CSS, or
         (3) CLSM when specifically required
c. Final backfill depth greater than 15 feet and not under pavement or future
   pavement
   1) Backfill with:
      a) Acceptable backfill material, or
      b) Blended backfill material

3. Required Compaction and Density
a. Final backfill depths less than 15 feet
   1) Compact acceptable backfill material, blended backfill material or select
      backfill to a minimum of 95 percent Standard Proctor per ASTM D698 at
      moisture content within -2 to +5 percent of the optimum moisture.
   2) CSS or CLSM requires no compaction.
b. Final backfill depths greater than 15 feet and under existing or future pavement
   1) Compact select backfill to a minimum of 98 percent Standard Proctor per
      ASTM D 698 at moisture content within -2 to +5 percent of the optimum
      moisture.
   2) CSS or CLSM requires no compaction.
c. Final backfill depths greater than 15 feet and not under existing or future pavement
   1) Compact acceptable backfill material blended backfill material, or select backfill to a minimum of 95 percent Standard Proctor per ASTM D 698 at moisture content within -2 to +5 percent of the optimum moisture.

4. Saturated Soils
a. If in-situ soils consistently demonstrate that they are greater than 5 percent over optimum moisture content, the soils are considered saturated.
   b. If saturated soils are identified in the Drawings or Geotechnical Report in the Appendix, Contractor shall proceed with Work following all backfill procedures outlined in the Drawings for areas of soil saturation greater than 5 percent.
   c. If saturated soils are encountered during Work but not identified in Drawings or Geotechnical Report in the Appendix:
      1) The Contractor shall:
         a) Immediately notify the City.
         b) Submit a Contract Claim for Extra Work associated with direction from The Engineer.
      2) The The Engineer shall:
         a) Investigate soils and determine if Work can proceed in the identified location.
         b) Direct the Contractor of changed backfill procedures associated with the saturated soils that may include:
            (1) Imported backfill
            (2) A site specific backfill design

5. Placement of Backfill
a. Use only compaction equipment specifically designed for compaction of a particular soil type and within the space and depth limitation experienced in the trench.
   b. Place in loose lifts not to exceed 12 inches.
   c. Compact to specified densities.
   d. Compact only on top of initial backfill, undisturbed trench or previously compacted backfill.
   e. Remove any loose materials due to the movement of any trench box or shoring or due to sloughing of the trench wall.
   f. Install appropriate tracking balls for water and sanitary sewer trenches in accordance with Section 33 05 26.

6. Backfill Means and Methods Demonstration
a. Notify the City in writing with sufficient time for the City to obtain samples and perform standard proctor test in accordance with ASTM D698.
   b. The results of the standard proctor test must be received prior to beginning excavation.
   c. Upon commencing of backfill placement for the project the Contractor shall demonstrate means and methods to obtain the required densities.
   d. Demonstrate Means and Methods for compaction including:
      1) Depth of lifts for backfill which shall not exceed 12 inches
      2) Method of moisture control for excessively dry or wet backfill
      3) Placement and moving trench box, if used
      4) Compaction techniques in an open trench
5) Compaction techniques around structure
   e. Provide a testing trench box to provide access to the recently backfilled
      material.
   f. The City will provide a qualified testing lab full time during this period to
      randomly test density and moisture content.
       1) The testing lab will provide results as available on the job site.

7. Varying Ground Conditions
   a. Notify the City of varying ground conditions and the need for additional
      proctors.
   b. Request additional proctors when soil conditions change.
   c. The Engineer may acquire additional proctors at its discretion.
   d. Significant changes in soil conditions will require an additional Means and
      Methods demonstration.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

   A. Field Tests and Inspections

      1. Proctors
         a. The City will perform Proctors in accordance with ASTM D698.
         b. Test results will generally be available to within 4 calendar days and distributed
            to:
            1) Contractor
            2) City Project Manager
            3) City Inspector
            4) Engineer
         c. Notify the City if the characteristic of the soil changes.
         d. City will perform new proctors for varying soils:
            1) When indicated in the geotechnical investigation in the Appendix
            2) If notified by the Contractor
            3) At the convenience of the City
         e. Trenches where different soil types are present at different depths, the proctors
            shall be based on the mixture of those soils.

      2. Density Testing of Backfill
         a. Density Test Shall be in conformance with ASTM D2922.
         b. Provide a testing trench protection for trenches deeper than 5 feet.
         c. Place, move and remove testing trench protection as necessary to facilitate all
            test conducted by the City.
         d. For final backfill depths less than 15 feet and trenches of any depth not under
            existing or future pavement:
            1) The City will perform density testing twice per working day when
               backfilling operations are being conducted.
            2) The testing lab shall take a minimum of 3 density tests of the current lift in
               the available trench.
         e. For final backfill depths greater than 15 feet deep:
            1) The City will perform density testing twice per working day when
               backfilling operations are being conducted.
2) The testing lab shall take a minimum of 3 density tests of the current lift in the available trench.
3) The testing lab will remain onsite sufficient time to test 2 additional lifts.
f. Make the excavation available for testing.
g. The City will determine the location of the test.
h. The City testing lab will provide results to Contractor and the City’s Inspector upon completion of the testing.
i. A formal report will be posted to the City’s Buzzsaw site within 48 hours.
j. Test reports shall include:
   1) Location of test by station number
   2) Time and date of test
   3) Depth of testing
   4) Field moisture
   5) Dry density
   6) Proctor identifier
   7) Percent Proctor Density

3. Density of Embedment
   a. Storm sewer boxes that are embedded with acceptable backfill material, blended backfill material, cement modified backfill material or select material will follow the same testing procedure as backfill.
b. The City may test fine crushed rock or crushed rock embedment in accordance with ASTM D2922 or ASTM 1556.

B. Non-Conforming Work
   1. All non-conforming work shall be removed and replaced.

3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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Revision Log
SECTION 33 05 13
FRAME, COVER, AND GRADE RINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Frame, cover and grade rings used as access ports into water, sanitary sewer and
      storm drain structures such manholes or vaults

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the
      Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. This Item is considered subsidiary to the structure containing the frame, cover
         and grade rings.
   2. Payment
      a. The work performed and the materials furnished in accordance with this Item
         are subsidiary to the unit price bid per each structure complete in place, and no
         other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   2. ASTM International (ASTM)
      b. ASTM A536 - Standard Specification for Ductile Iron Castings
      c. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections
   3. American Association of State Highways and Transportation Officials (AASHTO)
      a. AASHTO M306 – Standard Specification for Drainage, Sewer, Utility and
         Related Castings

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
1. All castings shall be cast with:
   a. Approved foundry’s name
   b. Part number
   c. Country of origin
2. Provide manufacturer’s:
   a. Specifications
   b. Load tables
   c. Dimension diagrams
   d. Anchor details
   e. Installation instructions

B. Certificates
1. Manufacturer shall certify that all castings conform to the ASTM and AASHTO designations.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, MATERIALS

A. Manufacturers
1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.
2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Castings
1. Use castings for frames that conform to ASTM A48, Class 35B or better.
2. Use castings for covers that conform to ASTM A536, Grade 65-45-12 or better.
3. Use clean casting capable of withstanding application of AASHTO HS-20 vehicle loading with permanent deformation.
4. Covers
a. Size to set flush with the frame with no larger than a 1/8 inch gap between the frame and cover.
b. Provide with 2 inch wide pick slots in lieu of pick holes.
c. Provide gasket in frame and cover.
d. Standard Dimensions
   1) Sanitary Sewer
      a) Provide a clear opening of 30 inches for all sanitary sewer frames and cover assemblies unless otherwise specified in the Contract Documents.
   2) Storm Drain
      a) Provide a clear opening of 19 3/4 inches for all storm drain frames, inlets and cover assemblies unless otherwise specified in the Contract Documents.
      b) Provide a minimum clear opening of 24 inches for all storm sewer manholes and junction structures.
e. Standard Labels
   1) Water
      a) Cast lid with the word “WATER” in 2-inch letters across the lid.
   2) Sanitary Sewer
      a) Cast lid with the word “SANITARY SEWER” in 2-inch letters across the lid.
   3) Storm Drain
      a) Cast lid with the word “STORM DRAIN” in 2-inch letters across the lid.
f. Hinge Covers
   1) Provide water tight gasket on all hinged covers.
   2) Water
      a) Provide hinged covers for all water structures.
   3) Sanitary Sewer
      a) Provide hinged covers for all manholes or structures constructed over 24-inch sewer lines and larger and for manholes where rim elevations are greater than 12 inches above the surface.

C. Grade Rings
   1. Provide grade rings in sizes from 2-inch up to 8-inch.
   2. Use concrete in traffic loading areas.
   3. In non-traffic areas concrete or HDPE can be used.

D. Joint Sealant
   1. Provide a pre-formed or trowelable bitumastic sealant in an extrudable or flat tape form.
   2. Provide sealant that is not dependant on a chemical action for its adhesive properties or cohesive strength.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Grade Rings

1. Place as shown in the water and sanitary sewer City Standard Details.

2. Clean surfaces of dirt, sand, mud or other foreign matter before placing sealant.

3. Seal each grade ring with sealant specified in this Specification and as shown on the City Standard Details.

B. Frame and Cover

1. Water

   a. For water structures install frame, cover and grade rings in accordance with applicable City Standard Detail.

2. Sanitary Sewer

   a. For sanitary sewer structures install frame, cover and grade rings in accordance with applicable City Standard Detail.

3. Storm Drain

   a. For storm drain structures install frame, cover and grade rings in accordance with applicable City Standard Detail.

4. Hinge Cover

   a. Provide hinge cover on elevated manholes, junction boxes, in the flood plain and where specified on the Drawings.

C. Joint Sealing

1. Seal frame, grade rings and structure with specified sealant.

D. Concrete Collar

1. Provide concrete collar around all frame and cover assemblies.
3.5 REPAIR / RESTORATION [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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SECTION 33 05 14
ADJUSTING MANHOLES, INLETS, VALVE BOXES, AND OTHER STRUCTURES TO GRADE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vertical adjustments to manholes, drop inlets, valve boxes, cathodic protection test stations and other miscellaneous structures to a new grade

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 05 10 – Utility Trench Excavation, Embedment and Backfill
   4. Section 33 05 13 – Frame, Cover and Grade Rings
   5. Section 33 39 10 – Cast-in-Place Concrete Manholes
   6. Section 33 39 20 – Precast Concrete Manholes
   7. Section 33 12 20 – Resilient Seated Gate Valve
   8. Section 33 12 21 – AWWA Rubber-Seated Butterfly Valve
   9. Section 33 04 11 – Corrosion Control Test Station
  10. Section 33 04 12 – Magnesium Anode Cathodic Protection

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Manhole – Minor Adjustment
      a. Measurement
         1) Measurement for this Item shall be per each adjustment using only grade rings or other minor adjustment devices to a grade specified on the Drawings.
      b. Payment
         1) The work performed and the materials furnished in accordance with this Item will be paid for at the unit price bid per each “Manhole Adjustment, Minor” completed.
      c. The price bid shall include:
         1) Pavement removal
         2) Excavation
         3) Hauling
         4) Disposal of excess material
         5) Grade rings or other adjustment device
         6) Furnishing, placing and compaction of embedment and backfill
7) Clean-up

2. Manhole - Major Adjustment
   a. Measurement
      1) Measurement for this Item shall be per each adjustment requiring structural
         modifications to manhole to a grade specified on the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item will be paid for at the unit price bid per each “Manhole Adjustment,
         Major” completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Structural modifications, grade rings or other adjustment device
      6) Furnishing, placing and compaction of embedment and backfill
      7) Clean-up

3. Inlet
   a. Measurement
      1) Measurement for this Item shall be per each adjustment requiring structural
         modifications to inlet to a grade specified on the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item will be paid for at the unit price bid per each “Inlet Adjustment”
         completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Structural modifications
      6) Furnishing, placing and compaction of embedment and backfill
      7) Clean-up

4. Valve Box
   a. Measurement
      1) Measurement for this Item shall be per each adjustment to a grade specified
         on the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item will be paid for at the unit price bid per each “Valve Box Adjustment”
         completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Adjustment device
      6) Furnishing, placing and compaction of embedment and backfill
      7) Clean-up
5. Cathodic Protection Test Station
   a. Measurement
      1) Measurement for this Item shall be per each adjustment to a grade specified on the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item will be paid for at the unit price bid per each “Cathodic Protection Test Station Adjustment” completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Adjustment device
      6) Furnishing, placing and compaction of embedment and backfill
      7) Clean-up

6. Fire Hydrant
   a. Measurement
      1) Measurement for this Item shall be per each adjustment requiring stem extensions to meet a grade specified by the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item will be paid for at the unit price bid per each “Fire Hydrant Stem Extension” completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Adjustment materials
      6) Furnishing, placing and compaction of embedment and backfill
      7) Clean-up

7. Miscellaneous Structure
   a. Measurement
      1) Measurement for this Item shall be per each adjustment requiring structural modifications to said structure to a grade specified on the Drawings.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item will be paid for at the unit price bid per each “Miscellaneous Structure Adjustment” completed.
   c. The price bid shall include:
      1) Pavement removal
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Structural modifications
      6) Furnishing, placing and compaction of embedment and backfill
   d. Clean-up
1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. Texas Commission on Environmental Quality (TCEQ):

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Cast-in-Place Concrete
   1. See Section 03 30 00.

B. Modifications to Existing Concrete Structures
   1. See Section 03 80 00.

C. Grade Rings
   1. See Section 33 05 13.

D. Frame and Cover
   1. See Section 33 05 13.

E. Backfill material
   1. See Section 33 05 10.

F. Water valve box extension
   1. See Section 33 12 20.

G. Corrosion Protection Test Station
   1. See Section 33 04 11.
H. Cast-in-Place Concrete Manholes
   1. See Section 33 39 10.
I. Precast Concrete Manholes
   1. See Section 33 39 20.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION
   A. Verification of Conditions
      1. Examine existing structure to be adjusted, for damage or defects that may affect
         grade adjustment.
        a. Report issue to City for consideration before beginning adjustment.

3.3 PREPARATION
   A. Grade Verification
      1. On major adjustments confirm any grade change noted on Drawings is consistent
         with field measurements.
        a. If not, coordinate with City to verify final grade before beginning adjustment.

3.4 ADJUSTMENT
   A. Manholes, Inlets, and Miscellaneous Structures
      1. On any sanitary sewer adjustment replace 24-inch frame and cover assembly with
         30-inch frame and cover assembly per TCEQ requirement.
      2. On manhole major adjustments, inlets and miscellaneous structures protect the
         bottom using wood forms shaped to fit so that no debris blocks the invert or the
         inlet or outlet piping in during adjustments.
        a. Do not use any more than a 2-piece bottom.
      3. Do not extend chimney portion of the manhole beyond 24 inches.
      4. Use the least number of grade rings necessary to meet required grade.
        a. For example, if a 1-foot adjustment is required, use 2 6-inch rings, not 6 2-inch
           rings.
   B. Valve Boxes
      1. Utilize typical 3 piece adjustable valve box for adjusting to final grade as shown on
         the Drawings.
   C. Backfill and Grading
      1. Backfill area of excavation surrounding each adjustment in accordance to Section
         33 05 10.
3.5 REPAIR / RESTORATION [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

### Revision Log

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SECTION 33 05 24  
INSTALLATION OF CARRIER PIPE IN CASING OR TUNNEL LINER PLATE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Requirements for the installation of carrier pipe into steel casings or tunnel liner plate at locations shown on the Drawings

B. Deviations from this City of Fort Worth Standard Specification
1. None.

C. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. Section 33 01 30 – Sewer and Manhole Testing

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Installation of Sanitary Sewer Carrier Pipe in Casing/Tunnel Liner Plate
   a. Measurement
      1) Measured horizontally along the surface from centerline to centerline of the beginning of the casing/liner to the end of the casing/liner
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot for “Sewer Carrier Pipe” complete in place for:
         a) Various Sizes
         b) The price bid shall include:
            1) Furnishing and installing Sanitary Sewer Main (Pipe) in Casing/Tunnel Liner Plate as specified by the Drawings
   2) Mobilization

A. Installation of Water Carrier Pipe in Casing/Tunnel Liner Plate
   a. Measurement
      1) Measured horizontally along the surface from centerline to centerline of the beginning of the casing/liner to the end of the casing/liner
   b. Payment
1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot for “Water Carrier Pipe” complete in place for:
   a) Various Sizes
   c. The price bid shall include:
      1) Furnishing and installing Water Main (Pipe) in Casing/Tunnel Liner Plate as specified by the Drawings
      2) Mobilization
      3) Grout
      4) Joint restraint
      5) Casing Spacers
      6) End seals
      7) Excavation
      8) Hauling
      9) Disposal of excess material
     10) Clean-up

1.3 REFERENCES

A. Definitions
   1. Carrier Pipe: Permanent pipe for operational use that is used to convey flows
   2. Casing: A steel pipe or tunnel liner installed by trenchless methods that supports the ground and provides a stable underground excavation for installation of the carrier pipe

B. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   3. International Organization for Standardization (ISO):
      a. 9001, Quality Management Systems - Requirements.
   4. Occupational Safety and Health Administration (OSHA)

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
1. Casing Isolators/Spacers
   a. Material Data

2. Grout Mix
   a. Material Data

B. Shop Drawings
1. Required for 24-inch and larger pipe installations
2. Submit Work Plan describing the carrier pipe installation equipment, materials and construction methods to be employed.
3. Casing Spacers/Isolators
   a. Detail drawings and manufacturer’s information for the casing isolators/spacers that will be used.
      1) Include dimension and component materials and documentation of manufacturer’s ISO 9001:2000 certification.
   b. Alternatives to casing spacers/isolators may be allowed by the City on a case-by-case basis.
   c. For consideration of alternate method, submit a detailed description of method including details.
4. End seal or bulkhead designs and locations for casing/liners.
5. Annular Space (between casing pipe and casing/tunnel liner plate) Grouting Work Plan and Methods including:
   a. Grouting methods
   b. Details of equipment
      c. Grouting procedures and sequences including:
         1) Injection methods
         2) Injection pressures
         3) Monitoring and recording equipment
         4) Pressure gauge calibration data
         5) Materials
   d. Grout mix details including:
      1) Proportions
      2) Admixtures including:
         a) Manufacturer’s literature
         b) Laboratory test data verifying the strength of the proposed grout mix
         c) Proposed grout densities
         d) Viscosity
         e) Initial set time of grout
            (1) Data for these requirements shall be derived from trial batches from an approved testing laboratory.
   e. Submit a minimum of 3 other similar projects where the proposed grout mix design was used.
   f. Submit anticipated volumes of grout to be pumped for each application and reach grouted.
   g. For pipe installations greater than 36-inches, without hold down jacks or a restrained spacer, provide buoyant force calculations during grouting and measures to prevent flotation.
      1) Calculations sealed by a licensed Engineer in the State of Texas.
   h. Description of methods and devices to prevent buckling of carrier pipe during grouting of annular space, if required
1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Certifications


1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers

1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.

   a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

3. The Casing Spacers/Isolators shall be new and the product of a manufacturer regularly engaged in the manufacturing of casing spacers/isolators.

B. Design Criteria and Materials

1. Carrier pipe shall be installed within the horizontal and vertical tolerances as indicated in PART 3 of this Specification, incorporating all support/insulator dimensions required.

   Diameter | Material | Specification Reference |
   -------- | -------- | ------------------------ |
   Water Line
   8-12    | DIP (Restrained) | 33 11 10 |
   16-20   | DIP (Restrained) | 33 11 10 |
           | AWWA C303 (Restrained) | 33 11 13 |
   24 and greater
   24 and greater | DIP (Restrained) | 33 11 10 |
   | AWWA C303 (Restrained) | 33 11 13 |
   | AWWA C301 (Restrained) | 33 11 15 |
   Waste Water Line
   8-15    | DIP (with Ceramic Epoxy) PVC SDR 26 | 33 11 10 |
           | | 33 31 20 |
   18 and greater
   18 and greater | DIP (with Ceramic Epoxy) Fiberglass | 33 11 10 |
           | | 33 31 13 |

2. Grout of annular space

   a. For gravity sewer carrier pipe installation:
1) Fill all voids between the carrier pipe and the casing or liner with grout.
2) All exterior carrier pipe surfaces and all interior casing or liner surfaces shall be in contact with the grout.

b. For water line installation:
1) No annular space fill will be used.

3. Grout Mixes
a. Low Density Cellular Grout (LDCC)
   1) Annular space (between sewer carrier pipe and casing/liner) grout shall be LDCC.
   2) The LDCC shall be portland cement based grout mix with the addition of a foaming agent designed for this application.
   3) Develop 1 or more grout mixes designed to completely fill the annular space based on the following requirements:
      a) Provide adequate retardation to completely fill the annular space in 1 monolithic pour.
      b) Provide less than 1 percent shrinkage by volume.
      c) Compressive Strength
         (1) Minimum strength of 10 psi in 24 hours, 300 psi in 28 days
         d) Design grout mix with the proper density and use proper methods to prevent floating of the carrier pipe.
         e) Proportion grout to flow and to completely fill all voids between the carrier pipe and the casing or liner.

4. End Seals
a. Provide end seals at each end of the casing or liner to contain the grout backfill or to close the casing/liner ends to prevent the inflow of water or soil.
   1) For water piping less than 24-inch diameter, use hard rubber seals, Model PL Link Seal as manufactured by the Thunderline Corporation or approved equal.
   2) For water piping 24-inch diameter and greater, use pull-on, 1/8 inch thick, synthetic rubber end seals, Model C, as manufactured by Pipeline Seal and Insulator, Inc. or approved equal.
   3) For sewer piping, no end seals are required since the annular space between the carrier pipe and the casing will be grouted.

b. Design end seals to withstand the anticipated soil or grouting pressure and be watertight to prevent groundwater from entering the casing.

5. Casing Spacers/Insulators
a. Provide casing spacers/insulators to support the carrier pipe during installation and grouting (where grout is used).

b. Casing Spacers/Insulators material and properties:
   1) Shall be minimum 14 gage
   2) For water pipe, utilize Stainless Steel.
   3) For sewer pipe, utilize Coated Steel.
   4) Suitable for supporting weight of carrier pipe without deformation or collapse during installation

c. Provide restrained-style casing spacers to hold all pipes stable during grouting operations and prevent floating or movement.

d. Provide dielectric strength sufficient to electrically isolate each component from one another and from the casing.

e. Design risers for appropriate loads, and, as a minimum:
1) Provide 10 gage steel risers
   a) Provide stainless steel bands and risers for water installations.

f. Band material and criteria
1) Provide polyvinyl chloride inner liner with:
   a) Minimum thickness of 0.09 inches
   b) Durometer “A” of 85-90 hardness
   c) Minimum dielectric strength of 58,000 volts

g. Runner material and criteria
1) Provide pressure-molded glass reinforced polymer or UHMW with:
   a) Minimum of 2 inches in width and a minimum of 11 inches in length.
2) Attach to the band or riser with 3/8 inch minimum welded steel or stainless
   steel studs.
3) Runner studs and nuts shall be recessed well below the wearing surface of
   the runner
   a) File recess with a corrosion inhibiting filler.

h. Riser height
1) Provide sufficient height with attached runner allow a minimum clearance
   of 2 inches between the outside of carrier pipe bells or couplings and the
   inside of the casing liner surface.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
1. Carrier pipe installation shall not begin until the following tasks have been
   completed:
   a. All required submittals have been provided, reviewed and accepted.
   b. All casing/liner joints are watertight and no water is entering casing or liner
      from any sources.
   c. All contact grouting is complete.
   d. Casing/liner alignment record drawings have been submitted and accepted by
      City to document deviations due to casing/liner installation.
   e. Site safety representative has prepared a code of safe practices and an
      emergency plan in accordance with applicable requirements.

2. The carrier pipe shall be installed within the casings or liners between the limits
   indicated on the Drawings, to the specified lines and grades and utilizing methods
   which include due regard for safety of workers, adjacent structures and
   improvements, utilities and the public.

B. Control of Line and Grade
1. Install Carrier pipe inside the steel casing within the following tolerances:
   a. Horizontal
      1) ± 2 inches from design line
   b. Vertical
      1) ±1 inch from design grade
2. Check line and grade set up prior to beginning carrier pipe installation.
4. The Contractor is fully responsible for the accuracy of the installation and the correction of it, as required.
   a. Where the carrier pipe installation does not satisfy the specified tolerances, correct the installation, including if necessary, redesign of the pipe or structures at no additional cost to City.

C. Installation of Carrier Pipe
   1. Pipe Installation
      a. Remove all loose soil from casing or liner.
      b. Grind smooth all rough welds at casing joints.
   2. Installation of Casing Spacers
      a. Provide casing spacers, insulators or other approved devices to prevent flotation, movement or damage to the pipe during installation and grout backfill placement.
      b. Assemble and securely fasten casing spacers to the pipeline to be installed in casings or tunnels.
      c. Correctly assemble, evenly tighten and prevent damage during tightening of the insulators and pipe insertion.
      d. Install spacers in accordance with manufacturer’s recommendations.
      e. Install carrier pipe so that there is no metallic contact between the carrier pipe and the casing.
      f. Carrier pipe shall be installed without sliding or dragging it on the ground or in the casing/liner in a manner that could damage the pipe or coatings.
         1) If guide rails are allowed, place cement mortar on both sides of the rails.
      g. Coat the casing spacer runners with a non-corrosive/environmentally safe lubricant to minimize friction when installing the carrier pipe.
      h. The carrier pipe shall be electrically isolated from the carrier pipe and from the casing.
      i. Grade the bottom of the trench adjacent to each end of the casing to provide a firm, uniform and continuous support for the pipe. If the trench requires some backfill to establish the final trench bottom grade, place the backfill material in 6-inch lifts and compact each layer.
      j. After the casing or tunnel liner has been placed, pump dry and maintain dry until the casing spacers and end seals are installed.
   3. Insulator Spacing
      a. Maximum distance between spacers is to be 6 feet.
      b. For ductile-iron pipe, flanged pipe or bell and spigot pipe, install spacers within 1 foot on each side of the bell or flange and 1 in the center of the joint where 18 foot or 20 foot long joints are used.
      c. If the casing or pipe is angled or bent, reduce the spacing.
d. The end spacer must be within 6 inches of the end of the casing pipe, regardless of size of casing and pipe or type of spacer used.
e. Install spacers on PVC pipe at the insertion line to prevent over-insertion of the spigot into the bell.

4. After installation of the carrier pipe:
   a. Mortar inside and outside of the joints, as applicable
   b. Verify electrical discontinuity between the water carrier pipe and tunnel liner.
      1) If continuity exists, remedy the short, by all means necessary including removing and reinstalling the carrier pipe, prior to applying cellular grout.
   c. If hold down jacks or casing spacers are used, seal or plug the ends of the casing.
   d. If steel pipe is used and not welded prior to installation in casing/liner, welding of pipe will only be allowed after grouting of annular space is complete.

D. Installation of End Seals
   1. For Water Pipes
      a. Grout end of casing/liner a minimum of 6 inches and a maximum of 12 inches.
      b. Place pull-on synthetic rubber end seals on the pipe and pull over the end of the casing. Securely fasten with stainless steel bands.

   2. For Sewer Pipes
      a. Grout annular space between carrier pipe and casing as indicated in this Specification.

E. Annular Space Grouting (For Sewer Only)
   1. Prepare pipe as necessary to prevent the pipe from floating during grouting operation as necessary.

   2. Mixing of Grout
      a. Mix material in equipment of sufficient size to provide the desired amount of grout material for each stage in a single operation.
         1) The equipment shall be capable of mixing the grout at the required densities for the approved procedure and shall be capable of changing the densities as required by field conditions.

   3. Backfill Annular Space with Grout
      a. Prior to filling of the annular space, test the carrier pipe in accordance with Section 33 01 30.
      b. Verify the maximum allowable pressure with the carrier pipe manufacturer and do not exceed this pressure.
      c. After the installation of the carrier pipe, the remaining space (all voids) between the casing/liner and the carrier shall be filled with LDCC grout.
         1) All surfaces of the exterior carrier pipe wall and casing/liner interior shall be in contact with the grout.
         2) Grout shall be pumped through a pipe or hose.
         3) Use grout pipes, or other appropriate materials, to avoid damage to carrier pipe during grouting.

   4. Injection of LDCC Grout
      a. Grout injection pressure shall not exceed the carrier pipe manufacturer’s approved recommendations or 5 psi (whichever is lower).
      b. Pumping equipment shall be of a size sufficient to inject grout at a volume, velocity and pressure compatible with the size/volume of the annular space.
c. Once grouting operations begin, grouting shall proceed uninterrupted, unless
grouting procedures require multiple stages.
d. Grout placements shall not be terminated until the estimated annular volume of
grout has been injected.
5. Block the carrier pipe during grouting to prevent flotation during grout installation.
6. Protect and preserve the interior surfaces of the casing from damage.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

A. Reports and Records required for pipe installations greater than 48-inches and longer
than 350 feet
1. Maintain and submit daily logs of grouting operations.
   a. Include:
      1) Grouting locations
      2) Pressures
      3) Volumes
      4) Grout mix pumped
      5) Time of pumping
   2. Note any problems or unusual observations on logs.

B. Grout Strength Tests
1. City will perform testing for 24-hour and 28-day compressive strength tests for the
cylinder molds or grout cubes obtained during grouting operations.
2. City will perform field sampling during annular space grouting.
   a. City will collect at least 1 set of 4 cylinder molds or grout cubes for each 100
cubic yards of grout injected but not less than 1 set for each grouting shift.
   b. City will perform 24-hour and 28-day compressive strength tests per ASTM
      C39 (cylindrical specimens) or ASTM C109 (cube specimens).
   c. Remaining samples shall be tested as directed by City.

C. Safety
1. The Contractor is responsible for safety on the job site.
   a. Perform all Work in accordance with the current applicable regulations of the
      Federal, State and local agencies.
   b. In the event of conflict, comply with the more restrictive applicable
      requirement.
2. No gasoline powered equipment shall be permitted in jacking shafts and receiving
   shafts/pits.
   a. Diesel, electrical, hydraulic and air powered equipment is acceptable, subject to
      applicable local, State and Federal regulations.
3. Methods of construction shall be such as to ensure the safety of the Work,
   Contractor's and other employees on site and the public.
4. Furnish and operate a temporary ventilation system in accordance with applicable
   safety requirements when personnel are underground.
   a. Perform all required air and gas monitoring.
b. Ventilation system shall provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in all underground work areas.

5. Perform all Work in accordance with all current applicable regulations and safety requirements of the federal, state and local agencies.
   b. In the event of conflict, comply with the more stringent requirements.

6. If personnel will enter the pipe during construction, the Contractor shall develop an emergency response plan for rescuing personnel trapped underground in a shaft excavation or pipe.
   a. Keep on-site all equipment required for emergency response in accordance with the agency having jurisdiction

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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**Revision Log**

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CITY OF FORT WORTH
STANDARD CONSTRUCTION SPECIFICATION DOCUMENTS
Revised July 1, 2011
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Buried and surface utility markers for utility construction

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. Measurement for this Item will be by lump sum.
   2. Payment
      a. The work performed and materials furnished in accordance with this Item will be paid for at the lump sum price bid for “Utility Markers”.
   3. The price bid shall include:
      a. Furnishing and installing Utility Markers as specified by the Drawings
      b. Mobilization
      c. Pavement removal
      d. Excavation
      e. Hauling
      f. Disposal of excess material
      g. Furnishing, placement and compaction of backfill
      h. Clean-up

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. American Public Works Association (AWPA):
      a. Uniform Color Code.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Buried Marker
   2. Surface Marker

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
   1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.
      a. The manufacturer must comply with this Specification and related Sections.
   2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.
   3. Provide new Utility Markers/Locators from a manufacturer regularly engaged in the manufacturing of Utility Markers/Locators.

B. Materials
   1. Buried Markers
      a. Detectable warning tape shall be as follows:
         1) 5.0 mil overall thickness
         2) Width – 3 inch minimum
         3) Weight – 27.5 pounds per inch per 1,000 square feet
         4) Triple Layer with:
            a) Minimum thickness 0.35 mils solid aluminum foil encased in a protective inert plastic jacket
               (1) 100 percent virgin low density polyethylene
               (2) Impervious to all known alkalis, acids, chemical reagents and solvents within soil
               (3) Aluminum foil visible to both sides
            5) Locatable by conductive and inductive methods
            6) Printing encased to avoid ink rub-off
            7) Color and Legends
               a) Potable water lines
(1) Color – Blue (in accordance with APWA Uniform Color Code)
(2) Legend – Caution Potable Water Line Below (repeated every 24 inches)
b) Reclaimed water lines
   (1) Color – Purple (in accordance with APWA Uniform Color Code)
   (2) Legend – Caution Reclaimed Water Line Below (repeated every 24 inches)
c) Sewer Line
   (1) Color – Green (in accordance with APWA Uniform Color Code)
   (2) Legend – Caution Sewer Line Below (repeated every 24 inches)
b. Electronic utility marker balls shall be as follows:
   1) Sealed shell containing a passive antenna – low-frequency resonance circuit tuned to specific frequency
   2) Size – 4.5-inch diameter
   3) Range – 5 feet minimum
   4) Field Type/Shape – Spherical
   5) Material – high-density polyethylene
   6) Color and Frequency
      a) Water Lines
         (1) Color – Blue (in accordance with APWA Uniform Color Code)
         (2) Frequency – 145.7 kHz
      b) Sewer Line Markers
         (1) Color – Green (in accordance with APWA Uniform Color Code)
         (2) Frequency – 121.6 kHz

2. Surface Markers
   a. Provide as follows:
      1) 4-inch diameter, 6-feet minimum length, polyethylene posts, or equal
      2) White posts with colored, ultraviolet resistant domes as follows:
         a) Water Lines
            (1) Color – Blue (in accordance with APWA Uniform Color Code)
            (2) Legend – Caution Potable Water Line Below
         b) Reclaimed water lines
            (1) Color – Purple (in accordance with APWA Uniform Color Code)
            (2) Legend – Caution Reclaimed Water Line Below
         c) Sewer lines
            (1) Color – Green (in accordance with APWA Uniform Color Code)
            (2) Legend – Caution Sewer Line Below
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Buried Markers

1. Detectable Warning Tape

a. Install in accordance with manufacturer’s recommendations below natural ground surface and directly above the utility for which it is marking.

1) Allow 18 inches minimum between utility and marker.

2) Bury to a depth of 3 feet or as close to the grade as is practical for optimum protection and detectability.

2. Electronic Marker Balls

a. Install in accordance with manufacturer’s recommendations below natural ground surface and directly above the utility for which it is marking.

1) Allow 4 inches minimum between utility and marker.

2) Bury to a depth of 5 feet maximum, or as close to the grade as is practical for optimum protection and detectability.

3) Allow at least 6 feet between each marker.

b. Use tie-downs for placement of markers if deemed necessary by the City, or Engineer.

c. Upon completion of installation, the City will inspect that electronic marker balls are installed in place, prior to paving over any of the required locations.

d. See table below for other details related to marker ball installation:
<table>
<thead>
<tr>
<th>Marker Ball Clearance, Spacing, Bury and Placement</th>
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<tbody>
<tr>
<td><strong>16-inch and Larger Water Lines</strong></td>
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<td><strong>Clearance between Utility and Marker</strong></td>
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<td><strong>Maximum Bury Depth</strong></td>
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<td><strong>Minimum Spacing</strong></td>
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B. Surface Markers

1. Bury a minimum of 2 feet deep, with a minimum of 4 feet above ground
2. The warning sign for all surface markers shall be 21 inches (not including post cap).
3. Where possible, place surface markers near fixed objects.
4. Place Surface Markers at the following locations:
   a. Buried Features
      1) Place directly above a buried feature.
   b. Above-Ground Features
      1) Place a maximum of 2 feet away from an above-ground feature.
   c. Water lines 16-inches and larger
      1) Each right-of-way line (or end of casing pipe) for:
         a) Highway crossings
         b) Railroad crossings
      2) Utility crossings such as:
         a) High pressure or large diameter gas lines
         b) Fiber optic lines
         c) Underground electric transmission lines
         d) Or other locations shown on the Drawings, or directed by the City
   d. Surface markers not required for 12-inch and smaller water lines
   e. For sanitary sewer lines:
1) In undeveloped areas, place marker maximum of 2 feet away from an
above-ground feature such as a manhole or combination air valve vault.
2) Place at 500-foot intervals along the pipeline.

3.5 REPAIR / RESTORATION [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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SECTION 33 05 30
EXPLORATORY EXCAVATION FOR EXISTING UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Locating and verifying the location and elevation of the existing underground utilities that may conflict with a facility proposed for construction

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 05 10 – Utility Trench Excavation, Embedment and Backfill

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Measurement
      a. Measurement for this Item shall be per each excavation performed as identified in the Drawings, or as directed.

   2. Payment:
      a. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per each “Exploratory Excavation of Existing Utilities” of the type specified.

   3. The price bid shall include:
      a. Grade survey
      b. Pavement removal
      c. Excavation
      d. Hauling
      e. Disposal of excess material
      f. Furnishing, placing and compaction of embedment
      g. Furnishing, placing and compaction of backfill
      h. Clean-up
      i. Surface restoration

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination
1. Coordinate with City Inspector at least 48 hours prior to commencing on site for Exploratory Excavation of Existing Utilities.
2. Coordinate location of all other existing utilities within vicinity of excavation prior to commencing Exploratory Excavation.
3. Coordinate staking of Exploratory Excavations with City at least 1 week prior to commencement.

B. Sequencing
1. Exploratory Excavations shall be conducted prior to the construction of the entire project.

C. Scheduling
1. For critical utility locations, the City may choose to be present during excavation.
2. Alter schedule for Exploratory Excavation of Existing Utilities to accommodate City personnel.

1.5 SUBMITTALS [NOT USED]

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS

A. Report of Utility Location
1. Horizontal location of utility as surveyed
2. Vertical elevation of utility as surveyed
   a. Top of utility
   b. Spring line of utility
   c. Existing ground
3. Material type, diameter and description of the condition of existing utility

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]
PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Verification of Conditions
   1. Verify location of existing utilities in accordance with the General Requirements, the General Notes and the Drawings.

3.3 PREPARATION

A. Coordinate with City Survey, if applicable.

3.4 INSTALLATION

A. Verify location of existing utility at location denoted on the Drawings, or as directed by the City or Engineer.
   1. Expose utility to spring line, as necessary.
   2. Excavate and Backfill Trench for the Exploratory Excavation in accordance with Section 33 05 10.

B. Upon completion of the utility exploration, submit a report of the findings.

C. If location of utility is in conflict with the Drawings, notify the City Project Manager for appropriate design modifications.

D. Place embedment and backfill in accordance with Section 33 05 10.

E. Once necessary data is obtained, immediately restore surface to existing conditions to:
   1. Obtain a safe and proper driving surface, if applicable
   2. Ensure the safety of the general public
   3. The satisfaction of the City

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 33 11 10
DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile Iron Pipe 3-inch through 64-inch for potable water, wastewater and reuse applications

B. Deviations from this City of Fort Worth Standard Specification
   1. Subparagraph 1.2.A.1.b.1

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. 33 01 31 – Closed Circuit Television (CCTV) Inspection
   4. 33 04 40 – Cleaning and Acceptance Testing of Water Mains
   5. 33 05 10 – Utility Trench Excavation, Embedment and Backfill
   6. 33 05 24 – Installation of Carrier Pipe in Casing
   7. 33 11 11 – Ductile Iron Fittings

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Ductile Iron Pipe
      a. Measurement
         1) Measured horizontally along the surface from center line to center line of the fitting, manhole, or appurtenance
      b. Payment
         1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per linear foot for “DIP” or “Water Pipe” installed for:
            a) Various sizes
            b) Various types of backfill
            c) Various linings
            d) Various gaskets
            e) Various Depths, for miscellaneous projects only
            f) Various restraints
            g) Various uses
      c. The price bid shall include:
         1) Furnishing and installing Ductile Iron Pipe with joints as specified by the Drawings
         2) Mobilization
         3) Polyethylene encasement
1. Lining
2. Pavement removal
3. Excavation
4. Hauling
5. Disposal of excess material
6. Furnishing, placement and compaction of embedment
7. Furnishing, placement and compaction of backfill
8. Trench Water Stop
9. Thrust restraint, if required in Contract Documents
10. Bolts and nuts
11. Gaskets
12. Clean-up
13. Cleaning
14. Disinfection
15. Testing

2. Hydrocarbon Resistant Gaskets
   a. Measurement
      1) Measurement for this Item shall be by lump sum.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item shall be paid for at the lump sum price for “Hydrocarbon Resistant Gaskets”.

1.3 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.


3. American Society of Mechanical Engineers (ASME):

4. ASTM International (ASTM):
   c. A674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

5. American Water Works Association (AWWA):
   c. M41, Ductile-Iron Pipe and Fittings.

   Threaded Flanges.
7. C600, Installation of Ductile-Iron Water Mains and their Appurtenances
8. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
9. Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer or the City prior to delivery and/or
   fabrication for specials.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Interior lining
      a. If it is other than cement mortar lining in accordance with AWWA/ANSI
      C104/A21.4, including:
         1) Material
         2) Application recommendations
         3) Field touch-up procedures

   2. Thrust Restraint
      a. Retainer glands, thrust harnesses or any other means

   3. Gaskets
      a. If hydrocarbon or other special gaskets are required

B. Shop Drawings – Furnish for Ductile Iron Pipe used in the water distribution system or
   for a wastewater force main for 24-inch and greater diameters, including:

   1. Wall thickness design calculations sealed by a Licensed Professional Engineer in
      Texas including:
      a. Working pressure
      b. Surge pressure
      c. Deflection

   2. Provide thrust restraint calculations for all fittings and valves, sealed by a Licensed
      Professional Engineer in Texas, to verify the restraint lengths shown in the
      Drawings.

   3. Lay schedule/drawing for 24-inch and greater diameters, sealed by a Licensed
      Professional Engineer in Texas including:
      a. Pipe class
      b. Joints type
c. Fittings

d. Stationing

e. Transitions

f. Joint deflection

C. Certificates

1. Furnish an affidavit certifying that all Ductile Iron Pipe meets the provisions of this Section, each run of pipe furnished has met Specifications, all inspections have been made, and that all tests have been performed in accordance with AWWA/ANSI C151/A21.51.

2. Furnish a certificate stating that buried bolts and nuts conform to ASTM B117.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers

a. Finished pipe shall be the product of 1 manufacturer.

1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.

b. Pipe manufacturing operations (pipe, lining, and coatings) shall be performed under the control of the manufacturer.

c. Ductile Iron Pipe

1) Manufactured in accordance with AWWA/ANSI C151/A21.51

a) Perform quality control tests and maintain results as outlined within standard to assure compliance.

2) Subject each pipe to a hydrostatic test of not less than 500 psi for duration of at least 10 seconds.

B. Preconstruction Testing

1. The City may, at its own cost, subject random lengths of pipe for testing by an independent laboratory for compliance with this Specification.

a. The compliance test shall be performed in the United States.

b. Any visible defects or failure to meet the quality standards herein will be grounds for rejecting the entire order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Ductile Iron Pipe shall be stored and handled in accordance with the guidelines as stated in AWWA M41.

2. Secure and maintain a location to store the material in accordance with Section 01 66 00.
1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Manufacturers
1. Only the manufacturers as listed in the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.
2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Pipe
1. Pipe shall be in accordance with AWWA/ANSI C111/A21.11, AWWA/ANSI C150/A21.15, and AWWA/ANSI C151/A21.51.
2. All pipe shall meet the requirements of NSF 61.
3. Pipe shall have a lay length of 18 feet or 20 feet except for special fittings or closure pieces and necessary to comply with the Drawings.
4. As a minimum the following pressures classes apply. The Drawings may specify a higher pressure class or the pressure and deflection design criteria may also require a higher pressure class, but in no case should they be less than the following:

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Min Pressure Class (psi)</th>
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<tr>
<td>3 through 12</td>
<td>350</td>
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<tr>
<td>14 through 20</td>
<td>250</td>
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<tr>
<td>24</td>
<td>200</td>
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<tr>
<td>30 through 64</td>
<td>150</td>
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5. Pipe markings shall meet the minimum requirements of AWWA/ANSI C151/A21.51. Minimum pipe markings shall be as follows:
   a. “DI” or “Ductile” shall be clearly labeled on each pipe
   b. Weight, pressure class and nominal thickness of each pipe
   c. Year and country pipe was cast
   d. Manufacturer’s mark

6. Pressure and Deflection Design
   a. Pipe design shall be based on trench conditions and design pressure class specified in the Drawings.
   b. Pipe shall be designed according to the methods indicated in AWWA/ANSI C150/A21.50, AWWA/ANSI C151/A21.51, and AWWA M41 for trench construction, using the following parameters:
      1) Unit Weight of Fill (w) = 130 pcf
2) Live Load = AASHTO HS 20
3) Trench Depth = 12 feet minimum, or as indicated in Drawings
4) Bedding Conditions = Type 4
5) Working Pressure \( (P_w) = 150 \text{ psi} \)
6) Surge Allowance \( (P_s) = 100 \text{ psi} \)
7) Design Internal Pressure \( (P_i) = P_w + P_s \) or 2:1 safety factor of the actual working pressure plus the actual surge pressure, whichever is greater.
   a) Test Pressure =
      (1) No less than 1.25 minimum times the stated working pressure (187 psi minimum) of the pipeline measured at the highest elevation along the test section.
      (2) No less than 1.5 times the stated working pressure (225 psi minimum) at the lowest elevation of the test section.
8) Maximum Calculated Deflection \( (D_c) = 3 \text{ percent} \)
9) Restrainted Joint Safety Factor \( (S_r) = 15 \text{ percent} \)
c. Trench depths shall be verified after existing utilities are located.
   1) Vertical alignment changes required because of existing utility or other conflicts shall be accommodated by an appropriate change in pipe design depth.
   2) In no case shall pipe be installed deeper than its design allows.
7. Provisions for Thrust
   a. Thrust at bends, tees, plugs or other fittings shall be mechanically restrained joints when required by the Drawings.
   b. Thrust at bends adjacent to casing pipe shall be restrained by mechanical means through casing and for a sufficient distance each side of casing.
   c. No thrust restraint contribution shall be allowed for the restrained length of pipe within the casing.
   d. Restrainted joints, when required, shall be used for a sufficient distance from each side of the bend, tee, plug, valve or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purpose of thrust, the following shall apply:
      1) Valves shall be calculated as dead ends.
      2) Design pressure shall be greater than the working pressure of the pipe or the internal pressure \( (P_i) \) whichever is greater.
      3) Restained joints shall consist of approved mechanical restrained or push-on restrained joints as listed in the City’s Standard Products List as shown in Section 01 60 00.
   c. The Pipe Manufacturer shall verify the length of pipe with restrained joints to resist thrust in accordance with the Drawings, AWWA M41, and the following:
      1) The weight of earth \( (W_e) \) shall be calculated as the weight of the projected soil prism above the pipe, for unsaturated soil conditions.
      2) Soil density = 130 pcf (maximum value to be used), for unsaturated soil conditions
      3) If indicated on the Drawings and the Geotechnical Borings that ground water is expected, account for reduced soil density.
8. Joints
   a. General – Comply with AWWA/ANSI C111/A21.11.
   b. Push-On Joints
c. Mechanical Joints

d. Push-On Restrained Joints
  1) Restraining Push-on joints by means of a special gasket
     a) Only those products that are listed in Section 01 60 00
     b) The working pressure rating of the restrained gasket must exceed the
        test pressure of the pipe line to be installed.
     c) Approved for use of restraining Ductile Iron Pipe in casing with a
        carrier pipe of 4-inches to 12-inches
     d) Otherwise only approved if specially listed on the Drawings
  2) Push-on Restrained Joint bell and spigot
     a) Only those products list in the standard products list will be allowed for
        the size listed in the standard products list per Section 01 60 00.
     b) Pressure rating shall exceed the working and test pressure of the pipe
        line.

e. Flanged Joints – AWWA/ANSI C115/A21.15, ASME B16.1, Class 125

f. Flange bolt circles and bolt holes shall match those of ASME B16.1, Class 125.

g. Field fabricated flanges are prohibited.

9. Gaskets
   a. All rubber joint gaskets utilized on Ductile Iron Pipe shall be in conformance
      with AWWA/ANSI C111/A21.11.
   b. Flanged Gaskets
      1) Full face
      2) Manufactured true to shape from minimum 80 durometer SBR rubber stock
         of a thickness not less than 1/8 inch
      3) Virgin stock
      4) Conforming to the physical and test requirements specified in
         AWWA/ANSI C111/A21.11.
      5) Finished gaskets shall have holes punched by the manufacturer and shall
         match the flange pattern in every respect.
      6) Frayed cut edges resulting from job site gasket fabrication are not
         acceptable.
      7) Furnish Viton® Rubber gaskets hydrocarbon restraint gaskets, when
         required.
   c. Isolation Flanges
      1) Flanges required by the drawings to be Isolation Flanges shall conform to
         Section 3 04 10.

10. Bolts and Nuts
    a. Mechanical Joints
       1) High strength corrosion restraint low-carbon weathering steel in
          accordance with AWWA/ANSI C111/A21.11 and ASTM A242.
       2) Cor-Blue coated with FluoroKote #1, or equal
          a) Coating shall conform to the performance requirements of ASTM B117
             for up to 4000 hours and shall include, if required, a certificate of
             conformance.
    b. Flanged Ends
       1) Meet requirements of AWWA C115.
          a) For buried and non-buried applications, provide ASTM A193 Grade B7
             Bolts and ASTM 194 Grade 2H Nuts.
11. Flange Coatings
   a. Connections to Steel Flanges
      1) Coatings for buried flanges shall be Densyl Tape system manufactured by
         Carboline, consisting of Densyl Mastic, Densyl Paste, and Densyl Tape, or
         approved equal.

12. Ductile Iron Pipe Exterior Coatings
   a. All ductile iron shall have an asphaltic coating, minimum of 1 mil thick, on the
      pipe exterior, unless otherwise specified in the Contract Documents.

13. Polyethylene Encasement
   a. All buried Ductile Iron Pipe shall be polyethylene encased.
   b. Only manufacturers listed in the City’s Standard Products List as shown in
      Section 01 60 00 will be considered acceptable.
   c. Use only virgin polyethylene material.
   d. Encasement for buried pipe shall be 8 mil linear low density (LLD)
      polyethylene conforming to AWWA/ANSI C105/A21.5 or 4 mil high density
      cross-laminated (HDCL) polyethylene encasement conforming to
      AWWA/ANSI C105/A21.5 and ASTM A674.
   e. Marking: At a minimum of every 2 feet along its length, the mark the
      polyethylene film with the following information:
      1) Manufacturer’s name or trademark
      2) Year of manufacturer
      3) AWWA/ANSI C105/A21.5
      4) Minimum film thickness and material type
      5) Applicable range of nominal diameter sizes
      6) Warning – Corrosion Protection – Repair Any Damage
   f. Special Markings/Colors
      1) Reclaimed Water, perform one of the following:
         a) Label polyethylene encasement with “RECLAIMED WATER”,
         b) Provide purple polyethylene in accordance with the American Public
            Works Association Uniform Color Code; or
         c) Attach purple reclaimed water marker tape to the polyethylene wrap.
      2) Wastewater, perform one of the following:
         a) Label polyethylene encasement with “WASTEWATER”;
         b) Provide green polyethylene in accordance with the American Public
            Works Association Uniform Color Code; or
         c) Attach green sanitary sewer marker tape to the polyethylene wrap.
   g. Minimum widths

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14. Ductile Iron Pipe Interior Lining
   a. Cement Mortar Lining
      1) Ductile Iron Pipe for potable water shall have a cement mortar lining in accordance with AWWA/ANSI C104/A21.04 and be acceptable according to NSF 61.
   b. Ceramic Epoxy or Epoxy Linings
      1) Ductile Iron Pipe for use in wastewater applications shall be lined with a Ceramic Epoxy or Epoxy lining as designated in the City’s Standard Products List as shown in Section 01 60 00.
      2) Apply lining at a minimum of 40 mils DFT.
      3) Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using a Joint Compound as supplied by the manufacturer.
         a) Apply the joint compound by brush to ensure coverage.
         b) Care should be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot ends.
         c) Coat the gasket seat and spigot ends after the application of the lining.
      4) Surface preparation shall be in accordance with the manufacturer’s recommendations.
      5) Check thickness using a magnetic film thickness gauge in accordance with the method outlined in SSPC PA 2.
      6) Test the interior lining of all pipe barrels for pinholes with a non-destructive 2,500 volt test.
         a) Repair any defects prior to shipment.
      7) Mark each fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.
      8) For all Ductile Iron Pipe in wastewater service where the pipe has been cut, coat the exposed surface with the touch-up material as recommended by the manufacturer.
         a) The touch-up material and the lining shall be of the same manufacturer.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General

1. Install pipe, fittings, specials and appurtenances as specified herein, as specified in AWWA C600, AWWA M41 and in accordance with the pipe manufacturer’s recommendations.

2. See Section 33 11 11 for installation requirements for Ductile Iron Fittings.

3. Lay pipe to the lines and grades as indicated in the Drawings.

4. Excavate and backfill trenches in accordance with Section 33 05 10.

5. Embed Ductile Iron Pipe in accordance with Section 33 05 10.

6. For installation of carrier pipe within casing, see Section 33 05 24.

B. Pipe Handling

1. Haul and distribute pipe and fittings at the project site.

2. Handle piping with care to avoid damage.

   a. Inspect each joint of pipe and reject or repair any damaged pipe prior to lowering into the trench.

   b. Do not handle the pipe in such a way that will damage the interior lining.

   c. Use only nylon ropes, slings or other lifting devices that will not damage the surface of the pipe for handling the pipe.

3. At the close of each operating day:

   a. Keep the pipe clean and free of debris, dirt, animals and trash – during and after the laying operation.

   b. Effectively seal the open end of the pipe using a gasketed night cap.

C. Joint Making

1. Mechanical Joints

   a. Bolt the follower ring into compression against the gasket with the bolts tightened down evenly then cross torqued in accordance with AWWA C600.

   b. Overstressing of bolts to compensate for poor installation practice will not be permitted.

2. Push-on Joints

   a. Install Push-on joints as defined in AWWA/ANSI C111/A21.11.

   b. Wipe clean the gasket seat inside the bell of all extraneous matter.

   c. Place the gasket in the bell in the position prescribed by the manufacturer.
d. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the
gasket and the outside of the spigot prior to entering the spigot into the bell.
e. When using a field cut plain end piece of pipe, refinish the field cut and scarf to
conform to AWWA C600.

3. Flanged Joints
   a. Use erection bolts and drift pins to make flanged connections.
      1) Do not use undue force or restraint on the ends of the fittings.
      2) Apply even and uniform pressure to the gasket.
   b. The fitting must be free to move in any direction while bolting.
      1) Install flange bolts with all bolt heads faced in one direction.

4. Joint Deflection
   a. Deflect the pipe only when necessary to avoid obstructions or to meet the lines
      and grades and shown in the Drawings.
   b. The deflection of each joint must be in accordance with AWWA C600 Table 3.
   c. The maximum deflection allowed is 50 percent of that indicated in AWWA
      C600.
   d. The manufacturer's recommendation may be used with the approval of the
      Engineer.

D. Polyethylene Encasement Installation
   1. Preparation
      a. Remove all lumps of clay, mud, cinders, etc., on pipe surface prior to
         installation of polyethylene encasement.
         1) Prevent soil or embedment material from becoming trapped between pipe
            and polyethylene.
      b. Fit polyethylene film to contour of pipe to affect a snug, but not tight encase
         with minimum space between polyethylene and pipe.
         1) Provide sufficient slack in contouring to prevent stretching polyethylene
            where it bridges irregular surfaces such as bell-spigot interfaces, bolted
            joints or fittings and to prevent damage to polyethylene due to backfilling
            operations.
         2) Secure overlaps and ends with adhesive tape and hold.
      c. For installations below water table and/or in areas subject to tidal actions, seal
         both ends of polyethylene tube with adhesive tape at joint overlap.
   2. Tubular Type (Method A)
      a. Cut polyethylene tube to length approximately 2 feet longer than pipe section.
      b. Slip tube around pipe, centering it to provide 1-foot overlap on each adjacent
         pipe section and bunching it accordion-fashion lengthwise until it clears pipe
         ends.
      c. Lower pipe into trench and make up pipe joint with preceding section of pipe.
      d. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
      e. After assembling pipe joint, make overlap of polyethylene tube, pull bunched
         polyethylene from preceding length of pipe, slip it over end of the new length
         of pipe and wrap until it overlaps joint at end of preceding length of pipe.
      f. Secure overlap in place.
      g. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel
         of pipe, securing fold at quarter points.
      h. Repair cuts, tears, punctures or other damage to polyethylene.
i. Proceed with installation of next pipe in same manner.

3. Tubular Type (Method B)
   a. Cut polyethylene tube to length approximately 1 foot shorter than pipe section.
   b. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end.
   c. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel
      of pipe, securing fold at quarter points; secure ends.
   d. Before making up joint, slip 3-foot length of polyethylene tube over end of
      proceeding pipe section, bunching it accordion-fashion lengthwise.
   e. After completing joint, pull 3-foot length of polyethylene over joint,
      overlapping polyethylene previously installed on each adjacent section of pipe
      by at least 1 foot; make each end snug and secure.

4. Sheet Type
   a. Cut polyethylene sheet to a length approximately 2 feet longer than piece
      section.
   b. Center length to provide 1-foot overlap on each adjacent pipe section, bunching
      it until it clears the pipe ends.
   c. Wrap polyethylene around pipe so that it circumferentially overlaps top
      quadrant of pipe.
   d. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
   e. Lower wrapped pipe into trench and make up pipe joint with preceding section
      of pipe.
   f. Make shallow bell hole at joints to facilitate installation of polyethylene.
   g. After completing joint, make overlap and secure ends.
   h. Repair cuts, tears, punctures or other damage to polyethylene.
   i. Proceed with installation of next section of pipe in same manner.

5. Pipe-Shaped Appurtenances
   a. Cover bends, reducers, offsets and other pipe-shaped appurtenances with
      polyethylene in same manner as pipe and fittings.

6. Odd-Shaped Appurtenances
   a. When it is not practical to wrap valves, tees, crosses, and other odd-shaped
      pieces in tube, wrap with flat sheet or split length polyethylene tube by passing
      sheet under appurtenances and bringing it up around body.
   b. Make seams by bringing edges together, folding over twice and taping down.
   c. Tape polyethylene securely in place at the valve stem and at any other
      penetrations.

7. Repairs
   a. Repair any cuts, tears, punctures or damage to polyethylene with adhesive tape
      or with short length of polyethylene sheet or cut open tube, wrapped around
      fitting to cover damaged area and secured in place.

8. Openings in Encasement
   a. Provide openings for branches, service taps, blow-offs, air valves and similar
      appurtenances by making an X-shaped cut in polyethylene and temporarily
      folding back film.
   b. After appurtenance is installed, tape slack securely to appurtenance and repair
      cut, as well as other damaged area in polyethylene with tape.
   c. Service taps may also be made directly through polyethylene, with any
      resulting damaged areas being repaired as described above.
9. Junctions between Wrapped and Unwrapped Pipe:
   a. Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet.
   b. Secure end with circumferential turns of tape.
   c. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from Cast or Ductile Iron Pipe.

3.5 REPAIR/RESTORATION

A. Patching
   1. Excessive field-patching is not permitted of lining or coating.
   2. Patching of lining or coating will be allowed where area to be repaired does not exceed 100 square inches and has no dimensions greater than 12 inches.
   3. In general, there shall not be more than 1 patch on either the lining or the coating of any 1 joint of pipe.
   4. Wherever necessary to patch the pipe:
      a. Make patch with cement mortar as previously specified for interior joints.
      b. Do not install patched pipe until the patch has been properly and adequately cured and approved for laying by the City.
   5. Promptly remove rejected pipe from the site.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

A. Potable Water Mains
   1. Cleaning, disinfection, hydrostatic testing and bacteriological testing of water mains
      a. Clean, flush, pig, disinfect, hydrostatic test and bacteriological test the water main as specified in Section 33 04 40.

B. Wastewater Lines
   1. Closed Circuit Television (CCTV) Inspection
      a. Provide a Post-CCTV Inspection in accordance with Section 33 01 31.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION
### Revision Log

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SECTION 33 11 11

DUCTILE IRON FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile Iron Fittings 3-inch through 64-inch for potable water, wastewater, and
      other liquids for use with Ductile Iron Pipe and Polyvinyl Chloride (PVC) Pipe
   
B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the
      Contract
   2. Division 1 – General Requirements
   3. 03 34 16 – Concrete Base Material for Trench Repair
   4. 33 04 40 – Cleaning and Acceptance Testing of Water Mains
   5. 33 05 10 – Utility Trench Excavation, Embedment and Backfill

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Ductile Iron Water Fittings
      a. Measurement
         1) Shall be per ton of fittings supplied
         2) Fittings weights are the sum of the various types of fittings multiplied by
            the weight per fitting as listed in AWWA/ANSI C153/A21.53.
         3) The fitting weights listed in AWWA/ANSI C110/A21.10 are only allowed
            for specials where an AWWA/ANSI C153/A21.53 is not available, or if the
            Drawings specifically call for an AWWA/ANSI C110/A21.10 fittings.
         4) If the Contractor chooses to supply AWWA/ANSI C110/A21.10 (full
            body) Ductile Iron Fittings in lieu of AWWA/ANSI C153/A21.53
            (compact) Ductile Iron Fittings at his convenience, then the weight shall be
            measured in accordance with AWWA/ANSI C153/A21.53.

      b. Payment
         1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” will be paid for at the unit
         price bid per ton of “Ductile Iron Water Fittings”.

      c. The price bid shall include:
         1) Furnishing and installing Ductile Iron Water Fittings as specified by the
            Drawings
         2) Polyethylene encasement
         3) Lining
         4) Pavement removal
         5) Excavation
6) Hauling
7) Disposal of excess material
8) Furnishing and installing bolts, nuts, and restraint (if required)
9) Furnishing, placement and compaction of embedment
10) Furnishing, placement and compaction of backfill
11) Clay Dams
12) Clean-up
13) Cleaning
14) Disinfection
15) Testing

2. Ductile Iron Sewer Fittings
   a. Measurement
      1) Shall be per ton of fittings supplied
      2) Fittings weights are the sum of the various types of fittings multiplied by
         the weight per fitting as listed in AWWA/ANSI C153/A21.53.
      3) The fitting weights listed in AWWA/ANSI C110/A21.10 are only allowed
         for specials where an AWWA/ANSI C153/A21.53 is not available, or if the
         Drawings specifically call for an AWWA/ANSI C110/A21.10 fittings.
      4) If the Contractor chooses to supply AWWA/ANSI C110/A21.10 (full
         body) Ductile Iron Fittings in lieu of AWWA/ANSI C153/A21.53
         (compact) Ductile Iron Fittings at his convenience, then the weight shall be
         measured in accordance with AWWA/ANSI C153/A21.53.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” will be paid for at the unit
         price bid per ton of “Ductile Iron Sewer Fittings”.
   c. The price bid shall include:
      1) Furnishing and installing Ductile Iron Water Fittings as specified by the
         Drawings
      2) Epoxy Coating
      3) Polyethylene encasement
      4) Lining
      5) Pavement removal
      6) Excavation
      7) Hauling
      8) Disposal of excess material
      9) Furnishing and installing bolts, nuts, and restraint (if required)
     10) Furnishing, placement and compaction of embedment
     11) Furnishing, placement and compaction of backfill
     12) Clean-up
     13) Cleaning
     14) Disinfection
     15) Testing

3. Hydrocarbon Resistant Gaskets
   a. Measurement
      1) Measurement for this Item shall be by lump sum.
   b. Payment
1) The work performed and the materials furnished in accordance with this Item shall be paid for at the lump sum price bid for “Hydrocarbon Resistant Gaskets”.

1.3 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.

2. American Society of Mechanical Engineers (ASME):

3. ASTM International (ASTM):
   b. A674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

4. American Water Works Association (AWWA):
   c. M41, Ductile-Iron Pipe and Fittings.


6. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.

7. Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer or the City prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Ductile Iron Fittings
      a. Pressure class
b. Interior lining
   c. Joint types

2. Polyethylene encasement and tape
   a. Planned method of installation
   b. Whether the film is linear low density or high density cross linked polyethylene
   c. The thickness of the film provided

3. The interior lining, if it is other than cement mortar lining in accordance with
   AWWA/ANSI C104/A21.4
   a. Material
   b. Application recommendations
   c. Field touch-up procedures

4. Thrust Restraint
   a. Retainer glands
   b. Thrust harnesses
   c. Any other means

5. Bolts and nuts for mechanical and or flange joints

6. Gaskets

B. Certificates

1. The manufacturer shall furnish an affidavit certifying that all Ductile Iron Fittings
   meet the provisions of this Section and meet the requirements of AWWA/ANSI
   C110/A21.10 or AWWA/ANSI C153/A21.53.

2. Furnish a certificate stating that buried bolts and nuts conform to ASTM B117.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers
   a. Fittings manufacturing operations (fittings, lining, and coatings) shall be
      performed under the control of the manufacturer.
   b. Ductile Iron Fittings shall be manufactured in accordance with AWWA/ANSI
      C110/A21.10 or AWWA/ANSI C153/A21.53.
      1) Perform quality control tests and maintain the results as outlined in these
         standards to assure compliance.

B. Preconstruction Testing

1. The City may, at its own cost, subject random fittings for destructive testing by an
   independent laboratory for compliance with this Specification.
   a. The compliance test shall be performed in the United States.
   b. Any visible defects or failure to meet the quality standards herein will be
      grounds for rejecting the entire order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Store and handle in accordance with the guidelines as stated in AWWA M41.
2. Secure and maintain a location to store the material in accordance with Section 01 60 00.

### 1.11 FIELD [SITE] CONDITIONS [NOT USED]

### 1.12 WARRANTY [NOT USED]

#### PART 2 - PRODUCTS

##### 2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

##### 2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Manufacturers

1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Ductile Iron Fittings


2. All fittings for potable water service shall meet the requirements of NSF 61.

3. Ductile Iron Fittings, at a minimum, shall meet or exceed the pressures classes of the pipe which the fitting is connected, unless specifically indicated in the Drawings.

4. Fittings Markings
   a. Meet the minimum requirements of AWWA/ANSI C151/A21.51.
   b. Minimum markings shall include:
      1) “DI” or “Ductile” cast or metal stamped on each fitting
      2) Applicable AWWA/ANSI standard for that the fitting
      3) Pressure rating
      4) Number of degrees for all bends
      5) Nominal diameter of the openings
      6) Year and country fitting was cast
      7) Manufacturer’s mark

5. Joints
   a. Push-On Joints
      1) Comply with AWWA/ANSI C111/A21.11.
   b. Mechanical Joints
      1) Comply with AWWA/ANSI C111/A21.11.
   c. Mechanical Joints with mechanical restraint
      1) Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
      2) The devices shall have the following working pressure ratings based on size and type of pipe:
         a) Ductile Iron Pipe
            (1) 3-inch – 16-inch, 350 psi
(2) 18-inch – 48-inch, 250 psi
b) PVC C900 and C905
   (1) 3-inch – 12-inch, 305 psi
   (2) 14-inch – 16-inch, 235 psi
   (3) 18-inch – 20-inch, 200 psi
   (4) 24-inch – 30-inch 165 psi
c) Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes
3) Restraint devices shall have specific designs for Ductile Iron and PVC and should be easily differentiate between the two.
4) Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536
5) Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
6) Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.
d. Push-On - Restrained Joints
   1) Restraining Push-on joints by means of a special gasket
      a) Only those products that are listed in 01 60 00
      b) The working pressure rating of the restrained gasket must exceed the test pressure of the pipe line to be installed.
      c) Approved for use of restraining Ductile Iron Pipe in casing with a carrier pipe of 4-inches to 12-inches
      d) Otherwise only approved if specially listed on the drawings
   2) Push-on Restrained Joint bell and spigot
      a) Only those products list in the standard products list will be allowed for the size listed in the standard products list per Section 01 60 00
      b) Pressure rating shall exceed the working and test pressure of the pipe line

e. Flanged Joints
   1) AWWA/ANSI C115/A21.15, ASME B16.1, Class 125
   2) Flange bolt circles and bolt holes shall match those of ASME B16.1, Class 125.
   3) Field fabricated flanges are prohibited.

6. Gaskets
   a. All rubber joint gaskets utilized on Ductile Iron Fittings shall be in conformance with AWWA/ANSI C111/A21.11.
b. Flanged Gaskets
   1) Full face
   2) Manufactured true to shape from minimum 80 durometer SBR rubber stock of a thickness not less than 1/8 inch
   3) Virgin stock
   4) Conforming to the physical and test requirements specified in AWWA/ANSI C111/A21.11
   5) Finished gaskets shall have holes punched by the manufacturer and shall match the flange pattern in every respect.
6) Frayed cut edges resulting from job site gasket fabrication are not acceptable.
7) Furnish Viton® Rubber gaskets hydrocarbon restraint gaskets, when required.
   c. Isolation Flanges
   1) Flanges required by the drawings to be Isolation Flanges shall conform to Section 3 04 10.
7. Bolts and Nuts
   a. Mechanical Joints
      1) High strength corrosion restraint low-carbon weathering steel in accordance with AWWA/ANSI C111/A21.11, and ASTM A242.
      2) Cor-Blue coated with FluoroKote #1, or equal
         a) Coating shall conform to the performance requirements of ASTM B117 for up to 4000 hours and shall include, if required, a certificate of conformance.
   b. Flanged Ends
      1) Meet requirements of AWWA C115.
         a) For buried and non-buried applications, provide ASTM A193 Grade B7 bolts and ASTM 194 Grade 2H Nuts.
8. Flange Coatings
   a. Connections to Steel Flanges
      1) Coatings for buried flanges shall be Densyl Tape system manufactured by Carboline, consisting of Densyl Mastic, Densyl Paste, and Densyl Tape, or approved equal.
9. Ductile Iron Fitting Exterior Coatings
   a. All Ductile Iron Fittings shall have an asphaltic coating, minimum of 1 mil thick, on the exterior, unless otherwise specified in the Contract Documents.
10. Polyethylene Encasement
    a. All buried Ductile Iron Fittings shall be polyethylene encased.
    b. Only manufacturers listed in the City’s Standard Products List as shown in Section 01 60 00 will be considered acceptable.
    c. Use only virgin polyethylene material.
    d. Encasement for buried fittings shall be 8 mil linear low density (LLD) polyethylene conforming to AWWA/ANSI C105/A21.5 or 4 mil high density cross-laminated (HDCL) polyethylene encasement conforming to conforming to AWWA/ANSI C105/A21.5 and ASTM A674.
    e. Marking: At a minimum of every 2 feet along its length, the mark the polyethylene film with the following information:
       1) Manufacturer’s name or trademark
       2) Year of manufacturer
       3) AWWA/ANSI C105/A21.5
       4) Minimum film thickness and material type
       5) Applicable range of nominal diameter sizes
       6) Warning – Corrosion Protection – Repair Any Damage
    f. Special Markings/Colors
       1) Reclaimed Water, perform one of the following:
          a) Label polyethylene encasement with “RECLAIMED WATER”,
b) Provide purple polyethylene in accordance with the American Public Works Association Uniform Color Code; or

c) Attach purple reclaimed water marker tape to the polyethylene wrap.

2) Wastewater, perform one of the following:

a) Label polyethylene encasement with “WASTEWATER”;

b) Provide green polyethylene in accordance with the American Public Works Association Uniform Color Code; or

c) Attach green sanitary sewer marker tape to the polyethylene wrap.

g. Minimum widths

### Polyethylene Tube and Sheet Sizes for Push-On Joint Fittings

<table>
<thead>
<tr>
<th>Nominal Fittings Diameter (inches)</th>
<th>Min. Width – Flat Tube (inches)</th>
<th>Min. Width – Sheet (inches)</th>
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<td>64</td>
<td>121</td>
<td>242</td>
</tr>
</tbody>
</table>

11. Ductile Iron Fittings Interior Lining

a. Cement Mortar Lining

1) Ductile Iron Fittings for potable water shall have a cement mortar lining in accordance with AWWA/ANSI C104/A21.4 and be acceptable according to NSF 61.

b. Ceramic Epoxy or Epoxy Linings

1) Ductile Iron Fittings for use in wastewater applications shall be lined with a Ceramic Epoxy or Epoxy lining as designated in the Standard Products List as shown in Section 01 60 00.

2) Apply lining at a minimum of 40 mils DFT

3) Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using a Joint Compound as supplied by the manufacturer.
a) Apply the joint compound by brush to ensure coverage.
b) Care should be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot ends.
c) Coat the gasket seat and spigot ends after the application of the lining.
d) Surface preparation shall be in accordance with the manufacturer’s recommendations.
e) Check thickness using a magnetic film thickness gauge in accordance with the method outlined in SSPC PA 2.
f) Test the interior lining of all fittings for pinholes with a non-destructive 2,500 volt test.
a) Repair any defects prior to shipment.

7) Mark each fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

8) For all Ductile Iron Fittings in wastewater service where the fitting has been cut, coat the exposed surface with the touch-up material as recommended by the manufacturer.
a) The touch-up material and the lining shall be of the same manufacturer.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
1. Install fittings, specials and appurtenances as specified herein, as specified in AWWA C600, AWWA M41, and in accordance with the fittings manufacturer’s recommendations.
2. Lay fittings to the lines and grades as indicated in the Drawings.
3. Excavate and backfill trenches in accordance with 33 05 10.
4. Embed Ductile Iron Fittings in accordance with 33 05 10.

B. Joint Making
1. Mechanical Joints
   a. Bolt the follower ring into compression against the gasket, with the bolts tightened down evenly then cross torqued in accordance with AWWA C600.
   b. Overstressing of bolts to compensate for poor installation practice will not be permitted.
2. Push-on Joints
   a. Install Push-on joints as defined in AWWA/ANSI C111/A21.11.
   b. Wipe clean the gasket seat inside the bell of all extraneous matter.
   c. Place the gasket in the bell in the position prescribed by the manufacturer.
d. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the
gasket and the outside of the spigot prior to entering the spigot into the bell.
e. When using a field cut plain end piece of pipe, refinished the field cut and scarf
to conform to AWWA M-41.

3. Flanged Joints
a. Use erection bolts and drift pins to make flanged connections.
   1) Do not use undue force or restraint on the ends of the fittings.
   2) Apply even and uniform pressure to the gasket.
b. The fitting must be free to move in any direction while bolting,
   1) Install flange bolts with all bolt heads faced in 1 direction.

4. Joint Deflection
a. Deflect the pipe only when necessary to avoid obstructions or to meet the lines
   and grades and shown in the Drawings.
b. The deflection of each joint must be in accordance with AWWA C600 Table 3.
c. The maximum deflection allowed is 50 percent of that indicated in AWWA
   C600.
d. The manufacturer’s recommendation may be used with the approval of the
   Engineer.

C. Polyethylene Encasement Installation:

1. Preparation
a. Remove all lumps of clay, mud, cinders, etc., on fittings surface prior to
   installation of polyethylene encasement.
   1) Prevent soil or embedment material from becoming trapped between
      fittings and polyethylene.
b. Fit polyethylene film to contour of fittings to affect a snug, but not tight encase
   with minimum space between polyethylene and fittings.
   1) Provide sufficient slack in contouring to prevent stretching polyethylene
   where it bridges irregular surfaces such as bell-spigot interfaces, bolted
   joints or fittings, and to prevent damage to polyethylene due to backfilling
   operations.
   2) Secure overlaps and ends with adhesive tape and hold.
c. For installations below water table and/or in areas subject to tidal actions, seal
   both ends of polyethylene tube with adhesive tape at joint overlap.

2. Tubular Type (Method A)
   a. Cut polyethylene tube to length approximately 2 feet longer than fittings
      section.
   b. Slip tube around fittings, centering it to provide 1 foot overlap on each adjacent
      pipe section and bunching it accordion-fashion lengthwise until it clears fittings
      ends.
   c. Lower fittings into trench with preceding section of pipe.
   d. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
   e. After assembling fittings make overlap of polyethylene tube, pull bunched
      polyethylene from preceding length of pipe, slip it over end of the fitting and
      wrap until it overlaps joint at end of preceding length of pipe.
   f. Secure overlap in place.
   g. Take up slack width at top of fitting to make a snug, but not tight, fit along
      barrel of fitting, securing fold at quarter points.
3. Tubular Type (Method B)
   a. Cut polyethylene tube to length approximately 1 foot shorter than fitting section.
   b. Slip tube around fitting, centering it to provide 6 inches of bare fitting at each end.
   c. Take up slack width at top of fitting to make a snug, but not tight, fit along barrel of fitting, securing fold at quarter points; secure ends.
   d. Before making up joint, slip 3-foot length of polyethylene tube over end of proceeding pipe section, bunching it accordion-fashion lengthwise.
   e. After completing joint, pull 3-foot length of polyethylene over joint, overlapping polyethylene previously installed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.

4. Sheet Type
   a. Cut polyethylene sheet to a length approximately 2 feet longer than piece section.
   b. Center length to provide 1-foot overlap on each fitting, bunching it until it clears the fitting ends.
   c. Wrap polyethylene around fitting so that it circumferentially overlaps top quadrant of fitting.
   d. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
   e. Lower wrapped fitting into trench with preceding section of pipe.
   f. Make shallow bell hole at joints to facilitate installation of polyethylene.
   g. After completing joint, make overlap and secure ends.
   h. Repair cuts, tears, punctures or other damage to polyethylene.
   i. Proceed with installation of fittings in same manner.

5. Pipe-Shaped Appurtenances
   a. Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe and fittings.

6. Odd-Shaped Appurtenances
   a. When it is not practical to wrap valves, tees, crosses and other odd-shaped pieces in tube, wrap with flat sheet or split length polyethylene tube by passing sheet under appurtenances and bringing it up around body.
   b. Make seams by bringing edges together, folding over twice and taping down.
   c. Tape polyethylene securely in place at the valve stem and at any other penetrations.

7. Repairs
   a. Repair any cuts, tears, punctures or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around fitting to cover damaged area, and secure in place.

8. Openings in Encasement
   a. Provide openings for branches, service taps, blow-offs, air valves and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film.
   b. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene with tape.
c. Service taps may also be made directly through polyethylene, with any
resulting damaged areas being repaired as described above.

9. Junctions between Wrapped and Unwrapped Fittings
   a. Where polyethylene-wrapped fitting joins an adjacent pipe that is not wrapped,
      extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet.
   b. Secure end with circumferential turns of tape.
   c. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric
      tape for minimum clear distance of 3 feet away from cast or Ductile Iron
      Fittings.

D. Blocking
   1. Install concrete blocking in accordance with Section 03 34 16 for all bends, tees,
crosses and plugs in the pipe lines as indicated in the Drawings.
   2. Place the concrete blocking so as to rest against firm undisturbed trench walls,
normal to the thrust.
   3. The supporting area for each block shall be at least as great as that indicated on the
      Drawings and shall be sufficient to withstand the thrust, including water hammer,
      which may develop.
   4. Each block shall rest on a firm, undisturbed foundation or trench bottom.
   5. If the Contractor encounters soil that appears to be different than that which was
      used to calculate the blocking according to the Drawings, the Contractor shall
      notify the Engineer prior to the installation of the blocking.

3.5 REPAIR/RESTORATION

A. Patching
   1. Excessive field-patching is not permitted of lining or coating.
   2. Patching of lining or coating will be allowed where area to be repaired does not
      exceed 100 square inches and has no dimensions greater than 12 inches.
   3. In general, there shall not be more than 1 patch on either the lining or the coating of
      any fitting.
   4. Wherever necessary to patch the fitting:
      a. Make patch with cement mortar as previously specified for interior joints.
      b. Do not install patched fitting until the patch has been properly and adequately
         cured and approved for laying by the City.
      c. Promptly remove rejected fittings from the site.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Potable Water Mains
   1. Cleaning, disinfection, hydrostatic testing and bacteriological testing of water mains
      a. Clean, flush, pig, disinfect, hydrostatic test and bacteriological test the water
         main as specified in Section 33 04 40.
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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<th>DATE</th>
<th>NAME</th>
<th>SUMMARY OF CHANGE</th>
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SECTION 33 11 12
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 24-inch for potable water, wastewater and reuse applications
B. Deviations from this City of Fort Worth Standard Specification
1. None.
C. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. 33 01 31 – Closed Circuit Television (CCTV) Inspection
4. 33 04 40 – Cleaning and Acceptance Testing of Water Mains
5. 33 05 10 – Utility Trench Excavation, Embedment and Backfill
6. 33 05 24 – Installation of Carrier Pipe in Casing

1.2 PRICE AND PAYMENT PROCEDURES
A. Measurement and Payment
1. Measurement
a. Measured horizontally along the surface from center line to center line of the fitting, manhole, or appurtenance
2. Payment
a. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per linear foot of “PVC Water Pipe” installed for:
1) Various sizes
2) Various types of backfill
b. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per linear foot of “Sewer Force Main” installed for:
1) Various sizes
3. The price bid shall include:
  a. Furnishing and installing PVC Pressure Pipe with joints as specified by the Drawings
  b. Mobilization
  c. Pavement removal
  d. Excavation
  e. Hauling
  f. Disposal of excess material
1.3 REFERENCES

   A. Reference Standards

      1. Reference standards cited in this Specification refer to the current reference
         standard published at the time of the latest revision date logged at the end of this
         Specification, unless a date is specifically cited.


      3. ASTM International (ASTM):
            Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
            Flexible Elastomeric Seals.

      4. American Water Works Association (AWWA):
         b. C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipes
            and Fittings for Water.
         c. C900, Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 IN
            through 12 IN, for Water Transmission and Distribution.
         d. C905, Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 14 IN
            through 48 IN, for Water Transmission and Distribution.
         e. M23, PVC Pipe – Design and Installation.

      5. NSF International (NSF):
         a. 61, Drinking Water System Components – Health Effects.

      6. Underwriters Laboratories, Inc. (UL).

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

   A. Submittals shall be in accordance with Section 01 33 00.

   B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

   A. Product Data

      1. For PVC Pressure Pipe that is used for water distribution, wastewater force mains
         or wastewater gravity mains, including:

         a. PVC Pressure Pipe
1. Manufacturer
2. Dimension Ratio
3. Joint Types
4. Restraint, if required in Contract Documents
   a. Retainer glands
   b. Thrust harnesses
   c. Any other means of restraint
5. Gaskets

B. Shop Drawings: When restrained joints are required, furnish for PVC Pressure Pipe used in the water distribution system or for a wastewater force main for 24-inch and greater diameters, including:
   1. Wall thickness design calculations sealed by a Licensed Professional Engineer in Texas including:
      a. Working pressure
      b. Surge pressure
      c. Deflection
   2. Provide thrust restraint calculations for all fittings and valves, sealed by a Licensed Professional Engineer in Texas, to verify the restraint lengths shown on the Drawings.
   3. Lay schedule / drawing for 24-inch and greater diameters sealed by a Licensed Professional Engineer in Texas including:
      a. Pipe class
      b. Joints type
      c. Fittings
      d. Stationing
      e. Transitions
      f. Joint deflection

C. Certificates
   1. Furnish an affidavit certifying that all PVC Pressure Pipe meets the provisions of this Section, each run of pipe furnished has met Specifications, all inspections have been made and that all tests have been performed in accordance with AWWA C900 or AWWA C905.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Finished pipe shall be the product of 1 manufacturer for each size, unless otherwise approved by the City.
         1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
      b. Pipe manufacturing operations shall be performed under the control of the manufacturer.
c. All pipe furnished shall be in conformance with AWWA C900 and AWWA C905.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
1. Store and handle in accordance with the guidelines as stated in AWWA M23.
2. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Manufacturers
1. Only the manufacturers as listed in the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.
2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Pipe
1. Pipe shall be in accordance with AWWA C900 or AWWA C905.
2. PVC Pressure Pipe for potable water shall meet the requirements of NSF 61.
3. Pressure Pipe shall be approved by the UL.
4. Pipe shall have a lay length of 20 feet except for special fittings or closure pieces necessary to comply with the Drawings.
5. The pipe material shall be PVC, meeting the requirements of ASTM D1784, with a cell classification of 12454-B. Outside diameters must be equal to those of cast iron and ductile iron pipes.
6. As a minimum the following Dimension Ratio’s apply:

<table>
<thead>
<tr>
<th>Diameter (inch)</th>
<th>Min Pressure Class (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 through 12</td>
<td>DR 14</td>
</tr>
<tr>
<td>16 through 24</td>
<td>DR 18</td>
</tr>
</tbody>
</table>

7. Pipe Markings
   a. Meet the minimum requirements of AWWA C900 or AWWA C905. Minimum pipe markings shall be as follows:
      1) Manufacturer’s Name or Trademark and production record
      2) Nominal pipe size
      3) Dimension Ratio
C. Pressure and Deflection Design

1. Pipe design shall be based on trench conditions and design pressure class specified in the Drawings. Pipe shall be designed according to the methods indicated in AWWA M23 for trench construction, using the following parameters:
   a. Unit Weight of Fill \( w \) = 130 pcf
   b. Live Load = AASHTO HS 20
   c. Trench Depth = 12 feet minimum, or as indicated in Drawings
   d. Maximum \( E' \) = 1,000 max
   e. Deflection Lag Factor = 1.0
   f. Working Pressure \( P_w \) = 150 psi
   g. Surge Allowance \( P_s \) = 100 psi minimum
   h. Test Pressure =
      1) No less than 1.25 times the stated working pressure (187 psi minimum) of the pipeline measured at the highest elevation along the test section.
      2) No less than 1.5 times the stated working pressure (225 psi minimum) at the lowest elevation of the test section.
   i. Maximum Calculated Deflection = 3 percent
   j. Restrained Joint Safety Factor (SF) = 1.5

2. Verify trench depths after existing utilities are located.
   a. Accommodate vertical alignment changes required because of existing utility or other conflicts by an appropriate change in pipe design depth.
   b. In no case shall pipe be installed deeper than its design allows.

3. Provisions for Thrust:
   a. Thrusts at bends, tees, plugs or other fittings shall be mechanically restrained joints when required by the Drawings.
   b. No thrust restraint contribution shall be allowed for the restrained length of pipe within the casing.
   c. Restrained joints, where required, shall be used for a sufficient distance from each side of the bend, tee, plug, valve, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purpose of thrust the following shall apply:
      1) Calculate valves as dead ends.
      2) Design pressure shall be greater than the pressure class of the pipe or the internal pressure \( P_i \), whichever is greater.
      3) Restrained joints shall consist of approved mechanical restrained or push-on restrained joints as listed in the City’s Standard Products List as shown in Section 01 60 00.
      4) Restrained PVC pipe is not allowed for pipe greater than 12 inches.
   d. The Pipe Manufacturer shall verify the length of pipe with restrained joints to resist thrust in accordance with the Drawings and the following:
      1) Calculate the weight of the earth \( W_e \) as the weight of the projected soil prism above the pipe, for unsaturated soil conditions.
      2) Soil density = 115 pcf (maximum value to be used), for unsaturated soil conditions
      3) In locations where ground water is encountered, reduce the soil density to its buoyant weight for the backfill below the water table.
a) Reduce the coefficient of friction to 0.25.

4. Joints
   a. Joints shall be gasket, bell and spigot and push-on type conforming to ASTM D3139.
   b. Since each pipe manufacturer has a different design for push-on joints, gaskets shall be part of a complete pipe section and purchased as such.
   c. Lubricant must be non-toxic and NSF approved for potable water applications.
   d. Push-On Restrained Joints shall only be as approved in the Standard Products List in Section 01 60 00.

5. Detectable Markers
   a. Provide detectable markers in accordance with Section 33 05 26.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install pipe, fittings, specials and appurtenances as specified herein, as specified in AWWA C600, AWWA C605, AWWA M23 and in accordance with the pipe manufacturer’s recommendations.
   2. Lay pipe to the lines and grades as indicated in the Drawings.
   3. Excavate and backfill trenches in accordance with Section 33 05 10.
   4. Embed PVC Pressure Pipe in accordance with Section 33 05 10.
   5. For installation of carrier pipe within casing, see Section 33 05 24.

B. Pipe Handling
   1. Haul and distribute pipe and fittings at the project site.
   2. Handle piping with care to avoid damage.
      a. Inspect each joint of pipe and reject or repair any damaged pipe prior to lowering into the trench.
      b. Use only nylon ropes, slings or other lifting devices that will not damage the surface of the pipe for handling the pipe.
   3. At the close of each operating day:
      a. Keep the pipe clean and free of debris, dirt, animals and trash – during and after the laying operation.
      b. Effectively seal the open end of the pipe using a gasketed night cap.

C. Joint Making
   1. Mechanical Joints
a. Bolt the follower ring into compression against the gasket, with the bolts
tightened down evenly then cross torque in accordance with AWWA C600.
b. Overstressing of bolts to compensate for poor installation practice will not be
permitted.

2. Push-on Joints
   a. Install Push-On joints as defined in AWWA C900 and AWWA C905.
   b. Wipe clean the gasket seat inside the bell of all extraneous matter.
   c. Place the gasket in the bell in the position prescribed by the manufacturer.
   d. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the
gasket and the outside of the spigot prior to entering the spigot into the bell.
   e. When using a field cut plain end piece of pipe, refinish the field cut to conform
to AWWA C605.

3. Joint Deflection
   a. Deflect the pipe only when necessary to avoid obstructions, or to meet the lines
and grades shown in the Drawings.
   b. The deflection of each joint must be in accordance with AWWA C600 Table 3.
   c. The maximum deflection allowed is 50 percent of that indicated in AWWA
C600.
   d. The manufacturer’s recommendation may be used with the approval of the
Engineer.

D. Detectable Metallic Tape Installation
   1. See Section 33 05 26.

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

A. Potable Water Mains
   1. Cleaning, disinfection, hydrostatic testing, and bacteriological testing of water
mains:
      a. Clean, flush, pig, disinfect, hydrostatic test and bacteriological test the water
main as specified in Section 33 04 40.

B. Wastewater Lines
   1. Closed Circuit Television (CCTV) Inspection
      a. Provide a Post-CCTV Inspection in accordance with Section 33 01 31.
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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END OF SECTION
SECTION 33 31 20
POLYVINYL CHLORIDE (PVC) GRAVITY SANITARY SEWER PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Polyvinyl Chloride (PVC) pipe 4-inch through 27-inch for gravity sanitary sewer applications

B. Deviations from this City of Fort Worth Standard Specification
1. None.

C. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. Section 33 01 30 – Sewer and Manhole Testing
4. Section 33 01 31 – Closed Circuit Television (CCTV) Inspection
5. Section 33 05 10 – Utility Trench Excavation, Embedment and Backfill
6. Section 33 05 26 – Utility Markers/Locators
7. Section 33 31 50 – Sanitary Sewer Service Connections and Service Line

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Measurement
   a. Measured horizontally along the surface from center line to center line of the manhole or appurtenance

2. Payment
   a. The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per linear foot of “PVC Pipe” installed for:
      1) Various sizes
      2) Various Standard Dimension Ratios
      3) Various embedments
      4) Various depths, for miscellaneous projects only

3. The price bid shall include:
   a. Furnishing and installing PVC gravity pipe with joints as specified by the Drawings
   b. Pavement removal
   c. Excavation
   d. Hauling
   e. Disposal of excess material
   f. Furnishing, placement and compaction of embedment
   g. Furnishing, placement and compaction of backfill
1. Trench Water Stops
2. Clean-up
3. Cleaning
4. Testing

1.3 REFERENCES

A. Reference Standards
1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. American Association of State Highway and Transportation (AASHTO).
3. ASTM International (ASTM):
4. Texas Commission on Environmental Quality (TCEQ):
   b. Title 30, Part I, Chapter 217, Subchapter C, Rule 217.54 – Criteria for Laying Pipe.
5. Underwriters Laboratories, Inc. (UL).

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Product data sheet
   2. Manufacturer
   3. Nominal pipe diameter
   4. Standard dimension ratio (SDR)
   5. Cell classification
   6. Laying lengths
B. Certificates
1. Furnish an affidavit certifying that all PVC Gravity Pipe meets the provisions of
this Section and has been air and deflection tested and meets the requirements of
ASTM D3034 and ASTM F679.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers

a. Finished pipe shall be the product of 1 manufacturer for each size per project,
   unless otherwise approved by the City.
   1) Change orders, specials and field changes may be provided by a different
      manufacturer upon City approval.
   b. Pipe manufacturing operations shall be performed under the control of the
      manufacturer.
   c. All pipe furnished shall be in conformance with ASTM D3034 (4-inch through
      15-inch) and ASTM F679 (18-inch through 27-inch).

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Gravity pipe shall be stored and handled in accordance with the manufacturer’s
   guidelines.
2. Secure and maintain a location to store the material in accordance with
   Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Manufacturers

1. Only the manufacturers as listed in the City’s Standard Products List will be
   considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.
2. Any product that is not listed on the Standard Products List is considered a
   substitution and shall be submitted in accordance with Section 01 25 00.

B. Performance / Design Criteria

1. Pipe

   a. Meet all requirements of TCEQ.
   b. Design in accordance with ASTM D3034 for 4-inch through 15-inch SDR 35/26
      and ASTM F679 for 18-inch through 27-inch 46PS/115PS.
   c. PVC Gravity Sanitary Sewer Pipe shall be approved by the UL.
d. Assume a standard lay length of 14 feet and 20 feet except for special fittings or
closure pieces necessary to comply with the Drawings.
e. Use green coloring for ground identification as sanitary sewer pipe.
f. PVC meeting the requirements of ASTM D1784, with a cell classification of
   12454 or 12364
g. Deflection Design

1) Base pipe design on pipe stiffness, soil stiffness and load on the pipe.
2) Design pipe according to the Modified Iowa Formula as detailed by the
   Uni-Bell PVC Pipe Association in the Handbook of PVC Pipe, using the
   following parameters:
   a) Unit Weight of Fill (w) = 130 pounds per cubic foot
   b) Live Load = AASHTO HS 20
   c) Trench Depth = 12 feet minimum, or as indicated in Drawings
   d) Maximum (E') = 1,000 max
   e) Deflection Lag Factor (DL) = 1.0
   f) Bedding Factor constant (K) = 0.1
   g) Mean radius of the pipe (r), inches, as indicated in Drawings
   h) Marston’s load per unit length (W), pounds per inch, calculate per
   Drawings
   i) PVC modulus of elasticity (E) = 400,000 psi
   j) Moment of inertia of pipe wall per unit length, (I) = t^3/12, (in^4/in), per
   pipe type and size
   (1) Where (t) = pipe thickness, inches
   k) Maximum Calculated Deflection = 5 percent

h. Pipe Flotation: If the pipe is buried in common saturated soil (about 120 pounds
   per cubic foot) with at least 1½ pipe diameters of cover, pipe is generally not
   subject to flotation. If shallower, check groundwater flotation potential.
   Flotation will occur if:

   \[ F_b > W_p + W_f + W_d \]

Where: \( F_b \) = buoyant force, pound per foot
\( W_p \) = empty pipe weight, pound per foot
\( W_f \) = weight of flooded soil, pound per foot
\( W_d \) = weight of dry soil, pound per foot

Values and formulas for the above variables can be obtained from the pipe
manufacturer and site specific soil conditions.

i. Verify trench depths after existing utilities are located.
j. Accommodate vertical alignment changes required because of existing utility or
   other conflicts by an appropriate change in pipe design depth.
k. In no case shall pipe be installed deeper than its design allows.

2. Minimum pipe stiffness of 46 psi at 5 percent deflection when test in accordance
   with ASTM D2412.

3. Pipe markings
   a. Meet the minimum requirements of ASTM D3034 and ASTM F679.
   b. Minimum pipe markings shall be as follows:
      1) Manufacturer’s Name or Trademark and production record
      2) Nominal pipe size
3) PVC cell classification
4) ASTM or Standard Dimension Ratio (SDR) designation
5) Seal of testing agency that verified the suitability of the pipe

4. Joints
   a. Joints shall be gasket, bell and spigot, push-on type conforming to
   ASTM D3212.
   b. Since each pipe manufacturer has a different design for push-on joints; gaskets
   shall be part of a complete pipe section and purchased as such.

5. Connections
   a. Only use manufactured fittings.
   b. See Section 33 31 50.

6. Detectable Metallic Tape
   a. See Section 33 05 26.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install pipe, specials and appurtenances as specified herein, as specified in Section
      33 05 10, and in accordance with the pipe manufacturer’s recommendations.
   2. Lay pipe to the lines and grades as indicated in the Drawings.
   3. Excavate and backfill trenches in accordance with Section 33 05 10.
   4. Embed PVC pipe in accordance with Section 33 05 10.

B. Pipe Handling
   1. Haul and distribute pipe and fittings at the project site.
   2. Handle piping with care to avoid damage.
      a. Inspect each joint of pipe and reject or repair any damaged pipe prior to
         lowering into the trench.
      b. Use only nylon ropes, slings or other lifting devices that will not damage the
         surface of the pipe for handling the pipe.
   3. At the close of each operating day:
      a. Keep the pipe clean and free of debris, dirt, animals and trash – during and after
         the laying operation.
      b. Effectively seal the open end of the pipe using a gasketed night cap.

C. Pipe Joint Installation
   a. Clean dirt and foreign material from the gasketed socket and the spigot end.
b. Assemble pipe joint by sliding the lubricated spigot end into the gasketed bell end to the reference mark.

c. Install such that identification marking on each joint are oriented upward toward the trench opening.

d. When making connection to manhole, use an elastomeric seal or flexible boot to facilitate a seal.

D. Connection Installation

1. See Section 33 31 50.

E. Detectable Metallic Tape Installation

1. See Section 33 05 26.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL

A. Field Tests and Inspections

1. Video Inspection
   a. Provide a Post-CCTV inspection in accordance with Section 33 01 31.

2. Air Test and Deflection (Mandrel) Test
   a. Perform in accordance with Section 33 01 30.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

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SECTION 33 31 50
SANITARY SEWER SERVICE CONNECTIONS AND SERVICE LINE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary sewer service connection, service line and 2-way cleanout from the main to the right-of-way, as shown on the Drawings, directed by the Engineer and specified herein for:

   a. New Service
   b. New Service (Bored)
   c. Private Service Relocation
   d. Service Reinstatement

B. Deviations from this City of Fort Worth Standard Specification

1. None.

C. Related Specification Sections include, but are not necessarily limited to:

   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 05 10 – Utility Trench Excavation, Embedment and Backfill
   4. Section 33 31 20 – Polyvinyl Chloride (PVC) Gravity Sanitary Sewer Pipe

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. New Service
   a. Measurement
      1) Measurement for this Item shall be per each “Sewer Service” complete in place.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid per each “Sewer Service” installed for:
         a) Various sizes
      c. The price bid shall include:
         1) Furnishing and installing New Sanitary Sewer Service Line as specified by the Drawings
         2) Pavement removal
         3) Excavation
         4) Hauling
         5) Disposal of excess material
         6) Tee connection to main
         7) Fittings
         8) 2-way cleanout
         9) Furnishing, placing and compaction of embedment
         10) Furnishing, placing and compaction of backfill
         11) Clean-up
2. New Ductile Iron Service
   a. Measurement
      1) Measurement for this Item shall be per each “DIP Sewer Service” complete
         in place.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         will be paid for at the unit price bid per each “DIP Sewer Service” installed
         for:
         a) Various sizes
   c. The price bid shall include:
      1) Furnishing and installing New DIP Sanitary Sewer Service Line as
         specified by the Drawings
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess material
      6) Tee connection to main
      7) Fittings
      8) 2-way cleanout
      9) Furnishing, placing and compaction of embedment
      10) Furnishing, placing and compaction of backfill
      11) Clean-up

3. Bored Sewer Service
   a. Measurement
      1) Measurement for this Item shall be per each “Bored Sewer Service”
         complete in place.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” will be paid for at the unit
         price bid per each “Bored Sewer Service” installed for:
         a) Various sizes
         b) Various materials
   c. The price shall include:
      1) Furnishing and installing New Sanitary Sewer Service Line as specified by
         the Drawings
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess material
      6) Tee connection to main
      7) Service Line
      8) Fittings
      9) 2-way cleanout
     10) Furnishing, placing and compaction of embedment and backfill
     11) Clean-up

4. Deep Sewer Service
   a. Measurement
      1) Measurement for this Item shall be per each “Deep Sewer Service”
         complete in place.
b. Payment
   1) The work performed and materials furnished in accordance with this Item
   and measured as provided under “Measurement” will be paid for at the unit
   price bid per each new “Deep Sewer Service” installed for:
      a) Various sizes
      b) Various materials

c. The price shall include:
   1) Furnishing and installing Deep Sanitary Sewer Service Line as specified by
      the Drawings
   2) Pavement removal
   3) Excavation
   4) Hauling
   5) Disposal of excess material
   6) Tee connection to main
   7) Service Line
   8) Fittings
   9) 2-way cleanout
   10) Furnishing, placing and compaction of embedment and backfill
   11) Clean-up

5. Private Service Relocation
   a. Measurement
      1) Measured horizontally along the surface from center line to center line of
         the fitting, manhole or appurtenance
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item and measured as provided under “Measurement” will be paid for at the
         unit price bid per linear foot for “Sewer Service, Private Relocation”
         installed for:
            a) Various sizes
            b) Various materials
   c. The price shall include:
      1) Performing relocation as specified in the Drawings
      2) Excavation
      3) Hauling
      4) Disposal of excess material
      5) Service Line - private side by plumber
      6) Fittings
      7) Furnishing, placing and compaction of embedment
      8) Furnishing, placing and compaction of backfill
      9) Clean-up

6. 2-way Cleanout
   a. Measurement
      1) Measurement for this Item shall be per each when only a “2-way Cleanout”
         is installed.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item shall be paid for at the unit price bid per each “2-way Cleanout”
         installed for:
            a) Various sizes
b) Various materials

c. The price bid shall include:
1) Furnishing and installing the 2-way Cleanout as specified in the Drawings
2) Pavement removal
3) Hauling
4) Disposal of excess material
5) Furnishing, placing and compaction of backfill
6) Clean-up

7. Service Reinstatement
a. Measurement
   1) Measurement for this Item shall be per each Reinstatement of Service
      associated with the sewer main being rehabilitated by a trenchless method.

b. Payment
   1) The work performed and materials furnished in accordance with this item
      and measured as provided under “Measurement” will be paid for at the unit
      price bid per each reinstatement of service for:
      a) Various sizes

   c. The price bid shall include:
      1) Tap to existing main (if required)
      2) Pavement removal
      3) Excavation
      4) Hauling
      5) Disposal of excess material
      6) Tee connection to main
      7) Service line (if required)
      8) Fittings
      9) Furnishing, placing and compaction of embedment and backfill
     10) Clean-up

1.3 REFERENCES

A. Definitions

1. New Service
   a. New service applies to the installation of a service with connection to a new or
      existing sewer main.
   b. The service materials would include service line, fittings and cleanout.

2. Bored Service
   a. Bored service applies to the installation of a service with connection to a new or
      existing sewer main including a bore under an existing road.
   b. The service materials would include service line, fittings and cleanout.

3. Deep Service (See Detail SAN-012)
   a. Deep service applies to the installation of a service to a new or existing sewer
      main where a difference of at least 15 feet exists between the finished grade and
      the top of the sewer main.
   b. The service materials would include service line, fittings and cleanout.

4. Private Service Relocation
   a. Private service relocation applies to the replacement of the existing sewer
      service line on private property typically associated with the relocation of the
      existing main.
   b. Typical main relocation will be from a rear lot easement or alley to the street.
5. Service Reinstatement
   a. Service reinstatement applies to the reconnection of an existing service to an
      existing main that has been rehabilitated by trenchless methods such as pipe
      enlargement (pipe bursting), slip lining or CIPP.

B. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   2. ASTM International (ASTM):
      a. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride)
         (PVC) Sewer Pipe and Fittings
      b. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic
         Pipe, Schedules 40, 80 and 120.
      c. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic
         Pipe for Sewers and Other Gravity-Flow Applications
      d. ASTM D2412 Standard Test Method for Determination of External Loading
         Characteristics of Plastic Pipe by Parallel-Plate Loading
      e. ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic
         Pipes Using Flexible Elastomeric Seals
   3. Texas Commission on Environmental Quality
      a. Title 30, Part I, Chapter 217, Subchapter C, Rule 217.54 – Criteria for Laying
         Pipe and Rule
      b. Title 30, Part I, Chapter 217, Subchapter C, 217.55 – Manholes and Related
         Structures

1.4 ADMINISTRATIVE REQUIREMENTS

A. Scheduling
   1. Provide advance notice for service interruption to property owner and meet
      requirements of Division 0.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product data shall include, if applicable:
   1. Tee connection or saddle
   2. Fittings (including type of cleanout)
   3. Service line

B. Certificates
   1. Furnish an affidavit certifying that service line and fittings meet the provisions of
      this Section.
1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Gravity pipe shall be stored and handled in accordance with the manufacturer’s guidelines.

2. Protect all parts such that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

3. Protect all equipment and parts against any damage during a prolonged period at the site.

4. Prevent plastic and similar brittle items from being directly exposed to sunlight or extremes in temperature.

5. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, MATERIALS

A. Manufacturers

1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.

   a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

3. The services and appurtenances shall be new and the product of a manufacturer regularly engaged in the manufacturing of services and appurtenances having similar service and size.

B. Materials/Design Criteria

1. Service Line and Fittings (including tee connections)

   a. PVC pipe and fittings on public property shall be in accordance with Section 33 31 20.

   b. PVC pipe and fittings on private property shall be Schedule 40 in accordance with ASTM D1785.

2. Service saddle

   a. Service saddles shall only be allowed when connecting a new service to an existing sanitary sewer main and shall:
1) Be a 1-piece prefabricated saddle, either polyethylene or PVC, with neoprene gasket for seal against main.
2) Use saddle to fit outside diameter of main.
3) Use saddle with grooves to retain band clamps.
4) Use at least 2 stainless steel band clamps for securing saddles to the main.
   b. No inserta tees service connections may be used.

3. Cleanout
   a. Cleanout stack should be the same material as the service line, except when DI pipe is being used.
   b. Use cast iron cap for cleanout cover.

4. Coupling
   a. For connections between new PVC pipe stub out and existing service line, use flexible adapter coupling consisting of neoprene gasket and stainless steel shear rings with 2-inch stainless steel band clamps.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION [NOT USED]

3.1 INSTALLERS

A. A licensed plumber is required for installations of the service line on private property.

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install service line, fittings and cleanout as specified herein, as specified in Section 33 05 10 and in accordance with the pipe manufacturer’s recommendations.

B. Handling
   1. Haul and distribute service lines, fittings and cleanouts at the project site and handle with care to avoid damage.
      a. Inspect each segment of service line and reject or repair any damaged pipe prior to lowering into the trench.
   2. Do not handle the pipe in such a way that will damage the pipe.

C. Service Line
   1. Lay service line at a minimum grade of 2 percent, as shown on details SAN-011 and SAN-011A or at lines and grades as indicated in the Drawings.
   2. If service line is installed by bore as an alternative to open cut the cost associated with open cut installation such as pavement removal, trenching, embedment and backfill and pavement patch will not be included as part of the bore installation.
   3. Excavate and backfill trenches in accordance with 33 05 10.
   4. Embed PVC Pipe in accordance with 33 05 10.
D. Cleanout
   1. Install out of traffic areas such as driveways, streets and sidewalks whenever possible.
      a. When not possible, install cast iron cleanout stack and cap.
   2. Install 2-way cleanout in non-paved areas in accordance with Detail SAN-011.
   3. Install 2-way cleanout in paved areas in accordance with Detail SAN-011A.

E. Service line connection to main
   1. New service on new or replacement main
      a. Determine location of service connections before main installation so the service fittings can be installed during main installation.
      b. Connect service line to main with a molded or fabricated tee fitting.
   2. Reconnection to main after pipe enlargement
      a. Tapping the existing main and installing a strap on tee connection may be used.
      b. Allow the new main to recover from imposed stretch before tapping and service installation.
         1) Follow manufacturer’s recommendation for the length of time needed.
      c. Tap main at 45 degree angle to horizontal when possible.
         1) Avoid tapping the top of main.
      d. Extend service line from main to property line or easement line before connecting to the existing service line.
   3. New service on existing main
      a. Connect service line to main with a molded or fabricated tee fitting if possible.
      b. Tapping the existing main and installing a strap on tee connection may be used.

F. Private Service Relocation
   1. Requirements for the relocation of service line on private property
      a. A licensed plumber must be used to install service line on private property.
      b. Obtain permit from the Development Department for work on private property.
      c. Pay for any inspection or permit fees associated with work on private property.
      d. Verify (by Exploratory Excavation of Existing Utilities) the elevations at the building cleanout and compare to data on the Drawings before beginning service installation.
      e. Submit elevation information to the City inspector.
      f. Verify that the 2 percent slope installation requirement can be met.
         1) If the 2 percent slope cannot be met, verify with the Engineer that line may be installed at the lesser slope.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION
   A. Service Relocation
      1. All relocations that are not installed as designed or fail to meet the City code shall be reinstalled at the Contractor’s expense.

3.7 FIELD [or] SITE QUALITY CONTROL
   A. Inspections
      1. Private property service line requires approval by the City plumbing inspector before final acceptance.
3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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SECTION 33 39 10
CAST-IN-PLACE CONCRETE MANHOLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sanitary Sewer Cast-in-Place Concrete Manholes

B. Deviations from this City of Fort Worth Standard Specification
   1. None.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 03 30 00 – Cast-In-Place Concrete
   4. Section 03 80 00 – Modifications to Existing Concrete
   5. Section 33 01 30 – Sewer and Manhole Testing
   6. Section 33 05 13 – Frame, Cover, and Grade Rings
   7. Section 33 39 60 – Epoxy Liners for Sanitary Sewer Structures

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Manhole
      a. Measurement
         1) Measurement for this Item shall be per each.
      b. Payment
         1) The work performed and the materials furnished in accordance with this Item shall be paid for at the unit price bid per each “Manhole” installed for:
            a) Various sizes
            b) Various types
      c. The price bid will include:
         1) Manhole structure complete in place
         2) Excavation
         3) Forms
         4) Reinforcing steel (if required)
         5) Concrete
         6) Backfill
         7) Foundation
         8) Drop pipe
         9) Stubs
         10) Frame
         11) Cover
         12) Grade rings
         13) Pipe connections
14) Pavement removal
15) Hauling
16) Disposal of excess material
17) Placement and compaction of backfill
18) Clean-up

2. Extra Depth Manhole
   a. Measurement
      1) Measurement for added depth beyond 6 feet will be per vertical foot,
         measured to the nearest 1/10 foot.
   b. Payment
      1) The work performed and the materials furnished in accordance with this
         Item and measured as provided under “Measurement” will be paid for at the
         unit price bid per vertical foot for “Extra Depth Manhole” specified for:
         a) Various sizes
   c. The price bid will include:
      1) Manhole structure complete in place
      2) Excavation
      3) Forms
      4) Reinforcing steel (if required)
      5) Concrete
      6) Backfill
      7) Foundation
      8) Drop pipe
      9) Stubs
     10) Frame
     11) Cover
     12) Grade rings
     13) Pipe connections
     14) Pavement removal
     15) Hauling
     16) Disposal of excess material
     17) Placement and compaction of backfill
     18) Clean-up

3. Sanitary Sewer Junction Structure
   a. Measurement
      1) Measurement for this Item will be per each Sewer Junction Structure being
         installed.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item
         and measured as provided under “Measurement” shall be paid for at the
         lump sum bid per each “Sewer Junction Structure” location.
   c. Price bid will include:
      1) Junction Structure complete in place
      2) Excavation
      3) Forms
      4) Reinforcing steel (if required)
      5) Concrete
      6) Backfill
      7) Foundation
1) Drop pipe
2) Stubs
3) Frame
4) Cover
5) Grade rings
6) Pipe connections
7) Pavement removal
8) Hauling
9) Disposal of excess material
10) Placement and compaction of backfill
11) Clean-up

1.3 REFERENCES

A. Definitions

1. Manhole Type
   a. Standard Manhole (See City Standard Details)
      1) Greater than 4 feet deep up to 6 feet deep
   b. Standard Drop Manhole (See City Standard Details)
      1) Same as Standard Manhole with external drop connection (s)
   c. Type “A” Manhole (See City Standard Details)
      1) Manhole set on a reinforced concrete block placed around 39-inch and
         larger sewer pipe
   d. Shallow Manhole (See City Standard Details)
      1) Less than 4 feet deep with formed invert for sewer pipe diameters smaller
         than 39-inch

2. Manhole Size
   a. 4 foot diameter
      1) Used with pipe ranging from 8-inch to 15-inch
   b. 5 foot diameter
      1) Used with pipe ranging from 18-inch to 36-inch
   c. See specific manhole design on Drawings for pipes larger than 36-inch.

B. Reference Standards

1. Reference standards cited in this Specification refer to the current reference
   standard published at the time of the latest revision date logged at the end of this
   Specification, unless a date is specifically cited.

2. ASTM International (ASTM):
   a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   b. D4259, Standard Practice for Abrading Concrete.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Drop connection materials
2. Pipe connections at manhole walls
3. Stubs and stub plugs
4. Admixtures
5. Concrete Mix Design

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, MATERIALS

A. Manufacturers

1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Materials

1. Concrete – Conform to Section 03 30 00.
2. Reinforcing Steel – Conform to Section 03 21 00.
3. Frame and Cover – Conform to Section 33 05 13.
4. Grade Ring – Conform to Section 33 05 13.
5. Pipe Connections
   a. Pipe connections can be premolded pipe adapter, flexible locked-in boot adapter, or integrally cast gasket channel and gasket.
6. Interior Coating or Liner – Conform to Section 33 39 60, if required.
7. Exterior Coating
   a. Use Coal Tar Bitumastic for below grade damp proofing.
   b. Dry film thickness shall be no less than 12 mils and no greater than 30 mils.
   c. Solids content is 68 percent by volume ± 2 percent.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Evaluation and Assessment
   1. Verify lines and grades are in accordance to the Drawings.

3.3 PREPARATION

A. Foundation Preparation
   1. Excavate 8 inches below manhole foundation.
   2. Replace excavated soil with course aggregate, creating a stable base for the manhole construction.
      a. If soil conditions or ground water prevent use of course aggregate base a 2-inch mud slab may be substituted.

3.4 INSTALLATION

A. Manhole
   1. Construct manhole to dimensions shown on Drawings.
   2. Cast manhole foundation and wall monolithically.
      a. A cold joint with water stop is allowed when the manhole depth exceeds 12 feet.
      b. No other joints are allowed unless shown on Drawings.
   3. Place, finish and cure concrete according to Section 03 30 00.
      a. Manholes must cure 3 days before backfilling around structure.

B. Pipe connection at Manhole
   1. Do not construct joints of sewer pipe within wall sections of manhole.

C. Invert
   1. Construct invert channels to provide a smooth waterway with no disruption of flow at pipe-manhole connections.
   2. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature.
      a. Provide curves for side inlets.
   3. Sewer pipe may be laid through the manhole and the top ½ of the pipe removed to facilitate manhole construction.
   4. For all standard manholes provide full depth invert.
   5. For example, if 8-inch pipe is connected to manhole, construct the invert to full 8 inches in depth.

D. Drop Manhole Connection
1. Install drop connection when sewer line enters manhole higher than 24 inches above the invert.

E. Final Rim Elevation
   1. Install concrete grade rings for height adjustment.
      a. Construct grade ring on load bearing shoulder of manhole.
      b. Use sealant between rings as shown on Drawings.
   2. Set frame on top of manhole or grade rings using continuous water sealant.
   3. Remove debris, stones and dirt to ensure a watertight seal.
   4. Do not use steel shims, wood, stones or other unspecified material to obtain the final surface elevation of the manhole frame.

F. Internal coating
   1. Internal coating application will conform to Section 33 39 60, if required by Drawings.

G. External coating
   1. Remove dirt, dust, oil and other contaminants that could interfere with adhesion of the coating.
   2. Cure for 3 days before backfilling around structure.
   3. Coat the same date the forms are removed.
   4. Prepare surface in accordance with ASTM D4258 and ASTM D4259.
   5. Application will follow manufacturer’s recommendation.

H. Modifications and Pipe Penetrations
   1. Conform to Section 03 80 00.

I. Junction Structures
   1. All structures shall be installed as specified in Drawings.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

   A. Field Tests and Inspections
      1. Perform vacuum test in accordance with Section 33 01 30.
1 3.8 SYSTEM STARTUP [NOT USED]
2 3.9 ADJUSTING [NOT USED]
3 3.10 CLEANING [NOT USED]
4 3.11 CLOSEOUT ACTIVITIES [NOT USED]
5 3.12 PROTECTION [NOT USED]
6 3.13 MAINTENANCE [NOT USED]
7 3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 33 39 20
PRECAST CONCRETE MANHOLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sanitary Sewer Precast Concrete Manholes

B. Deviations from this City of Fort Worth Standard Specification
1. Subparagraph 1.3.A.1.d
2. Paragraph 2.2.B.11

C. Related Specification Sections include, but are not necessarily limited to:
1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
2. Division 1 – General Requirements
3. Section 03 30 00 – Cast-in-Place Concrete
4. Section 03 80 00 – Modifications to Existing Concrete
5. Section 33 01 30 – Sewer and Manhole Testing
6. Section 33 05 13 – Frame, Cover, and Grade Rings
7. Section 33 39 60 – Epoxy Liners for Sanitary Sewer Structures

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
1. Manhole
   a. Measurement
      1) Measurement for this Item shall be per each concrete manhole installed.
   b. Payment
      1) The work performed and the materials furnished in accordance with this Item shall be paid for at the unit price bid per each “Manhole” installed for:
         a) Various sizes
         b) Various types
   c. The price bid will include:
      1) Manhole structure complete in place
      2) Excavation
      3) Forms
      4) Reinforcing steel (if required)
      5) Concrete
      6) Backfill
      7) Foundation
      8) Drop pipe
      9) Stubs
      10) Frame
      11) Cover
      12) Grade rings
13) Pipe connections
14) Pavement removal
15) Hauling
16) Disposal of excess material
17) Placement and compaction of backfill
18) Clean-up

2. Extra Depth Manhole
   a. Measurement
      1) Measurement for added depth beyond 6 feet will be per vertical foot, measured to the nearest 1/10 foot.
   b. Payment
      1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per vertical foot for “Extra Depth Manhole” specified for:
         a) Various sizes
      c. The price bid will include:
         1) Manhole structure complete in place
         2) Excavation
         3) Forms
         4) Reinforcing steel (if required)
         5) Concrete
         6) Backfill
         7) Foundation
         8) Drop pipe
         9) Stubs
         10) Frame
         11) Cover
         12) Grade rings
         13) Pipe connections
         14) Pavement removal
         15) Hauling
         16) Disposal of excess material
         17) Placement and compaction of backfill
         18) Clean-up

1.3 REFERENCES

A. Definitions

1. Manhole Type
   a. Standard Manhole (See City Standard Details)
      1) Greater than 4 feet deep up to 6 feet deep
   b. Standard Drop Manhole (See City Standard Details)
      1) Same as Standard Manhole with external drop connection(s)
   c. Type “A” Manhole (See City Standard Details)
      1) Manhole set on a reinforced concrete block placed around 39-inch and larger sewer pipe.
   d. Fiberglass Type “A” Manhole (See City Standard Detail for Tee Base Manhole)
      1) Manhole set on a reinforced concrete block placed around 39-inch and larger sewer pipe.
2) Fiberglass sewer pipe tee-base fitting.
3) Standard precast manhole riser per City Standard Details.
e. Shallow Manhole (See City Standard Details)
   1) Less than four 4 deep with formed invert for sewer pipe diameters smaller than 39-inch

2. Manhole Size
   a. 4 foot diameter
      1) Used with pipe ranging from 8-inch to 15-inch
   b. 5 foot diameter
      1) Used with pipe ranging from 18-inch to 36-inch
      2) See specific manhole design on Drawings for pipes larger than 36-inch.

B. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. ASTM International (ASTM):

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Precast Concrete Manhole
   2. Drop connection materials
   3. Pipe connections at manhole walls
   4. Stubs and stub plugs
   5. Admixtures
   6. Concrete Mix Design

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
1. Manufacturer’s Warranty shall be in accordance with Division 1.

**PART 2 - PRODUCTS**

**2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]**

**2.2 EQUIPMENT, PRODUCT TYPES, AND MATERIALS**

A. Manufacturers

1. Only the manufacturers as listed on the City’s Standard Products List will be considered as shown in Section 01 60 00.
   a. The manufacturer must comply with this Specification and related Sections.

2. Any product that is not listed on the Standard Products List is considered a substitution and shall be submitted in accordance with Section 01 25 00.

B. Materials

1. Concrete – Conform to Section 03 30 00.


3. Precast Sections
   a. Provide bell-and-spigot design incorporating a premolded joint sealing compound for wastewater use.
   b. Clean bell spigot and gaskets, lubricate and join.
   c. Minimize number of segments.
   d. Use long joints at the bottom and shorter joints toward the top.
   e. Include manufactures stamp on each section.

4. Lifting Devices
   a. Manhole sections and cones may be furnished with lift lugs or lift holes.
      1) If lift lugs are provided, place 180 degrees apart.
      2) If lift holes are provided, place 180 degrees apart and grout during manhole installation.

5. Frame and Cover – Conform to Section 33 05 13.

6. Grade Ring – Conform to Section 33 05 13 and ASTM C478.

7. Pipe Connections
   a. Utilize either an integrally cast embedded pipe connector or a boot-type connector installed in a circular block out opening conforming to ASTM C923.

8. Steps
   a. No steps are allowed.

9. Interior Coating or Liner – Conform to Section 33 39 60.

10. Exterior Coating
    a. Use Coal Tar Bitumastic for below grade damp proofing.
    b. Dry film thickness shall be no less than 12 mils and no greater than 30 mils.
    c. Solids content is 68 percent by volume ± 2 percent.

11. Fiberglass Tee Base – Conform to Section 33 31 13.
2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Evaluation and Assessment
   1. Verify lines and grades are in accordance to the Drawings.

3.3 PREPARATION

A. Foundation Preparation
   1. Excavate 8 inches below manhole foundation.
   2. Replace excavated soil with course aggregate; creating a stable base for manhole construction.
      a. If soil conditions or ground water prevent use of course aggregate base a 2-inch mud slab may be substituted.

3.4 INSTALLATION

A. Manhole
   1. Construct manhole to dimensions shown on Drawings.
   2. Precast Sections
      a. Provide bell-and-spigot design incorporating a premolded joint sealing compound for wastewater use.
      b. Clean bell spigot and gaskets, lubricate and join.
      c. Minimize number of segments.
      d. Use long joints used at the bottom and shorter joints toward the top.

B. Invert
   1. Construct invert channels to provide a smooth waterway with no disruption of flow at pipe-manhole connections.
   2. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature.
      a. Provide curves for side inlets.
   3. For all standard manholes provide full depth invert.
   4. For example, if 8-inch pipe in connected to manhole construct the invert to full 8 inches in depth.

C. Drop Manhole Connection
   1. Install drop connection when sewer line enters manhole higher than 24 inches above the invert.

D. Final Rim Elevation
   1. Install concrete grade rings for height adjustment.
      a. Construct grade ring on load bearing shoulder of manhole.
      b. Use sealant between rings as shown on Drawings.
2. Set frame on top of manhole or grade rings using continuous water sealant.
3. Remove debris, stones and dirt to ensure a watertight seal.
4. Do not use steel shims, wood, stones or other unspecified material to obtain the final surface elevation of the manhole frame.

E. Internal coating
   1. Internal coating application will conform to Section 33 39 60, if required by Drawings.

F. External coating
   1. Remove dirt, dust, oil and other contaminants that could interfere with adhesion of the coating.
   2. Cure manhole for 3 days before backfilling around the structure.
   3. Application will follow manufacturer’s recommendation.

G. Modifications and Pipe Penetrations
   1. Conform to Section 03 80 00.

3.5 REPAIR / RESTORATION [NOT USED]
3.6 RE-INSTALLATION [NOT USED]
3.7 FIELD QUALITY CONTROL
   A. Field Tests and Inspections
      1. Perform vacuum test in accordance with Section 33 01 30.

3.8 SYSTEM STARTUP [NOT USED]
3.9 ADJUSTING [NOT USED]
3.10 CLEANING [NOT USED]
3.11 CLOSEOUT ACTIVITIES [NOT USED]
3.12 PROTECTION [NOT USED]
3.13 MAINTENANCE [NOT USED]
3.14 ATTACHMENTS [NOT USED]

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Revision Log
SECTION 33 39 60
EPOXY LINERS FOR SANITARY SEWER STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of a high-build epoxy coating system to concrete utility structures such as manholes, lift station wet wells, junction boxes or other concrete facilities that may need protection from corrosive materials

B. Deviations from this City of Fort Worth Standard Specification

1. None.

C. Related Specification Sections include but are not necessarily limited to:

1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract

2. Division 1 – General Requirements

3. Section 33 01 30 – Sewer and Manhole Testing

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Manholes

a. Measurement

1) Measurement for this Item shall be per vertical foot of coating as measured from the bottom of the frame to the top of the bench.

b. Payment

1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid per vertical foot of “Epoxy Manhole Liner” applied.

c. The price bid shall include:

1) Furnishing and installing Liner as specified by the Drawings

2) Hauling

3) Disposal of excess material

4) Clean-up

5) Cleaning

6) Testing

2. Non-Manhole Structures

a. Measurement

1) Measurement for this Item shall be per square foot of area where the coating is applied.

b. Payment

1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per square foot of “Epoxy Structure Liner” applied.

c. The price bid shall include:

1) Furnishing and installing Liner as specified by the Drawings
2) Hauling
3) Disposal of excess material
4) Clean-up
5) Cleaning
6) Testing

1.3 REFERENCES

A. Reference Standards
1. Reference standards cited in this Specification refer to the current reference
standard published at the time of the latest revision date logged at the end of this
Specifcations, unless a date is specifically cited.
2. ASTM International (ASTM):
Reagents.
d. D790, Standard Test Methods for Flexural Properties of Unreinforced and
Reinforced Plastics and Electrical Insulating Materials.
the Taber Abraser.
f. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch
Gages.
g. D4541, Standard Test Method for Pull-off Strength of Coatings Using Portable
Adhesion Testers.
3. Environmental Protection Agency (EPA).
4. NACE International (NACE).
5. Occupational Safety and Health Administration (OSHA).
7. The Society for Protective Coatings/NACE International (SSPC/NACE):
a. sp 13/NACE No. 6, Surface Preparation of Concrete.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be approved by the Engineer or the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
1. Technical data sheet on each product used
2. Material Safety Data Sheet (MSDS) for each product used
3. Copies of independent testing performed on the coating product indicating the
product meets the requirements as specified herein
4. Technical data sheet and project specific data for repair materials to be topcoated
   with the coating product including application, cure time and surface preparation
   procedures
B. Contractor Data
   1. Current documentation from coating product manufacturer certifying Contractor’s
      training and equipment complies with the Quality Assurance requirements specified
      herein
   2. 5 recent references of Contractor indicating successful application of coating
      product(s) of the same material type as specified herein, applied by spray
      application within the municipal wastewater environment

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE
   A. Qualifications
      1. Contractor
         a. Be trained by, or have training approved and certified by, the coating product
            manufacturer for the handling, mixing, application and inspection of the coating
            product(s) to be used as specified herein
         b. Initiate and enforce quality control procedures consistent with the coating
            product(s) manufacturer recommendations and applicable NACE or SSPC
            standards as referenced herein

1.10 DELIVERY, STORAGE, AND HANDLING
   A. Keep materials dry, protected from weather and stored under cover.
   B. Store coating materials between 50 degrees F and 90 degrees F.
   C. Do not store near flame, heat or strong oxidants.
   D. Handle coating materials according to their material safety data sheets.

1.11 FIELD [SITE] CONDITIONS
   A. Provide confined space entry, flow diversion and/or bypass plans as necessary to
      perform the specified work.

1.12 WARRANTY
   A. Contractor Warranty
      1. Contractor’s Warranty shall be in accordance with Division 0.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, MATERIALS
   A. Repair and Resurfacing Products
      1. Compatible with the specified coating product(s) in order to bond effectively, thus
         forming a composite system
      2. Used and applied in accordance with the manufacturer’s recommendations
      3. The repair and resurfacing products must meet the following:
a. 100 percent solids, solvent-free epoxy grout specifically formulated for epoxy
topcoating compatibility
b. Factory blended, rapid setting, high early strength, fiber reinforced, non-shrink
repair mortar that can be towed or pneumatically spray applied and
specifically formulated to be suitable for topcoating with the specified coating
product used

B. Coating Product
1. Capable of being installed and curing properly within a manhole or concrete utility
environment
2. Resistant to all forms of chemical or bacteriological attack found in municipal
sanitary sewer systems; and, capable of adhering to typical manhole structure
substrates
3. The 100 percent solids, solvent-free ultra high-build epoxy system shall exhibit the
following characteristics:
   a. Application Temperature – 50 degrees F, minimum
   b. Thickness – 125 mils minimum
   c. Color – White, Light Blue, or Beige
   d. Compressive Strength (per ASTM D695) – 8,800 psi minimum
   e. Tensile Strength (per ASTM D638) – 7,500 psi minimum
   f. Hardness, Shore D (per ASTM D4541) – 70 minimum
   g. Abrasion Resistance (per ASTM D4060 CS 17F Wheel) – 80 mg loss
      maximum
   h. Flexural Modulus (per ASTM D790) – 400,000 psi minimum
   i. Flexural Strength (per ASTM D790) – 12,000 psi minimum
   j. Adhesion to Concrete, mode of failure (ASTM D4541): Substrate (concrete)
      failure
   k. Chemical Resistance (ASTM D543/G20) all types of service for:
      1) Municipal sanitary sewer environment
      2) Sulfuric acid, 30 percent
      3) Sodium hydroxide, 5 percent

C. Coating Application Equipment
1. Manufacturer approved heated plural component spray equipment
2. Hard to reach areas, primer application and touch-up may be performed using hand
tools.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL
1. Testing
   a. Take wet film thickness gauge per ASTM D4414 at 3 locations within the
      manhole, 2 spaced equally apart along the wall and 1 on the bench.
      1) Document and attest measurements and provide to the City.
   b. After coating has set, repair all visible pinholes by lightly abrading the surface
      and brushing the lining material over the area.
   c. Repair all blisters and evidence of uneven cover according to the
      manufacturer’s recommendations.
   d. Test manhole for final acceptance according to Section 33 01 30.
PART 3 - EXECUTION

3.1 INSTALLERS
A. All installers shall be certified applicators approved by the manufacturers.

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION
A. Manhole Preparation
   1. Stop active flows via damming, plugging or diverting as required to ensure all
      liquids are maintained below or away from the surfaces to be coated.
   2. Maintain temperature of the surface to be coated between 40 and 120 degrees F.
   3. Shield specified surfaces to avoid exposure of direct sunlight or other intense heat
      source.
      a. Where varying surface temperatures do exist, coating installation should be
         scheduled when the temperature is falling versus rising.

B. Surface Preparation
   1. Remove oils, grease, incompatible existing coatings, waxes, form release, curing
      compounds, efflorescence, sealers, salts or other contaminants which may affect the
      performance and adhesion of the coating to the substrate.
   2. Remove concrete and/or mortar damaged by corrosion, chemical attack or other
      means of degradation so that only sound substrate remains.
   3. Surface preparation method, or combination of methods, that may be used include
      high pressure water cleaning, high pressure water jetting, abrasive blasting,
      shotblasting, grinding, scarifying, detergent water cleaning, hot water blasting and
      others as described in SSPC SP 13/NACE No. 6.
   4. All methods used shall be performed in a manner that provides a uniform, sound,
      clean, neutralized, surface suitable for the specified coating product.

3.4 INSTALLATION
A. General
   1. Perform coating after the sewer line replacement/repairs, grade adjustments and
      grouting are complete.
   2. Perform application procedures per recommendations of the coating product
      manufacturer, including environmental controls, product handling, mixing and
      application.

B. Temperature
   1. Only perform application if surface temperature is between 40 and 120 degrees F.
   2. Make no application if freezing is expected to occur inside the manhole within 24
      hours after application.

C. Coating
   1. Spray apply per manufacturer’s recommendation at a minimum film thickness of
      125 mils.
   2. Apply coating from bottom of manhole frame to the bench/trough, including the
      bench/trough.
3. After walls are coated, remove bench covers and spray bench/trough to at least the same thickness as the walls.
4. Apply any topcoat or additional coats within the product’s recoat window.
   a. Additional surface preparation is required if the recoat window is exceeded.
5. Allow a minimum of 3 hours of cure time or be set hard to touch before reactivating flow.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [or] SITE QUALITY CONTROL
   A. Each structure will be visually inspected by the City the same day following the application.
   B. The inspector will check for deficiencies, pinholes and thin spots.
   C. If leaks are detected they will be chipped back, plugged and coated immediately with protective epoxy resin coating.
      1. Make repair 24 hours after leak detection.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES
   A. Upon final completion of the work, the manufacturer will provide a written certification of proper application to the City.
   B. The certification will confirm that the deficient areas were repaired in accordance with the procedure set forth in this Specification.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

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CITY OF FORT WORTH
STANDARD CONSTRUCTION SPECIFICATION DOCUMENTS
Draft 5/14/2012 3:33 PM
Revised July 1, 2011
SECTION 34 71 13
TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
  1. Installation of Traffic Control Devices and preparation of Traffic Control Plans
B. Deviations from this City of Fort Worth Standard Specification
  1. None.
C. Related Specification Sections include, but are not necessarily limited to:
  1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
  2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
  1. Installation of Traffic Control Devices
    a. Measurement
      1) Measurement for Traffic Control Devices shall be per month for the Project
duration.
      a) A month is defined as 30 calendar days.
    b. Payment
      1) The work performed and materials furnished in accordance with this Item
      and measured as provided under “Measurement” shall be paid for at the
      unit price bid for “Traffic Control”.
    c. The price bid shall include:
      1) Traffic Control implementation
      2) Installation
      3) Maintenance
      4) Adjustments
      5) Replacements
      6) Removal
  2. Portable Message Signs
    a. Measurement
      1) Measurement for this Item shall be per week for the duration of use.
    b. Payment
      1) The work performed and materials furnished in accordance to this Item and
      measured as provided under “Measurement” shall be paid for at the unit
      price bid per week for “Portable Message Sign” rental.
    c. The price bid shall include:
      1) Delivery of Portable Message Sign to Site
      2) Message updating
      3) Sign movement throughout construction
      4) Return of the Portable Message Sign post-construction
  3. Preparation of Traffic Control Plan Details
1. Measurement
   1) Measurement for this Item be per each Traffic Control Detail prepared.

2. Payment
   1) The work performed and materials furnished in accordance with this Item
      shall be paid for at the unit price bid per each “Traffic Control Detail”
      prepared.

3. The price bid shall include:
   1) Preparing the Traffic Control Plan Details
   2) Adherence to City and Texas Manual on Uniform Traffic Control Devices
      (TMUTCD)
   3) Obtaining the signature and seal of a licensed Texas Professional Engineer
   4) Incorporation of City comments

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference
      standard published at the time of the latest revision date logged at the end of this
      Specification, unless a date is specifically cited.
   3. Item 502, Barricades, Signs, and Traffic Handling of the Texas Department of
      Transportation, Standard Specifications for Construction and Maintenance of
      Highways, Streets, and Bridges.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. Contact Traffic Services Division (817-392-7738) a minimum of 48 hours prior to
      implementing Traffic Control within 500 feet of a traffic signal.

B. Sequencing
   1. Any deviations to the Traffic Control Plan included in the Drawings must be first
      approved by the City and design Engineer before implementation.

1.5 SUBMITTALS

A. Provide the City with a current list of qualified flaggers before beginning flagging
   activities. Use only flaggers on the qualified list.

B. Obtain a Street Use Permit from the Street Management Section of the Traffic
   Engineering Division, 311 W. 10th Street. The Traffic Control Plan (TCP) for the
   Project shall be as detailed on the Traffic Control Plan Detail sheets of the Drawing set.
   A copy of this Traffic Control Plan shall be submitted with the Street Use Permit.

C. Traffic Control Plans shall be signed and sealed by a licensed Texas Professional
   Engineer.

D. Contractor shall prepare Traffic Control Plans if required by the Drawings or
   Specifications. The Contractor will be responsible for having a licensed Texas
   Professional Engineer sign and seal the Traffic Control Plan sheets.

E. Contractor responsible for having a licensed Texas Professional Engineer sign and seal
   changes to the Traffic Control Plan(s) developed by the Design Engineer.
F. Design Engineer will furnish standard details for Traffic Control.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [or] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 ASSEMBLIES AND MATERIALS

A. Description

1. Regulatory Requirements
   a. Provide Traffic Control Devices that conform to details shown on the
      Drawings, the TMUTCD, and TxDOT’s Compliant Work Zone Traffic Control
      Device List (CWZTCDL).

2. Materials
   a. Traffic Control Devices must meet all reflectivity requirements included in the
      TMUTCD and TxDOT Specifications – Item 502 at all times during
      construction.
   b. Electronic message boards shall be provided in accordance with the TMUTCD.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 EXAMINATION [NOT USED]

3.2 PREPARATION

A. Protection of In-Place Conditions
   1. Protect existing traffic signal equipment.

3.3 INSTALLATION

A. Follow the Traffic Control Plan (TCP) and install Traffic Control Devices as shown on
   the Drawings and as directed.

B. Install Traffic Control Devices straight and plumb.
C. Do not make changes to the location of any device or implement any other changes to the Traffic Control Plan without the approval of the Engineer.
   1. Minor adjustments to meet field constructability and visibility are allowed.

D. Maintain Traffic Control Devices by taking corrective action as soon as possible.
   1. Corrective action includes but is not limited to cleaning, replacing, straightening, covering, or removing Devices.
   2. Maintain the Devices such that they are properly positioned, spaced, and legible, and that retroreflective characteristics meet requirements during darkness and rain.

E. If the Inspector discovers that the Contractor has failed to comply with applicable federal and state laws (by failing to furnish the necessary flagmen, warning devices, barricades, lights, signs, or other precautionary measures for the protection of persons or property), the Inspector may order such additional precautionary measures be taken to protect persons and property.

F. Subject to the approval of the Inspector, portions of this Project, which are not affected by or in conflict with the proposed method of handling traffic or utility adjustments, can be constructed during any phase.

G. Barricades and signs shall be placed in such a manner as to not interfere with the sight distance of drivers entering the highway from driveways or side streets.

H. To facilitate shifting, barricades and signs used in lane closures or traffic staging may be erected and mounted on portable supports.
   1. The support design is subject to the approval of the Engineer.

I. Lane closures shall be in accordance with the approved Traffic Control Plans.

J. If at any time the existing traffic signals become inoperable as a result of construction operations, the Contractor shall provide portable stop signs with 2 orange flags, as approved by the Engineer, to be used for Traffic Control.

K. Flaggers
   1. Provide a Contractor representative who has been certified as a flagging instructor through courses offered by the Texas Engineering Extension Service, the American Traffic Safety Services Association, the National Safety Council, or other approved organizations.
      a. Provide the certificate indicating course completion when requested.
      b. This representative is responsible for training and assuring that all flaggers are qualified to perform flagging duties.
   2. A qualified flagger must be independently certified by 1 of the organizations listed above or trained by the Contractor’s certified flagging instructor.
   3. Flaggers must be courteous and able to effectively communicate with the public.
   4. When directing traffic, flaggers must use standard attire, flags, signs, and signals and follow the flagging procedures set forth in the TMUTCD.
   5. Provide and maintain flaggers at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and Contractor’s personnel, and as shown on the Drawings or as directed by the Engineer.
      a. These flaggers shall be located at each end of the lane closure.

L. Removal
1. Upon completion of Work, remove from the Site all barricades, signs, cones, lights and other Traffic Control Devices used for work-zone traffic handling in a timely manner, unless otherwise shown on the Drawings.

3.4 REPAIR / RESTORATION [NOT USED]

3.5 RE-INSTALLATION [NOT USED]

3.6 FIELD [or] SITE QUALITY CONTROL [NOT USED]

3.7 SYSTEM STARTUP [NOT USED]

3.8 ADJUSTING [NOT USED]

3.9 CLEANING [NOT USED]

3.10 CLOSEOUT ACTIVITIES [NOT USED]

3.11 PROTECTION [NOT USED]

3.12 MAINTENANCE [NOT USED]

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Revision Log
Barcelona, January 2016

PABLO CASALS VILAR
CIVIL ENGINEER