

City of Killeen, Texas



INFRASTRUCTURE DESIGN & DEVELOPMENT STANDARDS MANUAL

July 24, 2012

Updated May 13, 2014

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NOTE: IN THE ABSENCE OF CITY OF KILLEEN STANDARD DRAINAGE DETAILS, THE



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SECTION 200 – PROJECT REQUIREMENTS

ITEM 201. DEVELOPMENT PROJECTS

201.1 **TESTING**

- A. All tests that require witness by the City of Killeen or its designated representative shall be scheduled a minimum of two (2) working days prior to the test. Working days shall be defined as Monday through Friday, 7:00 a.m. to 6:00 p.m., excluding all holidays observed by the City of Killeen.
- B. All tests shall be certified by the appropriate authority and documentation shall be provided to the City clearly stating the results of the tests.

201.2 **SPECIFICATIONS**

- A. All portions of the specifications found within shall apply to development projects excluding the PAYMENT sections. All testing as required by a specification shall be done in accordance with the appropriate section. The City of Killeen shall pay the costs for passing density tests. The cost of any failing density tests shall be the responsibility of the Developer or his Contractor.
- B. Section 204 – SUMMARY OF WORK shall not apply to development projects.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 202. DEFINITION OF TERMS

202.01

DEFINITIONS

- A. Wherever in these specifications or in other contract documents, the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:
1. CITY - The City of Killeen, party of the First Part.
 2. COUNCIL - The Killeen City Council.
 3. COUNTY - A political Subdivision of the State.
 4. ENGINEER- Representative of the City.
*ENGINEER - Representative of the Contractor or the Developer.
 5. INSPECTOR - The authorized representative of the City assigned to inspect any or all parts of the work and the materials to be used therein.
 6. CONTRACTOR - The individual, firm or corporation or any combination thereof, Party of the Second Part, with which the contract is made by the City, Developer or Public Cooperation.
 7. SUPERINTENDENT - The representative of the Contractor authorized to receive and fulfill instructions from the Engineer or representative of the City, and who shall supervise and direct the construction.
 8. PAVEMENT DESIGN MANUAL - Texas Department of Transportation manual outlining procedure to be followed in the design and control of asphaltic concrete and portland cement concrete mixes for structures and pavements.
 9. MANUAL OF TESTING PROCEDURES - Texas Department of Transportation Materials and Tests Division manual outlining testing methods and procedures.
 10. PLANS - The drawings approved by the City, or true reproductions thereof, which show the location, character, dimensions, and details of the work and which are a part of the contract. Plans and specifications to be prepared by a Professional Engineer registered in the State of Texas.
 11. SPECIFICATIONS - The directions, provisions and requirements contained herein or in the Special Provisions, supplemented by such “Special Provisions or Standards” as may be issued or made pertaining to the method and manner or performing the work or qualities of materials to be furnished. Where the phrases “or directed by the City”, “ordered by the City”, or “to the satisfaction of the City” occur, it is to be understood that the directions, orders, or instructions of which they relate are within the limitations of, and authorized by the contract. “Special Provisions” will cover work pertaining to a particular project included in the proposal but not covered by the specifications. Where reference is made to specifications of ASTM, AWWA, AASHTO or Bulletins and Manuals of the Texas Department of Transportation it shall be construed to mean the latest standard or tentative standard in effect on the date of the proposal.
 12. RIGHT OF WAY - The land provided for a highway or street, owned by the City of Killeen or the municipality in which the highway or street is in.



13. ROADWAY - The portion of the highway or street within the limits of construction.
14. ROADBED - The graded portion of the roadway between the intersection of top and side slopes upon which the base course, surface course, shoulders and median are constructed.
15. SUBGRADE - That portion of the roadbed upon which the subbase, base, or pavement structure is to be placed.
16. BRIDGES - Structures of over 20-foot span measured from face to face of abutments, or in case of copings, from face to face of copings, and multiple span structures of over 20-foot length, measured between inside of end walls along the centerline of the roadbed.
17. CULVERTS - All drainage structures not defined as bridges.
18. TEMPORARY STRUCTURES - All temporary bridges and structures required to maintain traffic during the construction of the work.
19. SUBSTRUCTURE - That part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls and wing walls of abutments shall be considered as parts of the substructure.
20. SUPERSTRUCTURE - The part of the structure above the bridge seats or above the springing lines of arches.
21. THE WORK - The work shall include the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.
22. PROJECT - The specific section or sections of the highway or street together with all appurtenances and construction to be performed thereon under the contract.
23. ASTM - American Society for Testing Materials.
24. AASHTO - American Association of State Highway and Transportation Officials.
25. ANSI - American National Standards Institute.
26. API - American Petroleum Institute.
27. UL - Underwriters Laboratory, Inc.
28. SCREENS AND SIEVES - As defined by the ASTM.
29. HIGHWAY, STREET OR ROAD - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas-highway or road.
30. ARTERIAL HIGHWAY OR STREET - A general term denoting a highway or street primarily for through traffic, usually on a continuous route.
31. MAJOR STREET OR MAJOR HIGHWAY - An arterial highway or street with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.



32. THROUGH STREET OR THROUGH HIGHWAY - Every highway, street, or portion thereof at the entrance to which vehicular traffic from intersecting highways or streets is required by law to stop before entering or crossing the same and when stop signs are erected.
33. LOCAL STREET OR LOCAL ROAD - A street or road primarily for access to residence, business, or other abutting property.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 203. ABBREVIATIONS

203.1

SCOPE

A. Whenever in these Contract Documents or Specifications the following abbreviations are used, the intent and meaning shall be interpreted as follows:

1. AA Aluminum Association
2. AAMA Architectural Aluminum Manufacturers' Association
3. AASHTO American Association of State Highway and Transportation Officials
4. ACI American Concrete Institute
5. AFBMA Anti-Friction Bearing Manufacturers' Association
6. AGA American Gas Association
7. AGMA American Gear Manufacturers' Association
8. AISC American Institute of Steel Construction
9. AISI American Iron and Steel Institute
10. AITC American Institute of Timber Construction
11. AMCA Air Moving and Conditioning Association
12. ANSI American National Standards Institute
13. APA American Plywood Association
14. API American Petroleum Institute
15. AREA American Railway Engineering Association
16. ASAE American Society of Agricultural Engineers
17. ASCE American Society of Civil Engineers
18. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
19. ASME American Society of Mechanical Engineers
20. ASTM American Society of Testing and Materials
21. AWI Architectural Woodwork Institute
22. AWPA American Wood Preservers' Association
23. AWPB American Wood Preservers' Bureau
24. AWS American Welding Society
25. AWWA American Water Works Association
26. BHMA Builders' Hardware Manufacturers' Association
27. CBMA Certified Ballast Manufacturers' Association
28. CDA Copper Development Association
29. CISPI Cast Iron Soil Pipe Institute
30. CMAA Crane Manufacturers' Association of America
31. CRSI Concrete Reinforcing Steel Institute



32.	Fed. Spec.	Federal Specifications
33.	HI	Hydraulic Institute
34.	HMI	Hoist Manufacturers' Institute
35.	ICBO	International Conference of Building Officials
36.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
37.	IPCEA	Insulated Power Cable Engineer's Association
38.	MMA	Monorail Manufacturers' Association
39.	NACE	National Association of Coatings Engineers
40.	NBMA	National Builders' Hardware Association
41.	NEC	National Electrical Code
42.	NEMA	National Electrical Manufacturers' Association
43.	NESC	National Electric Safety Code
44.	NFPA	National Fire Protection Association
45.	NLMA	National Lumber Manufacturers' Association
46.	NWMA	National Woodwork Manufacturers' Association
47.	OECI	Overhead Electrical Crane Institute
48.	OSHA	Occupational Safety and Health Act (both Federal & State)
49.	PS	Product Standards Sections - U.S. Department of Commerce
50.	RMA	Rubber Manufacturers' Association
51.	SAE	Society of Automotive Engineers
52.	SSPC	Steel Structures Painting Council
53.	TCA	Tile Council of America
54.	TxDOT	Texas Department of Transportation
55.	TEMA	Tubular Exchanger Manufacturers' Association
56.	UBC	Uniform Building Code
57.	UL	Underwriter's Laboratories, Inc.
58.	WWPA	Western Wood Products Association

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 204. SUMMARY OF WORK

*** For Projects Contracted by the City of Killeen for Capital Improvements ***

204.1 SCOPE OF WORK

- A. This specification covers the requirements for constructing TO BE COMPLETED BY DESIGN ENGINEER as shown on the construction Plans and specified herein.
- B. The Work is located within the City of Killeen as shown on the Location Map included in the Plans.
- C. The Work includes, but is not necessarily limited to, the following:
 - 1. DESCRIPTION TO BE COMPLETED BY DESIGN ENGINEER.

204.2 WORK SEQUENCE

- A. Perform work in sequence as agreed upon at the pre-construction conference.

204.3 PROGRESS OF THE WORK

- A. The Work shall be started within 10 days following the effective date of the Notice to Proceed, and the Work shall be executed with such progress as may be required to prevent any delay to the general completion of the project. The Work shall be executed at such times and in or on such parts of the project, and with such personnel, materials, and equipment to assure completion of the Work in the time established by the Agreement.
- B. If the Contractor for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request to the City and he shall allow ample time for satisfactory arrangements to be made for inspecting the work in progress. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Killeen.

204.4 CONSTRUCTION SCHEDULE

- A. The Contractor shall, within 5 days after the effective date of the Notice to Proceed, provide and submit to the City for approval, the Schedule for the project. A complete updated schedule shall be submitted with monthly pay requests. The Schedule shall account for all the work of the Contractor and his Subcontractors and suppliers. In addition to all reasonably important construction activities, the Schedule shall provide for the proper sequence of construction considering the various crafts, purchasing time, submittal approval, material delivery, equipment fabrication, and similar time consuming factors.
- B. The Schedule shall include, as a minimum, the earliest starting and finish dates, and latest starting and finish dates, and the total float for each task or item. The Contractor shall update (monitor) the schedule as necessary and shall submit to the City a copy of the updated schedule (monthly) at the same time the pay estimate is prepared. The schedule shall contain all of the items of the Periodic Estimate and Pay Schedule.

While the Contractor bears full responsibility for scheduling all phases and stages of the Work to ensure its successful prosecution and completion within the time specified in accordance with all provisions of these Specifications, the Contractor is specifically required to complete fully or complete such stages of work to enable his Subcontractors and suppliers to complete their work within the respective times specified.



- C. If the City determines that operations are falling behind schedule at any time during the construction period, the City may require the Contractor to add to his plant, equipment and/or construction forces, including increases in working hours, in such quantities as are required to bring operations back on schedule. Upon receipt of written communication from the City requiring such addition, the Contractor shall furnish same at no additional cost to the City.

204.5

PRECONSTRUCTION CONFERENCE

- A. A pre-construction conference shall be held as soon as possible after Award of Contract and before work is started. The conference will be held at a location selected by the City. The conference will be attended by:
1. Contractor's Office Representative.
 2. Contractor's General Superintendent.
 3. Any subcontractors' or suppliers' representatives whom the Contractor may desire to invite or the City may request.
 4. Engineer's Representatives.
 5. City's Representatives.
 6. Such other individuals that the City may invite.
- B. A suggested format would include but not be limited to the following subjects:
1. Check of required bonds and insurance certifications.
 2. Liquidated damages.
 3. Shop drawing submittal and approval procedure.
 4. Chain of command, direction of correspondence, and coordinating responsibility between Contractors.
 5. Schedule of periodic job meetings for all involved.
 6. Introduction of the key project personnel.
 7. Equal opportunity requirements.
 8. Laboratory testing of material requirements.
 9. Inventory of material stored on site provisions.
 10. Progress estimate and payment procedure.
 11. Discussion of Contractor's Safety program.
 12. Scheduled plan for work requiring interruption of existing operations.
 13. Review of the construction Plans and Specifications.
 14. Discussion of Contractor's storage facilities for the Project.
- C. The City's Representative will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be



circulated at the beginning of the conference.

204.6

CONSTRUCTION MEETINGS

- A. Periodic Construction meetings shall be held at intervals designated by the City, generally weekly to review the progress at the project, submittals, upcoming activities, pay requests, etc. The Contractor is expected to have at least the project Superintendent present for all meetings. Attendance at the meetings shall not be directly paid for but shall be considered subsidiary to the items of the Contract.

204.7

COORDINATION WITH CITY'S OPERATIONS AND EXISTING FACILITIES

- A. Several parts of the proposed Work under this Contract may connect with or into existing facilities. The Contractor shall plan carefully the schedule of that portion of the Work which will affect the existing facilities. Such plans and schedules shall be subject to the approval of the City of Killeen.
- B. Work which requires shutdown or in any way impedes the operations of existing facilities shall be closely coordinated with the City of Killeen. A minimum of 48 hours written notice shall be given to the City of Killeen.
- C. Immediately after the award of a Contract for this Project, the Contractor shall outline and submit a scheduled plan for installation of the work, which requires interruption of operations.

204.8

CONTRACTOR'S USE OF PREMISES

- A. Contractor shall limit the use of the premises for his/her work and coordinate use of the premises with the City to allow for:
 - 1. Work by other Contractors.
 - 2. Public use.
- B. Contractor shall assume full responsibility for security of all materials and equipment stored on the site.
- C. If directed by the City, move any stored items, which interfere with operations of the City, other contractors, or the public.
- D. Obtain and pay for use of additional storage or work areas at no additional cost to the City if needed to perform the Work.
- E. Contractor shall submit to the City for approval a plan of operations, designating proposed areas of the property to be used for his operations, material storage, equipment storage, employee's parking, offices and shops. The area shall effect minimal interference with the present operations.
- F. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- G. Any fence that is damaged or removed by the Contractor will be replaced at the Contractor's expense in like kind, and to the satisfaction of the City.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 205. SITE CONDITIONS

205.1 SCOPE OF WORK

- A. This specification covers the requirements for investigation and verification of site conditions for the Project.

205.2 SUBSURFACE INFORMATION

- A. Geotechnical investigations for this project were made by name of Geotechnical Engineering Company of name of City, Texas. **OR: No Geotechnical investigations were made for this project.**
- B. A copy of the Geotechnical Report is included in the back of the Contract Documents. The Geotechnical Report is provided for informational purposes only and no guarantees are implied as to the accuracy of any subsurface information. **(PARAGRAPH MAY BE DELETED IF NO GEOTECHNICAL INVESTIGATION WAS MADE FOR PROJECT).**

205.3 SITE INVESTIGATION AND REPRESENTATION

- A. The Bidder / Contractor acknowledges that he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this Contract.
- B. The Contractor further acknowledges that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information derived from exploratory work, if any, that has been done by the City as presented in the geotechnical report, if available, as well as from information presented herein as a part of these Contract Documents. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work. Neither the City nor the Engineer assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the City or the Engineer.

205.4 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Known utilities and structures adjacent to or encountered in the work are shown on the Plans. The locations shown are taken from existing records and the best information available from existing plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the City or the Engineer for their accuracy or completeness.
- B. Neither the City nor its officers or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the work.
- C. The Contractor shall at all times provide unobstructed access to fire hydrants and structures as per Fire Code, underground conduit, manholes, and water or gas valve boxes.



- D. Where the Contractor's operations could cause damage which might result in considerable expense, loss, or inconvenience when his operations are adjacent to or near railway, telegraph, telephone, television, power, oil, gas, water, sewer, irrigation, or other systems, no operations shall be commenced until the Contractor has made all arrangements necessary for the protection of these utilities and services.
- E. The Contractor shall notify all utility offices that are affected by the construction operation at least 15 days in advance of commencing construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.
- F. The Contractor shall be solely and directly responsible to the City and operators of such utility properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage that may result from the construction operations under this Contract.
- G. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, the Contractor shall promptly notify the proper authority and cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair.
- H. The Contractor shall replace, at his own expense, any and all other existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents.
- I. Where existing utility lines or structures are so located as to physically conflict with permanent structures to be constructed under this Contract, the conflicting utility line or structure shall be permanently relocated.
- J. The Contractor shall give immediate notice to the Engineer, the City and the owner of the utility (where applicable) when a physical conflict is determined to exist.
 - 1. Contractor will not be charged contract time for delays caused by unanticipated conflicts.
 - 2. Contractor shall not charge the City of Killeen for lost time or down time for unanticipated conflicts.
- K. Where existing utility lines or structures are so located as to interfere with the Contractor's prosecution of the work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at the expense of the Contractor.

205.5

INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Plans. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid known possible difficulties.
- B. Protect existing structures from damage, whether or not they lie within the right-of-way or the limits of the easements obtained by the City. Where existing structures must be removed to properly carry out the work, or are damaged during the work, they shall be restored at the Contractor's own expense to at least their original condition and to the satisfaction of the Engineer.
- C. The Contractor may, with the approval of the Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with the Contractor's operations.



205.6

FIELD RELOCATION

- A. During the progress of the work, minor relocations of the work may be necessary. Such relocations shall be made only by direction of the Engineer or the City. If existing structures are encountered that will prevent construction as shown, notify the Engineer before continuing with the work in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. If the Contractor fails to notify the Engineer when an existing structure is encountered and proceeds with the work despite this interference, he shall be responsible for any damage that may occur.

205.7

LAND MONUMENTS

- A. The Contractor shall preserve or replace any existing Federal, State, County, City, and private land monuments encountered.
- B. Any damaged or destroyed monuments shall be replaced at the sole expense of the Contractor as designated by the controlling authority of the Entity.

205.8

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 206. CONTRACTOR USE OF PREMISES

206.1 SCOPE OF WORK

- A. This specification covers the requirements for the Contractor's use of the premises for the Project.

206.2 GENERAL

- A. Contractor shall limit his use of the premises, for work and for storage, to the areas designated on the Plans, or approved by the City.
- B. Contractor shall assume full responsibility for the protection and safekeeping of materials under this Contract stored on the site.
- C. Contractor shall move any stored materials, under Contractor's control, which interfere with operations of the City of Killeen.
- D. Contractor shall obtain and pay for the use of additional storage or work areas needed for operations.
- E. Water meters for construction shall not be issued to parties that are indebted to the City of Killeen.
- F. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- G. Any fence that is damaged or removed by the Contractor will be replaced at the Contractor's expense in like kind, and to the satisfaction of the Engineer and the City.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 207. CONTROL OF WORK

207.1 SCOPE OF WORK

- A. This specification covers the requirements for exercising control of work performed on the Project.

207.2 AUTHORITY OF ENGINEER OR INSPECTOR

- A. The work will be done in accordance with the Contract, Plans and Specifications. The Engineer or Inspector will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed and the interpretations of the Plans and Specifications. His decisions will be final, and he will have executive authority to enforce and make effective such decisions and orders.

207.3 CONFORMITY WITH PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. All work performed and all materials furnished shall be in reasonable close conformity with the lines, grades, cross sections, dimensions, details, gradations, physical and chemical characteristics of materials in accordance with tolerances shown on the Plans or indicated in the Specifications and Special Provisions. The limits establishing reasonable close conformity will be as defined in these items of the contract.
- B. In the event the City finds that the work performed or the materials used are not within reasonable close conformity with the Plans, Specifications and Special Provisions, the affected material or product shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.
- C. Deviations from the Plans and approved working drawings as may be required will in all cases be determined by the City and authorized in writing. Before final acceptance of the project is issued by the City, the Contractor shall provide the City with a set of record drawings for the project certified by the Engineer of record.

207.4 COORDINATION OF PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. The Specifications, the accompanying Plans, Special Provisions, and Supplemental Agreements, are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be co-operative and to describe and provide for a complete work. In cases of disagreement, figured dimensions shall govern over scaled dimensions, the Plans shall govern over Specifications, and Special Provisions shall govern over both Specifications and Plans.

207.5 AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these Specifications, nor to approve or accept any portion of work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the work.



207.6

PLAN

- A. The Contractor shall furnish plan and equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Proposal. If at any time such plan appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character or increase the plan and equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of work and rate of progress required.

207.7

PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by written permission of the respective landowner. The Contractor shall provide the City of Killeen a copy of any agreement reached with private landowners.

207.8

PIPE LOCATIONS

- A. Pipelines shall be located substantially as indicated on the Plans, but the Engineer and the City reserve the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Plans, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

207.9

OPEN EXCAVATIONS

- A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight. The Contractor shall take precautions, such as fences and barricades, to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles, which could be dangerous to the public, shall be well lighted at night. All trenches shall conform to the requirements of OSHA.

207.10

TEST PITS

- A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer or the City. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer and the City.

207.11

MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street is received in writing from the proper authority, all excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer and the City.



- B. Detours around construction will be subject to the approval of the City and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the City.
- C. The Contractor shall take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

207.12 BLASTING

- A. No blasting shall be allowed unless approved in writing by the City of Killeen.

207.13 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better than existing before the damage was done, or he shall make good the damage in some other manner acceptable to the Engineer and the City.
- B. A preconstruction video will be required for CIP projects.

207.14 MAINTENANCE OF FLOW

- A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and the City well in advance of the interruption of any flow.

207.15 COOPERATION WITHIN THIS CONTRACT

- A. The Contractor shall cooperate with Subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the Contractor and his Subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer or the City.

207.16 CLEANUP

- A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. The Contractor shall dispose of all rubbish resulting from the construction work and, at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

207.17 FINAL INSPECTION

- A. Whenever the work provided for in, and contemplated under, the contract has been satisfactorily completed, the City will make the "Final Inspection". If the work is found to be satisfactory, the Contractor will be notified in writing of the acceptance of the same. The City will require a Certificate of Completion and Final Acceptance from the Inspector before any building, electric or plumbing permits will be issued or any City utilities provided. No such Certificate will be issued until all monuments have been set and record drawing reviewed by the Engineer of Record is provided to the City. If items are found in need of repair or completion, a final punch list will be generated and the



items shall be completed by the Contractor. The City will inspect the punch list items one time following their completion. Any subsequent inspections due to inadequate repair or completion of the punch list items shall be paid for by the Contractor or Developer.

- B. Final acceptance of the Project or Development does not relieve the Contractor or Developer of the responsibility of insuring all work shown on the Plans has been completed. If any portion of the work is found during the warranty period to be inferior or incomplete, the Contractor or Developer shall replace or complete the work at no expense to the City.

207.18

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 208. CONTROL OF MATERIALS

208.1 **SCOPE OF WORK**

- A. This specification covers the requirements for exercising control of materials used on the Project.

208.2 **SOURCES OF SUPPLY AND QUALITY OF MATERIALS**

- A. The source of supply of each of the materials shall be approved by the City before any deliveries and at the option of the City, may be sampled and tested for determining compliance with the governing Specifications by the City before delivery begins. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other approved sources. Only materials conforming to the requirements of these Specifications and approved by the City shall be used in the work. All materials being used are subject to inspection or test at any time during their preparation or use. Any materials which have been tested and accepted at the source of supply may be subjected to a check test after delivery and all materials which, when retested, do not meet approval or have in any way become unfit for use shall not be used in the work.
- B. Throughout these Specifications where reference is made to ASTM, AASHTO or bulletins of the Texas Department of Transportation for the quality of materials or sampling and testing, the most current standard, tentative standard or bulletin issued prior to the date of the proposal shall govern.

208.3 **SAMPLES AND TEST**

- A. All materials, before being incorporated in the work, shall be inspected, tested and approved by the City and any work in which materials are used without prior test and approval or written permission of the City may be ordered removed and replaced at the Contractor's expense. The Contractor shall be responsible for and pay for all charges of testing laboratories for services in conjunction with initial tests made on all imported materials to the project site including but not limited to embedment materials, fill materials, backfill materials, select material, crushed limestone base, sub-base, concrete, steel, wood forms, liquid asphalt, aggregate, water, cement, guard rail etc. Sampling and testing of all materials, on the project site will be coordinated by the Contractor and passing tests will be paid for by the City. Any retests due to failing results shall be paid for by the Contractor. The selection of the method of test shall be designated by the City. Where tests are required, other than those made in the laboratory, for the purpose of control in the manufacture of a construction item, the Contractor will be required to furnish such facilities and equipment as may be necessary to perform the tests and inspection and shall be responsible for calibration of all test equipment required. When requested, the Contractor shall furnish a complete written statement of the origin, composition, and/or manufacture of any or all materials that are to be used in the work. Testing of all materials and work shall conform to the Texas Department of Transportation "Manual of Testing Procedures" which outlines testing methods and procedures. Other Texas Department of Transportation Bulletins shall apply.

208.4 **PAYMENT**

- A. No separate payment will be made for work performed under this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 209. LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

209.1 SCOPE OF WORK

- A. This specification covers the requirements for complying with all Federal, State, and local laws, ordinances, and regulations, which in any manner affect the conduct of the work on the Project.

209.2 LAWS TO BE OBSERVED

- A. The Contractor shall make himself familiar with and at all times shall observe and comply with all Federal, State, and local laws, ordinances, and regulations which in any manner affect the conduct of the work and shall indemnify and save harmless the City and its representatives against any claim arising from the violation of any such law, ordinance, or regulation, whether by himself or by his employees.

209.3 PERMITS, LICENSES AND TAXES

- A. The Contractor shall procure all permits and licenses, pay all charges, fee and taxes, and give all notices necessary and incident to the due and lawful prosecution of the work as outlined in the construction documents.

209.4 RESTORATION OF SURFACES OPENED BY PERMIT

- A. The Contractor shall not allow any party to make an opening in the highway or street unless a duly authorized permit signed by the owner of the facility is presented. Until the acceptance of the work, the Contractor shall make all necessary repairs in the roadway where openings have been made by due authority.

209.5 PUBLIC SAFETY AND CONVENIENCE

- A. The safety of the public and the convenience of traffic shall be regarded as of prime importance. Unless otherwise shown on the Plans or except as herein provided, all portions of the highway and street shall be kept open to traffic. It shall be the entire responsibility of the Contractor to provide for traffic along and across the highway and streets as well as for ingress and egress to private property all as specified herein, as shown on the Plans or as directed by the City.
- B. The Contractor shall plan and execute his operations in a manner that will cause the minimum interference with traffic. The Contractor shall secure the City's approval of his proposed plan of operation, sequence of work and methods of providing for the safe passage of traffic before it is placed into operation. If at any time during construction, the approved plan does not accomplish the intended purpose, due to weather or other conditions affecting the safe handling of traffic, the Contractor shall immediately make necessary changes in accordance with the latest version of the TMUTCD to correct the unsatisfactory conditions.
- C. If due to rains or other reasons, the shoulders, slopes and ditches become unsatisfactory for handling traffic, construction operations shall be suspended and the base course or surface area shall be opened to traffic. Where the Specifications require that traffic be carried over or along the proposed work, construction operations shall be so prosecuted and new material so kept that placement and spreading will allow the passage of traffic in comfort and safety.
- D. Where an Asphalt Surface Treatment is placed for the full width in an operation, traffic shall be carried on the shoulder slopes and ditches where appropriate. During the operation of placing asphalt and aggregate, the surface or pavement shall not be closed to traffic for a period of more than 45 minutes.



- E. During construction of proposed structures, unless otherwise shown on the Plans, the Contractor shall provide and maintain detours including temporary structures or crossovers of adequate structural design as may be required for the safety and convenience of the traffic.
- F. At night or otherwise, all equipment not in use shall be stored in such manner and such locations as not to interfere with the safe passage of traffic. The Contractor shall provide and maintain flagmen 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 directed by the City. Flagmen shall have a sense of responsibility for the safety of the public and the workers, adequate training in safe temporary traffic control practices, average intelligence, good physical condition, including sight, mobility, and hearing, mental alertness and the ability to react in an emergency, courteous but firm manner, and a neat appearance. When directing traffic, flagmen shall use the standard attire, flags and signals and follow the flagging procedure set forth in "Instructions to Flagmen" published by the Texas Department of Transportation.

209.6

BARRICADES AND DANGER, WARNING AND DETOUR SIGNS

- A. The Contractor shall place and maintain in good condition, standard barricades and warning signs at each end of the project and at other locations therein as called for on the Plans or as called for in the Contractor's approved plan of operation. The signs shall be of standard design as shown on the Plans and in accordance with Texas Department of Transportation Standards.
- B. All barricades and signs remaining in place at night and all points of hazard to traffic shall be either retro-reflective with a material that has a smooth, sealed outer surface or illuminated by lights to show the same shape and similar color both day and night. Signs which refer to construction operations which do not apply after work has ended for the day, shall be moved to points out of the clear zone that are not visible to traffic until construction is resumed.
- C. The Contractor may provide special signs not covered by the Plans to protect the traveling public against special conditions or hazards, provided however, that such signs are first approved by the City.
- D. Upon completion of the work, all signs and evidences thereof shall be removed by the Contractor.

209.7

PROJECT IDENTIFICATION SIGNAGE

- A. Project identification signage shall be in accordance with Section 216- PROJECT IDENTIFICATION SIGNAGE. This does not apply to private development Projects.

209.8

USE OF EXPLOSIVES

- A. When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, and all storage places shall be marked clearly, "DANGEROUS - EXPLOSIVES". The method of storing and handling explosives and highly flammable materials shall conform with Federal and State laws and regulations. **The use of explosives must be approved in writing by the City prior to any use.**
- B. In advance of doing any blasting work, involving the use of electric blasting caps within 200 feet of any railroad track, the Contractor shall give at least 24 hours advance notice to the nearest Roadmaster, Section Foreman, Agent, Signal Maintainer or Telegraph Operator with the request that his Superintendent be advised immediately of the pending use of explosives.

209.9

PROTECTION OF ADJOINING PROPERTY

- A. The Contractor shall take proper measures to protect the adjacent or adjoining property which might be damaged by any process of construction, and in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Contractor, he shall restore at his own expense the damaged property to a condition equal or better than that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.



209.10

RESPONSIBILITY FOR DAMAGE CLAIMS

- A. The Contractor shall save harmless the City from all suits, actions or claims brought on account of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work by the Contractor, or from any claims or amounts arising or recovered under the “Workmen’s Compensation Laws” or any other laws. He shall be responsible for all damage or injury to property of any character occurring during the prosecution of the work resulting from any act, omission, neglect, or misconduct on his part in the manner or method of executing the work; or from his failure to properly execute the work; or from defective work or materials. He shall not be released from such responsibility until all claims have been settled and suitable evidence to that effect furnished the Council.
- B. The Contractor’s attention is directed to the fact that pipelines and other underground installations as may be shown on the Plans have been taken from the best available information. There may be other pipelines or installations. The Contractor shall save harmless the City from any and all suits or claims resulting from damage by his operations to any pipeline or underground installation.

209.11

CONTRACTOR’S RESPONSIBILITY FOR WORK

- A. Until the final acceptance of the work by the City as evidenced in writing, it shall be under the charge and care of the Contractor. The Contractor shall rebuild and make good at his own expense all injuries and damages to the work occurring before its completion and acceptance. In case of suspension of work for any cause, the Contractor shall be responsible for the preservation of all materials. He shall provide suitable drainage of the roadway and shall erect temporary structures where required. The Contractor shall maintain the roadway in good and passable condition until final acceptance.
- B. Wherever, in the opinion of the City, any roadway or portion thereof is in suitable condition for travel, it shall be opened to traffic, as may be directed, and such opening shall not be held to be in any way the final acceptance of the roadway or any part of it or as a waiver of any of the provisions of the Contract. Where it is considered by the City to be in the public interest, any substantially completed roadway or portion thereof may be opened to traffic.

209.12

PERSONAL LIABILITY OF PUBLIC OFFICIALS

- A. In carrying out the provisions of the contract or in exercising any power or authority granted thereunder, there shall be no liability upon the City or its authorized assistant, either personally or otherwise, as they are agents and representatives of the City.

209.13

PROSECUTION OF WORK

- A. Prior to beginning construction operations, the Contractor shall submit to the City a chart or brief outlining the manner of prosecution of the work that he intends to follow in order to complete the Contract. Before any work is started on the project or development, a “Pre-Construction Conference”, shall be held between the City, Contractor, Developer and any other interested parties.

209.14

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 210. ENVIRONMENTAL PROTECTION PROCEDURES

210.1 SCOPE OF WORK

- A. This specification covers the requirements for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.
- C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area. Specific requirements are specified in Section 306- SEDIMENTATION AND TEMPORARY EROSION CONTROL.
- D. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Texas Commission on Environmental Quality, and U.S. EPA.

210.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including descriptions of any special operations required, temporary roads and embankments, and all other pertinent data to illustrate conformance to the specification found within.

210.3 APPLICABLE REGULATIONS

- A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

210.4 NOTIFICATIONS

- A. The Engineer and/or City will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. The Contractor shall, after receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his/her authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the City may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.



210.5

IMPLEMENTATION

- A. Prior to commencement of the work, the Contractor shall meet with the City to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program. All environmental and pollution control features shall be in place prior to any construction.
- B. Remove temporary environmental control features, when approved by the Engineer, and incorporate permanent control features into the Project at the earliest practical time.

210.6

PROTECTION OF WATERWAYS

- A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
- B. Contractors are specifically cautioned that disposal of materials into any waters of the State must conform with the requirements of the Texas Commission on Environmental Quality, and an applicable permit from the U.S. Army Corps of Engineers.
- C. The Contractor shall be responsible for providing holding ponds or an approved method which will handle, carry through, or divert around his work all flows, including storm flows and flows created by construction activity, so as to prevent silting of waterways or flooding damage to the property or adjacent properties.
- D. The Contractor is responsible for researching the need for a U.S. EPA NPDES permit for the construction site. If one is required, the Contractor is responsible for obtaining the permit and for monitoring the site per the permit requirements until final completion.

210.7

DISPOSAL OF EXCESS EXCAVATION AND OTHER WASTE MATERIALS

- A. Excess excavated material not required or suitable for backfill and other waste material must be disposed of at sites approved by the City and Engineer.
- B. Unacceptable disposal sites, include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.
- C. The Contractor may make his own arrangements for disposal subject to submission of proof to the Engineer that the Owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency and submission of a haul route plan including a map of the proposed route(s).
- D. The Contractor shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

210.8

USE OF CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture or any other applicable regulatory agency. Use of all such chemicals and disposal of residues shall be in conformance with the Manufacturer's instructions.
- B. Any oil or other hydrocarbon spilled or dumped during construction must be excavated and completely removed from the site prior to final acceptance. Soil contaminated by the Contractor's operations shall become the property of the Contractor, who will bear all costs of testing and disposal.



- C. Before a Contractor commences work, the following steps shall be completed.
1. The City will inform the Contractor of his rights under the Texas Hazards Communication Act.
 2. The City will provide a copy of the Chemical List giving the hazardous chemicals to which the Contractor, his employees and agents may be exposed to on the Project site.
 3. The City will provide copies of all Material Safety Data Sheets (MSDS) to the Contractor for the hazardous chemicals, which he may be exposed to on the Project site.
 4. The City will inform the Contractor of his obligation to inform his employees and agents of each of the above requirements.
 5. The Contractor shall provide MSDS for all hazardous chemicals he may bring onto the project site that the City's employees may be exposed to.
 6. The Contractor shall sign a Contractor Acknowledgement certifying that he/she has received the information provided by the City on hazardous chemicals and maintain the Acknowledgement with the original Contract.

210.9

EROSION CONTROL

- A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, silt fences, rock berms, hay check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Flow of surface water into excavated areas shall be prevented. Ditches around the construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

210.10

PROTECTION OF STREAMS

- A. Care shall be taken to prevent, or reduce to a minimum, any damage to any stream from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such waters will be diverted through a settling basin or filter before being directed into the streams.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a Contingency Action Plan approved by the Texas Commission on Environmental Quality. Contractor shall submit two (2) copies of approved contingency plans to the Engineer.
- D. Water being flushed from structures or pipelines after disinfection, with a Cl_2 residue of 2 mg/l or greater, shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.



PROTECTION OF LAND RESOURCES

- A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the Project. Confine all construction activities to the appropriate areas shown on the Plans.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them in accordance with Section 306- SEDIMENTATION AND TEMPORARY EROSION CONTROL. Monuments and markers shall be protected similarly before beginning operations near them.
- D. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition. The Engineer or the City will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.

All scars made on trees by equipment, construction operations, or by the removal of limbs larger than one (1) inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.

Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer or the City, shall be immediately removed and replaced.

- E. The locations of the Contractor's storage, and other construction buildings, required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Plans and shall require written approval of the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Plans showing storage facilities shall be submitted for approval of the Engineer or the City.
- F. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he/she shall submit the following for approval at least 10 days prior to scheduled start of such temporary work.
 - 1. A layout of all temporary roads, excavations and embankments to be constructed within the work area.
 - 2. Details of temporary road construction.
 - 3. Plans and cross sections of proposed embankments and their foundations, including a description of proposed materials.
 - 4. A landscaping drawing showing the proposed restoration of the area. Removal of any trees and shrubs outside the limits of existing clearing area shall be indicated. The drawing shall also indicate location of required guard posts or barriers required to control vehicular traffic passing close to trees and shrubs to be maintained undamaged. The drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final



condition of the area. Modification of the Contractor's approved drawings shall be made only with the written approval of the Engineer. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.

- G. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess waste materials, or any other vestiges of construction as directed by the Engineer or the City. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in Section 307- LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL, or as approved by the Engineer or the City.
- H. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

210.12 PROTECTION OF AIR QUALITY

- A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted without necessary notification of City / County Fire Marshall, as appropriate.
- B. Dust Control. The Contractor will be required to maintain all excavations, embankment, subgrade, road bed, base course stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer or the City.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer or the City.

210.13 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. During the life of this Contract, the Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

210.14 NOISE CONTROL

- A. The Contractor shall make every effort to minimize noises caused by his/her operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with State and Federal regulations.

210.15 PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 211. SUBMITTALS

211.1 SCOPE OF WORK

- A. This specification covers the requirements for submissions applicable to the following work-related submittals: Shop Drawings, Product Data, Samples, Mock Ups, Construction Photographs, and Construction or Submittal Schedules. Detailed submittal requirements will be specified in the technical specification sections.
- B. All submittals shall be clearly identified by reference to Specification Section, Paragraph, Drawing No. or Detail as applicable. Submittals shall be clear and legible and of sufficient size for sufficient presentation of data.

211.2 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A. Shop Drawings

- 1. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the Work.
- 2. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
- 3. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the Plans and Specifications. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
- 4. All details on shop drawings submitted for approval shall show clearly the relation of the various parts to the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the Plans before being submitted for approval.

B. Product Data

- 1. Product data as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliance's and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples

- 1. Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units



of work to be used by the Engineer or the City for independent inspection and testing, as applicable to the work.

211.3

CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Catalog numbers and similar data
 - 4. Conformance with the Specifications
- B. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." If submitted in hard copy, shop drawings and product data sheets eleven by seventeen (11" x 17") and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Resident Project Representative a copy of each submittal transmittal sheet for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples to the Engineer or the City.
- C. Notify the Engineer or the City in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
- D. The review and approval of shop drawings, samples or product data by the Engineer or the City shall not relieve the Contractor from his/her responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer or the City will have no responsibility therefore.
- E. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The City will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- F. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

211.4

SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor.
- B. Each submittal, appropriately coded, will be returned within 30 working days following receipt of submittal by the Engineer or the City.



C. Number of submittals required:

1. Shop Drawings as defined in Paragraph G10.02 A: Three (3) copies.
2. Product Data as defined in Paragraph G10.02 B: Three (3) copies.
3. Samples: Submit the number stated in the respective Specification Sections.

D. Submittals shall contain:

1. The date of submission and the dates of any previous submissions.
2. The Project title and number.
3. Contractor identification.
4. The names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
5. Identification of the product, with the specification section number, page and paragraph(s).
6. Field dimensions, clearly identified as such.
7. Relation to adjacent or critical features of the Work or materials.
8. Applicable standards, such as ASTM or Federal Specification numbers.
9. Identification of deviations from Contract Documents.
10. Identification of revisions on re-submittals.
11. Two (2) five-inch by three-inch (5"x3") blank space for Contractor and Engineer stamps.

211.5

REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

- A. The review of shop drawings, data, and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed as:
 1. Permitting any departure from the Contract requirements;
 2. Relieving the Contractor of responsibility for any errors, including details, dimensions, and materials; and/or
 3. Approving departures from details furnished by the Engineer or the City, except as otherwise provided herein.
- B. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
- C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the City and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.



D. Submittals will be returned to the Contractor under one of the following codes.

Code 1 "REVIEWED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 "PROVIDE AS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 "PROVIDE AS NOTED/CONFIRM". This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 "PROVIDE AS NOTED/RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a re-submittal of the package. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This re-submittal is to address all comments, omissions and non-conforming items that were noted. Re-submittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the re-submittal.

Code 5 "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

- E. Re-submittals will be handled in the same manner as first submittals. On re-submittals the Contractor shall direct specific attention, in writing on the letter of transmittal and on resubmitted shop drawings by use of revision triangles or other similar methods, to revisions other than the corrections requested by the Engineer, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the Engineer.
- F. Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor, and will be considered "Not Approved" until resubmitted. The Engineer may at his/her option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.
- G. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least seven (7) working days prior to release for manufacture.
- H. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.



211.6

DISTRIBUTION

- A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer but shall not exceed six (6).

211.7

MOCK UPS

- A. Mock Up units as specified in individual Sections include, but are not necessarily limited to, complete units of the standard of acceptance for that type of work to be used on the Project. Remove at the completion of the Work or when directed.

211.8

GENERAL PROCEDURES FOR SUBMITTALS

- A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections, of the Specifications, so that the installation will not be delayed by processing times including disapproval and re-submittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 212. TRENCH SAFETY REQUIREMENTS

212.1 SCOPE OF WORK

- A. This specification covers the requirements to plan, design, construct, install, maintain, monitor, modify as necessary, and remove upon completion, a Trench Safety System as specified herein.
- B. The requirements of this Section apply to all trenches which equal or exceed a depth of five (5) feet, measured from the ground surface at the highest side of the trench to the trench bottom.
- C. All applicable and non-conflicting portions of Section 304- TRENCHING, BACKFILLING AND COMPACTION apply as appropriate.

212.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, but not less than 10 calendar days prior to execution of any trench excavation operations, the Contractor shall submit a site specific Trench Safety System Conformance Affidavit stating that operations will be conducted in full conformance with the OSHA Standards.
 - 1. The Conformance Letter shall also describe the Trench Safety System techniques proposed to be used on the Project.
 - 2. Specific references to the applicable OSHA Standards sections shall be included for each technique to be used.
- B. The Trench Safety System Plan shall be in writing, site specific and sufficiently detailed and clear to be understandable and usable by all personnel who will be executing, supervising and witnessing the trenching operations. A copy of the Trench Safety System Plan shall be available at the site of trenching operations at all times.
- C. If borings and/or detailed geotechnical analyses are required to develop the Trench Safety System Plan, they shall be executed by the Contractor at his cost.
- D. For trenches having depths greater than the various limits given in the OSHA Standards (8, 12 or 20 feet, depending on the techniques used), a site specific protective system shall be designed by a Registered Professional Engineer, registered in the State of Texas experienced in soil mechanics and structural design. The design shall be signed, sealed and dated by the Professional Engineer, and it shall identify those specific locations where the design is applicable.

212.3 GENERAL

- A. All materials and products incorporated into the Trench Safety System shall be suitable for their intended uses; shall meet all design criteria and parameters used by the Trench Safety System designer; and shall meet all applicable requirements of OSHA Standards.

212.4 METHODS OF PROVIDING FOR TRENCH SAFETY

- A. Protective systems referenced in this Section shall be as defined and described in 29 CFR 1962.652, "Requirements for Protective Systems."
- B. It is the duty, responsibility and prerogative of the Contractor to determine the specific applicability of a proposed Trench Safety System for each field condition encountered on the Project. Contractor specifically holds the City, Engineer, and any of their designated representatives harmless in any actions resulting from the failure or inadequacy of the Trench Safety System used to complete the Project.



- C. Unless otherwise noted on the drawings or excluded below, Sloping/Benching, Trench Shielding with trench boxes, and/or Sheeting/Shoring/Bracing protective systems may be used on this Project.
- D. Restrictions on the use of the various protective systems for this Project are as follows:
 - 1. Sloping or Benching. Allowed with prior approval from the City.
 - 2. Trench Shields/Boxes. No restrictions.
 - 3. Sheeting/Shoring/Bracing. No restrictions.

212.5 INSPECTION DUTIES OF CONTRACTOR

- A. Provide a Competent Person, as defined in the OSHA Standards, to make frequent inspections of the trenching operations and the Trench Safety System in full conformance with the OSHA Standards.
- B. If evidence of a possible cave-in or landslide is apparent, all work in the trench shall immediately cease and not be resumed until all necessary precautions have been taken to safeguard personnel entering the trench.
- C. In an emergency situation, which may threaten or affect the safety or welfare of any persons or properties, the Contractor shall act at his discretion to prevent possible damage, injury or loss. Any additional compensation or time extension claimed for such actions shall be considered in view of the cause of the emergency and in accordance with the General Conditions.

212.6 MEASUREMENT AND PAYMENT

- A. Payment for the Trench Safety Plan shall be on a Lump Sum price basis, the Lump Sum price being as given in the Bid Proposal.
- B. Payment for the Trench Safety Plan Implementation shall be on a unit price basis, the unit price being as given in the Bid Proposal, and the unit of measure being linear feet of trench and/or square foot of bore pit or structure, without regard to whether specific trench safety precautions are required or used for the trench reach being measured.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 213. TESTING OF PIPELINES AND MANHOLES

213.1 SCOPE OF WORK

- A. This specification covers the requirements to perform ex-filtration testing and deflection testing of gravity pipelines and to perform pressure and leakage testing of pressure pipelines.

213.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including a description of the deflection test procedure, video inspection of gravity wastewater lines after installation, and all other pertinent data to illustrate conformance to the specification found within.

213.3 GENERAL

- A. The entire length of the installed gravity line and the force main shall be field tested for water tightness. Gravity wastewater lines shall be video taped by camera.
- B. Hydrostatic pressure and leakage tests shall be made on all pressure pipelines carrying wastewater or water.
- C. All labor and equipment, including, but not limited to test pump with regulated by-pass meters and gauges required for conducting pipeline tests, shall be furnished by the Contractor. The Contractor shall furnish equipment and necessary piping as required to transport water used in testing from source to test location.
- D. Time and sequence of testing shall be scheduled by the Contractor, subject to observation and approval by the City. The Contractor shall provide adequate labor, tools and equipment to operate valves and to locate and repair any leaks discovered during the initial filling of the pipeline prior to actual testing or during the course of the tests.

213.4 CLEANING

- A. At the conclusion of the work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Engineer will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired, and/or replaced by the Contractor at his expense.

213.5 TEST PROCEDURES FOR GRAVITY PIPELINES AND MANHOLES

- A. Scope: After sewers and manholes have been installed and backfilled, subject newly laid gravity lines and manholes to a leakage test. Contractor to furnish all labor, materials, tools and equipment to test lines. Take such precautions as required to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at Contractor's expense. Conduct test in presence of Engineer or designated City Representative.
- B. Test Procedures for Leakage Test of Gravity Sewer: Contractor, at his option, may test lines by hydrostatic or low pressure air test as specified below. However, the Engineer may direct a specific test be performed in specified areas of the Project.



C. Infiltration or Exfiltration Test (for Gravity Sewer)

1. Preparation: Seal ends of line section being tested with water tight plugs, equipped with pipe riser inserted and braced in the inlet of the manholes. Fill section with water 24-hours prior to start of test. Fill slowly from downstream manhole in test section so that no air is trapped in the line. Leave outlets of stacks and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe. After completion of satisfactory test, remove lengths of pipe added for test.
2. Duration of Test: Test for 24-hours. Minimum head of either two (2) feet measured above the crown, inside pipe at upper end of section or four (4) feet measured above trench water table, whichever is higher, so that a net positive of two (2) feet TCEQ is used for testing.
3. Allowable Leakage: Allowable leakage or exfiltration in any individual section under construction shall not exceed 10 gallons per inch of inside diameter per mile of pipe per 24 hours.

D. Low Pressure Air Test

1. Preparation: Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water or by use of water jet cleaning equipment. After manhole to manhole reach of pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psig. Add air slowly to the section under test until the internal pressure of 4.0 psig is obtained. Allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
2. Duration of Test and Allowable Leakage

Decrease pressure to 3.5 psig and start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times are indicated in seconds and shall be computed by the following equation:

$$T = (0.085 \times D \times K) / Q$$

T = time for pressure to drop 1.0 pound per square inch gauge in seconds

K = $0.000419 \times D \times L$, but not less than 1.0

D = average inside diameter in inches

L = length of line of same pipe size being tested, in feet

Q = rate of loss assume 0.0015 cubic feet per minute per square foot internal surface shall be used

Since K value of less than 1.0 shall not be used, there are minimum times for each pipe diameter as outlined below:

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)



Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)
36	2040	66	30.771(L)

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge shall be 10 seconds.

E. Test Procedures for Hydrostatic Test for Manholes

1. Manholes shall be tested for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, or other methods acceptable to the City. If a manhole fails a leakage test, the manhole must be made water tight and retested. The maximum leakage for hydrostatic testing shall be 0.025 gallon per vertical foot per hour. Alternative test methods must ensure compliance with the above allowable leakage. Hydrostatic exfiltration testing shall be performed as follows: all wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water and maintained full for at least one (1) hour. For concrete manholes a wetting period of 24-hours may be used prior to testing in order to allow saturation of the concrete.

F. Test Procedures for Vacuum Testing Manholes

1. In lieu of the hydrostatic exfiltration test, manholes may be tested by vacuum. Manholes tested by vacuum shall be performed by the Contractor in compliance with these specifications.
2. Manholes shall be tested after installation of all connections (existing and/or proposed) in place. All lift holes shall be plugged with an approved non-shrink grout and all drop connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond the drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches of mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time as shown in the following table. If the drop in the level is less than one (1) inch of mercury (final vacuum of nine (9) inches of mercury), the manhole will have passed the vacuum test. The required test time shall be three (3) minutes.
3. Manholes which have a final vacuum of nine (9) inches of mercury after the time indicated will be accepted. If there has been no pressure loss during the first 23-seconds the test may be stopped and the manhole will be accepted. Any manhole which fails the vacuum test as described above shall be repaired with an approved non-shrink grout or other material acceptable to the Engineer and the City based on the material from which the manhole is



constructed. The manhole shall be retested as described above until a successful test is made.



G. Exfiltration Test

1. Preparation: Seal ends of manhole being tested with watertight plugs. Fill manhole 24-hours prior to start of test. Manholes to be filled to top of manhole cone section.
2. Duration of Test: The test shall be performed for a 24-hour duration.
3. Allowable Leakage: No leakage is allowed. The water elevation shall be the same at beginning and end of test period.

H. Deflection Testing

1. Deflection tests shall be performed on all flexible pipes. For pipes with inside diameters less than 27-inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter of 27-inches and greater, the Contractor shall submit to the Engineer the proposed method, with which shall provide a precision of \pm two tenths of one percent (0.2%) deflection, for review and approval by the Texas Commission on Environmental Quality. The test shall be conducted after final backfill has been in place at least 30 days in the presence of a representative of the City's Utilities Department. No pipe shall exceed a deflection of five percent (5%). If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. Test shall be performed without mechanical pulling devices.
 2. Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter of the pipe minus two minimum wall thickness for O.D. controlled pipe and the average inside diameter for the I.D. Controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
 3. Mandrel Design: The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.
 4. Method Options: Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Commission on Environmental Quality for review and approval. Mandrels with removable legs or runners may also be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Commission on Environmental Quality for review and approval.
- I. Repairs of Lines: Remove and replace or make approved corrective repairs to any section of line or manhole which has leakage that exceeds above amounts. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. Individual leaks will ordinarily be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations or immediately after water leakage is emptied from sewer.
- J. Retest: Sewers and/or manholes failing to meet requirements of leakage test will, after repair by Contractor, be tested again for leakage. No sewer or manhole will be accepted until leakage is less than allowable amount.



K. Video Inspection

1. The use of a television camera for inspection prior to placing the sewer in service will be required. Initial video inspection may be provided by the City at no cost to the Contractor. Follow-up videos shall be charged on a per foot basis at the rate specified by the City. The Contractor also has the option to use a private video contractor, provided that the operator is certified to complete the video work. Two (2) copies of the videotapes shall be submitted to the City along with a letter of concurrence from the Project Engineer acknowledging that all newly constructed sewer within the project has been videotaped and that he/she has reviewed the videotape and has not found any deficiencies in the videotaped sewer.
2. Post construction video of the gravity wastewater lines will be evaluated on a case-by-case basis for acceptance. Preparation for video taping of wastewater line shall be as follows:
 - a. Contractor/developer shall flush and clean the gravity wastewater line prior to videotaping. Contractor/developer shall be responsible for removal of debris from the collection system.
 - b. The videotape shall display the station, in accordance with the Plans and Standards, and counter on the screen. Manhole numbers and stations shall correspond to the contract documents.
 - c. If debris is evident in the line during the video, the line will be flushed and cleaned to allow a clean video.
 - d. All manholes will be identified at the beginning and end of the video corresponding to contract documents with upstream and downstream ends identified.

L. Golf Ball Test

1. During the video inspection, water shall be flowed into the pipe to permit meaningful observations. Any pipe settlement which causes excessive ponding of water in the pipe shall be cause for rejection. Excessive ponding shall be defined as a golf ball (1-5/8" dia.) submerged at any point along the line.

213.6

TEST PROCEDURES FOR PRESSURE PIPELINES

A. General

1. After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure specified below for that particular type of pipe. The duration of the hydrostatic test shall be at least two (2) hours. Unless otherwise specified or noted on the Plans. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.
2. Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the Contractor shall install, at his own expense, corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the Contractor. Replacement shall be with sound material and the test shall be repeated until satisfactory to the City.



- B. Special Requirements: Where any section of pipeline is provided with concrete reaction blocking, the hydrostatic pressure shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.
- C. Leakage Test: A Leakage Test will be conducted on each valved section over the entire Project. The leakage test shall be at 150 psi for at least four (4) hours.
- D. Allowable Leakage
1. The allowable hydrostatic leakage rate shall be based on the following formula:

$$L = \frac{SD \sqrt{P}}{133,200}$$

- L = testing allowance in gallons per hour
 S = length of pipe tested in feet
 D = nominal diameter of the pipe in inches
 P = average test pressure during the hydrostatic test in pounds per square inch (gauge)

Table 6A
 Hydrostatic testing allowance per 1,000 ft of pipeline* - *gph*†

Avg. Test Pressure <i>psi</i>	Nominal Pipe Diameter – in.																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	.48	.64	.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	.45	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	.42	.56	.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	.39	.52	.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	.37	.50	.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	.36	.47	.71	.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	.34	.45	.68	.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	.32	.43	.64	.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	.30	.40	.59	.80	.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	.28	.37	.55	.74	.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88
125	.25	.34	.50	.67	.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37
100	.23	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

* If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

† Calculated on the basis of Eq. 1.

- a. These formulas are based on a testing allowance of 11.65 gpd/mi/in. (1.079 L/d/km/mm) of nominal diameter at a pressure of 150 psi (1,034 kPa).
- b. 5.2.1.6.1 Testing allowance at various pressures is shown in Tables 6A and 6B.
- c. 5.2.1.6.2 When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/h/in. (1.2 mL/h/mm) of nominal valve size shall be allowed.



- d. 5.2.1.6.3 When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
 - e. 5.2.1.7 Acceptance of installation. Acceptance shall be determined on the basis of testing allowance. If any test of laid pipe discloses a testing allowance greater than that specified in Sec. 5.2.1.6, repairs or replacements shall be accomplished in accordance with the specifications.
 - f. 5.2.1.7.1 All visible leaks are to be repaired regardless of the allowance used for testing.
2. If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the specified allowance. All known leaks, irregardless of this test, shall be repaired.
- E. Pressure Test: After satisfactorily completing the leakage test, each valved section over the entire project, shall be tested at 200 psi for a sufficient period (approximately 10 min) to discover all leaking or defective materials and/or workmanship.
- F. Disinfecting Water Mains: The Contractor shall disinfect all water mains before the new facilities are placed into service. Disinfection must be performed in accordance with AWWA C651, latest revision and water samples must be submitted to a laboratory approved by the Texas Department of Health. Sample must be collected by the Contractor or his representative in the presence of the City or his representative. The Contractor shall be responsible for delivering the samples to an approved laboratory for testing. Sample results must indicate the facility is free of microbiological contamination before it is placed into service. It shall be the Contractor's responsibility to obtain a current copy of AWWA C651 to determine the correct forms of chlorine for disinfection, the basic disinfection procedure, preventive and corrective measures during construction, methods of chlorination, final flushing procedures, procedures for bacteriological tests, procedures for re-disinfection and disinfection procedures when cutting into existing mains. The Contractor, at his expense, will supply the concentrated chlorine disinfecting material, the City's personnel will supervise and direct the overall sterilization procedure. The Contractor, at his own expense, shall provide all other equipment, supplies and necessary labor to perform the sterilization under general supervision by the City.
- G. General
- 1. All valves shall be arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The new pipeline shall then be completely filled with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of chlorine as prescribed in AWWA C651.
 - 2. Unless otherwise identified, all quantities called for herein refer to measurements by the testing procedures in the current edition of "Standard Methods of Examination of Water and Wastewater". The chlorine concentration of each step in the sterilization procedure shall be verified by chlorine residual determinations. This disinfecting solution shall be retained in the piping for at least twenty-four (24) hours, and all valves, hydrants, etc., shall be operated to disinfect all their parts. After this retention period, the water shall contain no less than the chlorine residual prescribed in AWWA C651 throughout the treated section of the pipeline.
 - 3. This heavily chlorinated water shall then be carefully flushed from the line until the chlorine concentration is not higher than the residual generally prevailing in the existing distribution system, or approximately 1.0 parts per million. Proper planning and appropriate preparations to handle, dilute and dispose of this strong chlorine solution without causing injury or damage to the public, the water system, the environment must be approved by the City before flushing of the line may begin, and the flushing shall be witnessed by an



authorized representative of the City.

H. Bacteriological Testing

1. After final flushing of the strong disinfecting solution, water samples from the line shall be tested for bacteriological quality, at the Contractor's expense, and must be found free of coliform organisms before the pipeline may be placed in service. One (1) test sample shall be drawn from the end of the main and additional samples collected at intervals of not more than one-thousand (1,000) feet along the pipeline. A minimum of three (3) samples must be collected.
2. The Contractor, at his own expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly shall be removed and retained for future use.
3. Samples for bacteriological analysis shall be collected only from suitable taps, in sterile bottles. Collection of the test samples shall be made in the presence of City personnel. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained, before the piping may be placed in service.

213.7

FINAL ACCEPTANCE

- A. No pipe installation will be accepted until all known leaks have been repaired whether or not leakage is within allowable limits. Locating and repairing of leaks shall be performed by the Contractor at no additional cost to the City.
- B. The City will certify that all required pressure and leakage tests have been successfully completed before the pipeline is accepted.

213.8

PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 214. SUMMARY OF TESTING (MISCELLANEOUS)

214.1 SCOPE OF WORK

A. This specification covers the requirements to perform testing of various work items for this Project.

214.2 SUBMITTALS

A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature and all other pertinent data to illustrate conformance to the specification found within.

214.3 TESTING FOR ROADS

Testing for roads shall be in accordance with Table 14-1.

Table 14-1

Item	Test Method	Passing Criteria	Comments
Hot Mix Asphaltic Concrete (HMAC)	Tex-200-F	See 501. 6 A	Sieve Analysis of Fine and Coarse Aggregate
	Tex-207-F	94.5%-97.5%Lab Density; 91.0%-96.0%In-PlaceField Density	Determining Density of Compacted Bituminous Mixtures
	Tex-210-F	See 501.6 B	Determining Asphalt Content of Bituminous Mixtures by Extraction
	Tex-227-F		Max. Specific Gravity of Bituminous Mixtures
	Tex-208-F	Min 35	Stability
Trench Backfill	Applicable Tex Testing Method	See Section 304.5	Minimum of one test every 250 linear feet of trench length for each lift.
Embankment	Tex-114-E	See Section 503.6 and 503.7	Test every 2,000 SY of roadbed surface
Flexible Base	Tex-107-E, Part II Tex-411-A Tex-110-E ASTM D1557, Method D Tex-116-E Tex-117-E	2% shrinkage 95% Density	Bar Linear Shrinkage Magnesium Soundness Sieve Analysis Density, test every 750 square yards of roadbed surface or every 250 linear feet
	Tex-460-A Tex-106-E Tex-104-E Tex-103-E	45 Max. 45 psi @ 0 psi lateral & 175 psi @ 15 psi lateral Max. increase \leq 20 Plasticity Index \leq 12 Liquid Limit \leq 40 \pm 2% Optimum	Wet Ball Mill Triaxial Test (Part I or II) Particle Count (Part I) Plasticity Index Liquid Limit Moisture Content



Table 14-1, cont.

Item	Test Method	Passing Criteria	Comments
Striping	Tex-828-B	10 or more stripes visible (day) 6 or more stripes visible (night) 0.060-inches minimum thickness for edgeline markings	Glass Beads: If criteria is not met, check Tex-828-B for scheduling replacement of striping.
	Tex-854-B	0.090-inches minimum thickness for stop bars, legends, symbols, gore and centerline/no passing barrier line markings 0.180-inches maximum thickness for all markings	The average of the readings across each sample must be equal to or above the specified minimum thickness. No reading should be more than 10-mils below the specified minimum thickness.

214.4 TESTING FOR WATER/WASTEWATER

Testing for water/wastewater shall be in accordance with Table 14-2.

Table 14-2

Item	Test Method	Passing Criteria	Comments
Valves, Hydrants and Appurtenances	Manufacturer's Recommendations	Manufacturer's Recommendations	Functional field test of each valve, including actuators and valve control equipment.
Water and Wastewater Lines			As described in Section 213: Testing of Pipelines

214.5 TESTING FOR CONCRETE

Testing for concrete shall be in accordance with Table 14-3. Two (2) samples shall be tested for each truck load.

Table 14-3

Item	Test Method	Passing Criteria	Comments
Asphalt Board	Tex-524-C	Deflection from horizontal $<1:3\frac{1}{2}$	
Concrete Slump	Tex-415-A		See Table 14-4 for Slump
Compressive Strength	Tex-418-A		See Table 4 in Section 802.5
Flexural Strength	Tex-448-A		See Table 4 in Section 802.5
Coarse Aggregate	Tex-413-A	0.25% by weight clay lumps 1.00% by weight shale 5.00% by weight laminated and/or friable particles	See Table 14-5 for Gradation
	Tex-410-A Tex-411-A	40% wear 12% loss Sodium Sulfate 18% loss Magnesium Sulfate	Soundness Test



Table 14-3, cont.

Fine Aggregate	Tex-612-J Tex-408-A Tex-401-F Tex-203-F Tex-402-A	60% by weight acid insoluble residue subject to direct traffic. Color shall not be darker than Organic Color No. 3 (Gardner No. 11) Not less than 80 Between 2.3 & 3.1 for Non-Class K Between 2.6 & 2.8 for Class K	Color Test See Table 14-6 for Gradation Sand Equivalent Fineness Modulus
Membrane Curing	Tex-219-F	2% loss for 24-hour test 4% loss for 72-hour test	Water Retention Test

Table 14-4

Concrete Designation	Slump	Maximum Slump
1. All drill shaft	6	7
2. Uncased drill shafts, thin walled sections (<9") and pre-stressed concrete members	4	5
3. Slabs, caps, columns, piers, wall sections over 9", etc.	3	4
4. Underwater or seal concrete	6	7
5. Riprap, curb, gutter and other miscellaneous concrete.	As specified by City.	

Table 14-5

Aggregate Grade No.	Nominal Size (in)	Amount Retained (%)								
		2 ¹ / ₂ in	2 in	1 ¹ / ₂ in	1 in	¾ in	½ in	¾ in	No 4	No 8
1	2	0	0-20	15-50		60-80			95-100	
2 (467)*	1 ¹ / ₂			0-5		30-65		70-90	95-100	
3	1 ¹ / ₂			0-5		10-40	40-75		95-100	
4 (57)*	1				0-5		40-75		90-100	95-100
5 (67)*	¾					0-10		45-80	90-100	95-100
6 (7)*	½							30-60	85-100	95-100
7	¾							5-30	75-100	
8	¾							0-5	35-80	90-100

Table 14-6

Aggregate Grade No.	Amount Retained (%)							
	¾ in	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1	0	0-5	0-20	15-50	35-75	65-90	90-100	97-100

214.6

PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 215. PROJECT CLOSEOUT

215.1 SCOPE OF WORK

- A. This specification covers the administrative and procedural requirements for Project closeout, including but not limited to:
1. Closeout procedures.
 2. Final cleaning.
 3. Adjusting.
 4. Project record documents.
 5. Spare parts and maintenance materials.

215.2 RECORD DOCUMENTS

- A. Maintain on site, one (1) set of the following documents; actual revisions to the Work shall be recorded in these documents:
1. Contract Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other Modifications to the Contract.
 5. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and Modifications.
- E. Contract Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
1. Measured depths of foundations in relation to finish floor datum.
 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 4. Field changes of dimension and detail.



5. Details not on original Contract Drawings.

F. Submit documents to City with claim for final Application or Payment. For CIP Projects, retention monies will not be released until complete record documents have been submitted. For private projects, building permits will not be issued until complete record documents have been submitted.

215.3

CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's and/or City's inspection.

B. Provide submittals to the City that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Submit record drawings in both hard copy format and digital, as required by the City Engineer.

E. Submit Maintenance Bond to warranty the project for one (1) year.

215.4

FINAL CLEANING

A. At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:

1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the City.

2. All Subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.

3. The Contractor shall remove all temporary structures and all debris, including all dirt, sand, gravel, rubbish and waste material.

4. Should the Contractor not remove rubbish or debris, or not clean the buildings and site as specified above, the City reserves the right to have the cleaning done at the expense of the Contractor.

B. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.

F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Replace air-handling filters if units were operated during construction.

H. Vacuum clean all interior spaces, including inside cabinets. Broom clean paved surfaces, mow any



areas planted with grass which are in excess of two (2) inches high, and rake clean other surfaces of grounds.

- I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.
- J. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

215.5 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

215.6 FINAL INSPECTION

- A. After final cleaning and restoration and upon written notice from the Contractor that the work is completed, the Engineer and/or City will make a preliminary inspection, with the Contractor present. Upon completion of this preliminary inspection, the Engineer and/or City will notify the Contractor, in writing, of any particulars in which this inspection reveals that the work is defective or incomplete.
- B. Upon receiving written notice from the Engineer and/or City, the Contractor shall immediately undertake the work required to remedy deficiencies and complete the work to the satisfaction of the City.
- C. When the Contractor has corrected or completed the items as listed in the Engineer's/ City's written notice, he/she shall inform the City in writing, that the required work has been completed. Upon receipt of this notice, the Engineer and/or City and the Contractor, will make the final inspection of the Project.
- D. Should the Engineer and/or City find all work satisfactory at the time of his inspection, the Contractor will be allowed to make application for final payment in accordance with the provisions of the Standard Form of Agreement. Should the Engineer and/or City still find deficiencies in the work, the Engineer and/or City will inform the Contractor of the deficiencies and will deny the Contractor's request for final payment until such time as the Contractor has satisfactorily completed the required work. Additional inspections of deficiencies shall be paid for by the Contractor at \$200.00 per inspection.

215.7 ACCESSORY ITEMS

- A. The Contractor shall provide to the City, upon acceptance of the equipment, all special accessories required to place each item of equipment in full operation. These special accessory items include, but are not limited to, the specified spare parts, adequate oil and grease as required for the first lubrication of the equipment, initial fill-up of all chemical tanks and fuel tanks, light bulbs, fuses, hydrant wrenches, valve wrenches, valve keys, handwheels, and other expendable items as required for initial start-up and operation of all equipment.

215.8 GUARANTEES, BONDS, AND AFFIDAVITS

- A. 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 Engineer.

215.9 RELEASE OF LIENS OR CLAIMS

- A. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the City as required by the Standard Form of Agreement.



FINAL PAYMENT

- A. Final payment will be made to the Contractor in accordance with Item 47- "Payment Procedures", Standard Form of Agreement. Final payment and release of retention monies will not be made until the Contractor has submitted three (3) sets of as-built plans (digital and hard copy) to the City for the Project.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 216. PROJECT IDENTIFICATION SIGNAGE

216.1 SCOPE OF WORK

- A. This specification covers the requirements for furnishing, fabricating and erecting Project Signs on Capital Improvement Projects (C.I.P.) and for project identification at other construction sites, when required on the Plans or by the City.

216.2 MATERIALS

- A. Sign Face: The sign face shall be manufactured on standard exterior waterproof plywood sheets or other suitable material approved by the Engineer or the City. Unless indicated otherwise on the Plans, the thickness of the plywood sheet shall be a minimum of $\frac{3}{4}$ -inches.
- B. Posts: Plastic post, of the size indicated on the Plans, shall be pressure treated with pentachlorophenol.
- C. Paint: Exterior oil base paint shall be used and colors shall be as indicated on the Plans.
- D. Signs for Capital Improvements Projects: City seals shall be provided by the City.

216.3 INSTALLATION

- A. The signs shall be erected at each major entrance to the project for maximum public identification and exposure. At locations where construction is confined to an adequate area defined by the City, the installed sign size shall be four-feet by eight-feet (4'x8'). At locations where roadway construction is in progress, such as a street paving or construction of a sidewalk, the sign shall be two-feet by three-feet (2'x3'). The signs shall be posted on portable wood frames or stanchions and will be located in the proximity of the work area as construction progresses. All lumber shall be painted with two (2) coats of paint as indicated on the Plans.
- B. In special cases, the size of the sign may be changed to meet special requirements, but general proportions shall be maintained.
- C. It shall be the responsibility of the Contractor to maintain and relocate signs, if necessary, during the progression of the project. Care shall be exercised to assure that placement of the signs does not interfere with or cause sight obstruction to vehicular and pedestrian traffic.
- D. The Contractor may install, at his own expense, company signs to identify the Contractor, Developer, etc. Signs are to be securely attached to the posts at locations indicated on the Plans and shall not be larger than 18-inches by 36-inches.

216.4 PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 217. WARRANTY

217.1 SCOPE OF WORK

- A. This specification covers the requirements of the Contractor's or Developer's one (1) year warranty period for all work performed on the Project.

217.2 WARRANTY

- A. Upon final acceptance by the City of Killeen, the Contractor warrants for a period of one (1) year, the construction of the Project according to Plans and Specifications as they may be modified in accordance with the Contract Documents, and further warrants the proper operation of mechanical, electrical, and other devices or other equipment, if any, included in the project for a period of one (1) year. The Contractor or Developer warrants to the City that all materials and equipment furnished under this Contract shall be new unless otherwise approved by the City's Representative and that all work will be of good quality, free from faults and defects, and in conformance to these requirements, including substitutions not properly approved and authorized, may be considered defective.
- B. This warranty is in addition to any rights or warranties expressed or implied by law and consumer protection claims arising from misrepresentations by the Contractor or Developer. This warranty obligation shall be covered by any performance or payment bonds tendered in compliance with the Contract Provisions.
- C. If within one (1) year after the date of substantial completion of the work or designated portion thereof, or within one (1) year after acceptance by the City of the designated Project, or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents, any of the work is found or determined to be defective, including obvious defects, or otherwise not in accordance with the Contract Documents, the Contractor or Developer shall correct it promptly.
- D. If within 10 days after the City has notified the Contractor or Developer of a defect, failure, or abnormality in the work, the Contractor or Developer has not started to make the necessary repairs or adjustments, the City is hereby authorized to make the repairs or adjustments, or to order the work to be done by a third party. The cost of the work shall be paid by the Contractor or Developer. The cost of all materials, parts labor, transportation, supervision, special tools, and supplies required for the replacement or repair of parts and for correction of defects, shall be paid by the Contractor, Developer or by the surety. This guarantee shall be extended to cover all repairs and replacements furnished under the guarantee, and the period of the guarantee for each repair or replacement shall be one (1) year after the installation or completion. The one (1) year warranty shall cover all work equipment, and materials that are part of this project, whether or not a warranty is specified in the individual section prescribing that particular aspect of the work. Where more than a one (1) year warranty is specified in the individual section, that warranty shall govern.
- E. After receipt of written notice from the City to begin corrective work, the Contractor or Developer shall promptly begin the corrective work, unless the City's Representative has previously given the Contractor a written acceptance of such condition. This obligation shall survive the termination of the Contract. This guarantee shall not constitute the exclusive remedy of the City, nor shall other remedies be limited to either the warranty or guarantee period.

217.3 PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 200 – PROJECT REQUIREMENTS

ITEM 218. INSPECTION OF PROJECTS

218.1

INSPECTION

- A. All Projects, whether by a private development or the City of Killeen shall be inspected by the City or a designated representative of the City.
- B. The time that the City of Killeen or its designated representative will be available for inspection is from 7:00 a.m. to 6:00 p.m. on working days. Working days shall be defined as Monday through Friday excluding all holidays observed by the City of Killeen. All inspections shall be scheduled with the City a minimum of two (2) working days prior to the inspection.
- C. If the Contractor, for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request to the City and he shall allow ample time for satisfactory arrangements to be made for inspecting the Work in progress. The Contractor shall pay the expenses for extra inspection required for work outside regular hours at a rate of \$50.00/hour. Normal working hours for this purpose are Monday through Friday, 7:00 a.m. to 6:00 p.m. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Killeen.

218.2

AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the Work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the Work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the Work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these Specifications, nor to approve or accept any portion of the Work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the Work.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 301. BARRICADES, SIGNS AND TRAFFIC HANDLING

301.1 SCOPE OF WORK

- A. This specification covers the requirements to provide, install, move, replace, maintain, clean and remove temporary or permanent street closure barricades, signs or other devices required to handle the traffic in conformance with the current edition of the Texas Manual on Uniform Traffic Control Devices for Streets and Highways (TMUTCD) and as indicated by the Engineer or the City.

301.2 SUBMITTALS

- A. Within 10 days after the Notice to Proceed, the Contractor shall submit to the Engineer a site-specific Traffic Control Plan. The Traffic Control Plan shall be sealed by a Professional Engineer Registered in the State of Texas as required by the Project Specifications, City, or Engineer.

301.3 CONSTRUCTION METHODS

- A. Prior to commencing the construction, suitable "Barricades, Signs and Traffic Handling" devices shall be installed to protect the workers and the public. A traffic control plan specific to the Project shall be designed and submitted to the City prior to the start of construction. If indicated by the Plans or requested by the City, the plan shall be designed by a qualified traffic engineer who is a Registered Professional Engineer in the State of Texas.
- B. The Contractor shall be responsible for installing all markers, signs and barricades conforming to the Texas Manual on Uniform Traffic Control Devices and/or as indicated. If, in the opinion of the Engineer, additional markers, signs or barricades are needed in the interest of safety, the Contractor will install such as are required or as directed by the Engineer.

301.4 MAINTENANCE AND INSPECTION

- A. It shall be the Contractor's responsibility to maintain, clean, move and replace if necessary, barricades, signs and traffic handling devices during the time required for construction of the Project. When no longer needed all temporary barricades, signs and traffic handling devices shall be removed and the area restored to its original condition or as directed by the Engineer.
- B. Bimonthly barricade inspections shall be conducted using a form similar to TxDOT Form 599 for temporary traffic controls. One inspection shall be made for traffic control during the day and one inspection shall be made for traffic control during the night, on separate days.

301.5 PAYMENT

- A. Payment shall be made for the work performed in accordance with this specification and the appropriate bid items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 302. SITE PREPARATION

302.1 SCOPE OF WORK

- A. This specification covers the requirements for performing all clearing, grubbing and stripping of topsoil complete as shown on the Plans and as specified herein. Any items regarding site preparation that are not covered by this specification shall meet the requirements of Item 100, Texas Department of Transportation (TxDOT), Standard Specifications for Construction of Highways, Streets and Bridges.

302.2 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards or requested by the City or the Engineer.

302.3 CLEARING AND GRUBBING

- A. Except as otherwise directed, cut, grub, remove and dispose of all trees, stumps, brush, shrubs, roots and any other objectionable material within the limits defined on the Plans.
- B. All trees, stumps, brush, shrubs, roots and other objectionable material shall be cut, grubbed, removed and disposed of from areas to be occupied by buildings, structures, roads, pipelines and any other areas to be stripped. Trees and brush shall be removed to a depth at least three (3) feet below the finished grade.
- C. In addition, heavy growths of weeds or other plants shall be stripped from the surface in order to provide clear access to the work site and to prevent their inclusion in stockpiled soil which is to be reused later. Trees, stumps, surface plants and all debris removed from the site shall be disposed of off-site by the Contractor at his own expense.
- D. Before the start of construction, protect trees or groups of trees, designated by the Engineer to remain, from damage by all construction operations by erecting suitable barriers, or by other approved means. Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees designated to remain.
- E. Areas outside the limits of clearing shall be protected from damage and no equipment or materials shall be stored in these areas.
- F. No stumps, trees, limbs, or brush shall be buried in any fills or embankments.

302.4 STRIPPING

- A. Strip topsoil from all areas to be occupied by buildings, structures, roadways and all areas to be excavated or filled. Avoid mixing topsoil with subsoil and stockpile topsoil in areas on the site as approved by the Engineer. Topsoil shall be free from brush, trash, large stones and other extraneous material and protected until it is placed as specified under Section 307- LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL. Dispose of any remaining topsoil as directed by the City. All excess topsoil shall remain property of the City at its option, and Contractor shall place extra materials at a site designated by the City.



302.5

DISPOSAL OF MATERIALS

- A. All tree trunks, limbs, roots, stumps, brush, foliage, other vegetation and objectionable material shall be removed from the site and disposed of in a permitted disposal site in a manner satisfactory to the Engineer.
- B. Burning of cleared and grubbed materials will not be permitted unless approved by the Director of Public Works and a permit is obtained from the City of Killeen Fire Department.
- C. Disposal of Excavated Materials
 - 1. Suitable excavated materials may be stockpiled to be used for backfilling. Excess excavated materials and unsuitable backfill materials shall be disposed of by the Contractor in the following manner:
 - a. Clays, sands and gravel in excess of project requirements shall be disposed of by the Contractor at such locations and under consideration arranged by the Contractor at his expense.
 - b. Limestone and other rock excavation shall be disposed of by the Contractor at such locations and under consideration arranged by the Contractor at his expense.
 - 2. The classification of clays, sands, gravel, limestone and rock shall be made in accordance with the Unified Soil Classification System, U.S. Army Corps of Engineers, T.M. 3-357.
 - 3. Desirable topsoil, sod, or area fill shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to the City's operations, and to permit safe and convenient access to private and public property adjacent to the work

302.6

UNAUTHORIZED EXCAVATION

- A. Whenever the excavation is carried beyond or below the lines and grades as shown on the plans, except as specified above, all such excavated space shall be refilled with such material and in such a manner, as may be directed by the City, so as to insure the stability of the affected structure. Beneath all structures, space excavated without authority shall be refilled by the Contractor, at his own expense, with Class "C" concrete, crushed stone or selected fill materials, as directed by the City.

302.7

PAYMENT

- A. Payment will be made for work performed in accordance with this specification by the unit quantity for the item for right-of-way preparation in the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 303. SITE CLEARING

303.1 SCOPE OF WORK

- A. This specification covers the requirements for site clearing operations for this Project.

303.2 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards, or requested by the City or the Engineer.

303.3 TRAFFIC

- A. Conduct site-clearing operations to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

303.4 PROTECTION

- A. Provide temporary fences, barricades, coverings, or other protection to preserve existing items indicated to remain and to prevent injury or damage to persons or property. Provide protection for adjacent properties as required.
- B. Restore damaged work to condition existing prior to start of work.
- C. Protect existing trees and vegetation that are indicated to remain from physical damage. Do not store materials or equipment within tree drip line. Replace damaged trees that cannot be restored to full growth, as determined by arborist, unless otherwise deemed acceptable by the Engineer or the City.
- D. Protect existing property and easement corners and pins. In the event that property or easement corners or pins are moved, disturbed or destroyed, the Contractor shall replace them at his own expense. They shall be replaced by a Registered Professional Land Surveyor registered in the State of Texas.

303.5 EXISTING SERVICES

- A. Locations indicated are approximate; determine exact location before commencing work. Coordinate with local utility service requirements and comply with their instructions.

303.6 SITE CLEARING

- A. Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as indicated or that interfere with new construction. Removal includes digging out stumps and roots, together with subsequent off-site disposal.
- B. Strip and stockpile topsoil that will be reused in the Work.
- C. Remove existing improvements, both above-grade and below-grade, to extent indicated or as otherwise required to permit new construction.



303.7 SALVAGEABLE ITEMS

- A. Carefully remove items indicated to be salvaged and store on the City's premises where indicated or directed.

303.8 AIR POLLUTION

- A. Control air pollution caused by dust and dirt; comply with governing regulations.

303.9 REGRADING

- A. Fill depressions and voids resulting from site-clearing operations. Using satisfactory soil materials, place in maximum six (6) inch deep horizontal layers and compact each layer to density of surrounding original ground.
- B. Grade ground surface to conform to required contours and to provide surface drainage.

303.10 DISPOSAL OF MATERIAL

- A. Dispose of waste materials including trash, debris and excess topsoil. No waste material shall remain on the City's property.
- B. Burning waste materials on site is not permitted.

303.11 PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 304. TRENCHING, BACKFILLING AND COMPACTION

304.1 SCOPE OF WORK

- A. This specification covers the requirements for furnishing all labor, equipment and material and performing all work necessary, in connection with excavation, trenching, embedment, encasement, and backfilling, for the installation of water lines, storm sewer lines, wastewater lines, etc. in this Project.

304.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including a Trench Safety Plan (which shall be sealed by a Professional Engineer registered in the State of Texas, if required) embedment material (source, gradation and type), backfill material (source, gradation and type), encasement material (if required), equipment and all other pertinent data to illustrate conformance to the specification found within.

304.3 EXCAVATION

A. General

- 1. Excavation shall include the removal of any trees, stumps, brush, debris, or other obstacles that may obstruct the line of work, and the excavation and removal of all earth, rock or other materials to the extent necessary to install the pipe and appurtenances in conformance with the line and grades shown in the Plans, or as specified.

B. Maximum and Minimum Width of Trenches

- 1. The sides of all trenches shall be cut as nearly vertical as possible. Unless otherwise specified on the Plans, the minimum width of trench in which the pipe may be installed shall not be less than 12-inches plus the outside diameter of the pipe for pipe less than 20-inches in diameter and not less than 24-inches plus the outside diameter of the pipe for pipe greater than 20-inches in diameter. The maximum width shall not be more than 30-inches plus the outside diameter of the pipe, measured at an elevation in the trench which is 12-inches above the top of the pipe when it is laid to grade.
- 2. Wherever the prescribed maximum trench width is exceeded, the Contractor shall use the class embedment or encasement required by the Engineer to provide the load carrying capacity for the trench width as actually cut, and the additional cost incurred will be borne by the Contractor.

C. Sheeting and Shoring

- 1. Where required in the Contractor's Trench Safety System, or where required for other reasons in caving ground, or in wet, saturated or flowing materials, the sides of all trenches and excavations shall be adequately sheeted and braced so as to maintain the excavation free from slides or cave-ins.
- 2. Sheeting and shoring shall not be left in place unless its removal is impractical.



D. Dewatering Excavations

1. There shall be sufficient pumping equipment, in good working order, available at all times to remove any water that accumulates in excavations. Where the pipeline crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the work will be prevented. Provisions shall be made for the satisfactory disposal of surface water pumped so as to prevent damage to public or private property. The Contractor shall be responsible for maintaining safe working conditions and suitable construction techniques.

E. Disposal of Excavated Materials

1. Suitable excavated materials may be piled adjacent to the work to be used for backfilling. Excavated materials unsuitable for backfilling, or in excess of that required for backfilling, shall be disposed of by the Contractor. Desirable topsoil, sod, etc. shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to public travel. Suitable selected bedding or backfill material shall be provided at no additional cost to the City.

F. Trench Depth

1. Excavation for the pipeline shall be removed to a depth below the pipe barrel and pipe bell as shown in the Plans for the type of embedment specified, and the bottom of the trench brought to true subgrade with the embedment or encasement shown in the Plans.

G. Soft Subgrade

1. Where soft or spongy material is encountered in the excavation at subgrade level, it shall be removed to such a depth that a stable foundation is achieved by replacing the unsuitable material with tamped gravel, brought to the level of the bottom of bedding.
2. Gravel used shall be washed gravel or crushed stone and may fit any gradation of size up to three (3) inches. The particular gradation shall take into consideration the actual field conditions.

H. Excavated Materials

1. Excavated materials shall be piled adjacent to the work to be used for backfilling as required. After the trench has been refilled, topsoil shall be replaced to the extent that rock excavated from the trench will be completely covered and the area is returned to its original condition.
2. Where required on the Plans or when otherwise specified, desirable topsoil shall be piled separately in a careful manner and replaced in its original position.
3. Where a trench is required to cross a paved area, the asphalt or concrete shall be saw cut and removed for a total width that is two (2) feet greater than the trench width. The Contractor shall dispose of all excavated concrete, asphalt and subgrade material that is unsuitable for backfilling or in excess of that required for backfilling.

I. Damage to Existing Utilities

1. Where existing utilities are damaged, they shall be replaced immediately with material equal to or better than the existing material. Such work shall be at the entire expense of the Contractor.



EMBEDMENT AND ENCASEMENT

A. General

1. Embedment shall be as required in the Plans or Standards. All embedment materials shall be free of grass, roots, vegetation, and other deleterious materials. Embedment Standards are shown on the Plans or Standards.
2. When the pipe has been checked for line and grade, the trench shall be backfilled with enough granular material or concrete on both sides to hold the pipe firmly in position. When placing granular material or concrete around the pipe, care shall be taken to fill all voids around the pipe. The pipe shall not be floated. The embedment or encasement material shall be carefully tamped to assure uniform pipe support and density.

B. Embedment Materials

1. Material for embedment shall conform to the following sieve analysis:

<u>Sieve Size</u>	<u>³/₈" F % Retained</u>	<u>¹/₂" D % Retained</u>	<u>Washed Gravel % Retained</u>
¹ / ₂ "	0	0	0
³ / ₈ "	0-2	5-25	---
4m	40-85	80-100	---
10m	95-100	96-100	---
³ / ₄ "	---	---	100

2. Sand will not be allowed as an acceptable embedment material.

C. Concrete Embedment and Encasement

1. Concrete embedment and encasement and cap shall have a minimum compressive strength of 2,000 pounds per square inch at 28 days.
2. Dry mix will not be permitted. The concrete cushion portion of the embedment or encasement will be mixed moist or damp to give a slump of not more than one (1) inch. Concrete for the sides and top, if specified, shall be mixed to obtain a slump of not less than one (1) inch or more than three (3) inches.
3. After pipe joints are completed, the voids at the joints in the embedment section shall be filled with concrete, and the embedment shall be brought up to proper grade. Where concrete is placed over or along the pipe, it shall be placed in such a manner as not to damage or injure the joints or displace the pipe. Care shall be taken in the placement of concrete to assure that a uniform pad, free of voids and of specified thickness, is constructed under the entire pipe section.
4. A cleavage line between the base concrete and the side embedment concrete will not be allowed. Backfilling shall be done in a careful manner and at such time, after concrete embedment or encasement has been placed, as not to damage the concrete in any way.

BACKFILLING

A. General

1. Backfilling shall include the refilling and consolidating of the fill in trenches and excavations up to the surrounding ground surface or road grade at crossings. No backfill shall be placed



until the Engineer, the City or his authorized Inspector has inspected the trench and pipe in place and has authorized the placing of backfill.

2. Backfilling shall be done with native material, flexible base material, select backfill material, or flowable concrete backfill as described hereafter and shown on the Plans. No material of a perishable, spongy or otherwise unsuitable nature shall be used in backfilling.

B. Native Material

1. Native materials shall be placed over the top of the embedment/encasement material, where designated on the Plans and as shown in embedment Standards. Native material shall consist of material excavated from the trench, free from lumps, large stones, clay, debris, and organic materials. Native material used as backfill shall not have rocks with an average dimension larger than one (1) inch nor any dimension greater than two (2) inches.
2. Native material for backfill shall be compacted per the following table.

Field Density Control Requirements

Description	Density	Moisture Control
	Tex-115-E	
PI ≤ 15	≥ 98% Max. Dry Density	
15 < PI ≤ 35	98% ≥ Max. Dry Density ≤ 102%	≥ Optimum Moisture Content
PI > 35	95% ≥ Max. Dry Density ≤ 100%	≥ Optimum Moisture Content

3. It shall be the full responsibility of the Contractor to explore the project and subsurface materials to determine if the trench excavation will be suitable for use as backfill materials and to follow as closely as possible this Specification to insure a good, sound pipeline when completed.

C. Flexible Base Material

1. Flexible base material shall be placed over the top of the embedment/encasement material, where designated on the Plans and as shown in embedment Standards. Flexible base material shall consist of a TxDOT Type A – Grade 2 crushed limestone base compacted to 95% of the maximum density as determined by ASTM D1557 (Method D) at optimum moisture to +2%.

D. Select Backfill Material

1. Unless otherwise shown on the Plans, or approved by the Engineer, select material shall be used for backfill.
2. Select materials shall be placed over the top of the embedment/encasement material, where designated on the Plans and as shown in embedment Standards. Select material shall consist of a free-flowing material like sand or mixed sand and gravel, free from lumps, large stones, clay, debris, and organic materials. Select material may also include rock cuttings from a ditching machine (preferably wheel-type), provided that the largest chips shall have an average dimension in one place less than one (1) inch, and no dimension greater than two (2) inches.
3. If approved by the Engineer, good, sound earth may be used as select material for backfill over the pipe. Good, sound earth as defined as gravel, sandy loam or loam, free from excessive clay and having a Plasticity Index less than 20. Select material shall not have rocks with an average dimension larger than one (1) inch.
4. Select backfill shall be compacted per the following table.



Field Density Control Requirements

Description	Density	Moisture Control
	Tex-115-E	
PI≤15	≥98% Max. Dry Density	
15 < PI≤35	98% ≤ Max. Dry Density ≤ 102%	≥ Optimum Moisture Content
PI > 35	95% ≤ Max. Dry Density ≤ 100%	≥ Optimum Moisture Content

5. It shall be the full responsibility of the Contractor to explore the project and subsurface materials to determine if the trench excavation will be suitable for use as select materials and to follow as closely as possible this Specification to insure a good, sound pipeline when completed.

E. Concrete Trench Cap

1. Where 36-inch minimum cover can not be obtained or due to potential surface loading, the City may require a cap to be installed.

F. Flowable Concrete Backfill

1. Where shown on the Plans, flowable concrete backfill shall be in accordance with Section 806, FLOWABLE BACKFILL. All material shall be mixed in a concrete mixer or transit mixed unless otherwise approved by the City.

G. Backfilling Operation

1. After the pipe and embedment or encasement have been placed in trenches under non-paved areas, the remainder of the trench shall then be filled with material described in Section 304.5 (B-F). Mechanical tamping in ten (10) inch maximum lifts shall be used (except for flowable concrete backfill). Backfill material shall be compacted as described in the appropriate section listed above. A minimum of one density test shall be taken every two hundred fifty (250') feet for each ten (10") inch lift of subgrade for all backfill materials except flowable concrete.
2. All trenches under proposed or existing concrete roadways, driveways and sidewalks, paved waterways, brick roadways, asphaltic roadways with concrete base, gravel roadways, and roadways with gravel base and asphalt surface, shall be backfilled by hand or mechanically tamping selected materials in maximum six (6) inch layers compacted as described in the appropriate section listed above. Jetting with water will not be permitted. A minimum of one density test shall be taken every two hundred fifty (250') feet for each six (6") inch lift of subgrade for all backfill materials except flowable concrete.
3. After the trench has been refilled, topsoil shall be replaced to the extent that rock excavated from the trench will be completely covered or removed and the area is returned to its original condition, except that in cultivated areas a minimum of six (6) inches of topsoil shall be replaced.

304.6

PAYMENT

- A. No separate payment will be made for work performed under this Specification for excavating, trenching, embedment, and backfilling. All costs incurred shall be included in the contract price for the appropriate items in the Proposal and Bid Schedule.
- B. No separate payment will be made for the bedding used in embedment. All costs incurred shall be included in the contract price for the appropriate bid item.



- C. Separate payment, if authorized by the City, will be made for crushed stone or washed gravel as described in these specifications under Section 304.3(G), SOFT SUBGRADE, at the contract unit price per cubic yard as provided in the Proposal and Bid Schedule under "Extra Gravel for Embedment."
- D. Separate payment will be made for 2,000 psi Concrete Encasement or Backfill at the contract unit price per cubic yard or linear foot as provided in the Proposal and Bid Schedule under 2,000 psi Concrete Encasement. Concrete and three (3) sack granular sand or rock material mix backfill will be measured in cubic yards or linear feet actually placed based on actual trench width not to exceed the specified maximum trench width and will be paid for at the contract price per cubic yard or linear foot as provided in the Proposal and Bid Schedule.
- F. Where authorized by the Engineer, gravel used to replace unsuitable material will be paid for at the unit bid price for Extra Gravel for embedment.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 305. GRANULAR FILL MATERIALS

305.1 SCOPE OF WORK

- A. This specification covers the requirements for the use of granular fill materials for this Project.

305.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to Engineer or the City for approval, technical product literature including the source of the material, gradation, type of material, and all other pertinent data to illustrate conformance to the specification found within.

305.3 GENERAL

- A. Granular fill materials are specified in this Section, but their use for bedding pipe, pavement base, are specified in detail in sections 304 TRENCHING, BACKFILLING AND COMPACTION and 504 FLEXIBLE BASE. The Engineer may respectively order the use of fill materials for purposes other than those specified in other Sections if, in his/her opinion, such use is advisable.

305.4 MATERIALS

- A. Common fill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible, or which cannot be compacted properly. Common fill shall not contain stones larger than six (6) inches in any dimension, broken concrete, masonry, rubble, asphalt pavement, or other similar materials. It shall have physical properties, as approved by the Engineer, such that it can be readily spread and compacted.
- B. Select fill shall consist of suitable granular material with no stones larger than two (2) inches in its largest dimension, free from vegetation or other objectionable matter and reasonably free from lumps of earth. When tested by standard TxDOT laboratory methods Tex-105-E, Tex-106-E and Tex-107-E, the select fill shall meet the following requirements:
1. Liquid Limit shall not exceed 45.
 2. Plasticity index shall not exceed 15.
 3. Bar linear shrinkage shall not be less than 2.
- C. Crushed Stone Backfill shall consist of hard, durable, particles of proper size and gradation, free from sand, loam, clay, excess fines and deleterious materials. The size of the particles shall be uniformly graded such that the following bedding specifications are met:

<u>Sieve Size</u>	<u>³/₈" F % Retained</u>	<u>¹/₂" D % Retained</u>	<u>Washed Gravel % Retained</u>
¹ / ₂ "	0	0	0
³ / ₈ "	0-2	5-25	---
4m	40-85	80-100	---
10m	95-100	96-100	---
³ / ₄ "	---	---	100

- D. Crushed Stone Base shall consist of sound, durable stone, free of any foreign material, angular in shape, free from structural defects and comparatively free of chemical decay. This material shall comply with TxDOT Item 247, Type "A", Grade 1 unless otherwise shown on the Plans or Standards. The stone shall have a maximum size of ⁷/₈-inch.



- D. Cement Stabilization Sand Backfill shall consist of a mixture of ASTM C33 fine aggregate and Type I cement. The mix shall be proportioned of two (2) sacks of cement per cubic yard.
- E. Sand that is not cement stabilized will not be allowed as an acceptable backfill material.

305.5

PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 306. SEDIMENTATION AND TEMPORARY EROSION CONTROL

306.1 SCOPE OF WORK

- A. This specification covers the requirements necessary to perform all installation, maintenance, removal and area cleanup related to sedimentation control work as shown on the Plans and as specified herein.

306.2 SUBMITTALS

- A. Within 10 days after Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature for all commercial products to be used for sedimentation and erosion control.

306.3 GENERAL

- A. The work shall include, but not necessarily be limited to: triangular filter dike, rock berm, silt fence, curb inlet protection, stabilized construction entrance, tree protection, excelsior matting, and temporary mulching, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, excelsior matting installation and final cleanup. All sedimentation and erosion control shall be installed prior to the start of any construction activities.

306.4 QUALITY ASSURANCE

- A. The Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Plans necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the City will be considered.

306.5 MATERIALS

A. Triangular Filter Dike

1. Triangular filter dike sections shall be either 10-feet or 20-feet in length.
2. Geotextile fabric shall extend to 12-inches upstream of triangular filter dike structure.
3. Triangular filter dike structure shall be 18-inches in length on all three (3) faces.
4. Three (3) inch to five (5) inch open graded rock shall be placed over skirt to anchor it on the upstream side.
5. Structure shall be formed by six (6) gauge six inch by six inch (6"x6") welded wire mesh.
6. Geotextile fabric shall be non-woven, 4.5 oz. minimum and 36-inches wide.

B. Rock Berm

1. Woven wire sheathing shall be 20-gauge with one (1) inch openings.
2. Rock shall be three inches to five inches (3"-5") open graded.



C. Silt Fence

1. Steel posts shall be a minimum of four (4) feet in length, heavy weight T-Post.
2. Welded wire fabric shall be two-inch by four-inch (2"x4") mesh of 12-gauge by 12-gauge galvanized wire mesh.
3. Silt fence fabric shall be a 4.5 oz minimum non-woven geotextile filter fabric 36-inches wide.
4. Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings), or ¹/₃₂-inch diameter soft aluminum wire.
5. Prefabricated commercial silt fence may be substituted for built-in-field fence. Prefabricated silt fence shall be "Envirofence" as manufactured by Mirafi Inc., Charlotte, NC or equal.

D. Curb Inlet Protection

1. 4.5 oz. minimum non-woven geotextile filter fabric shall be used.
2. Sand bags shall be used to hold the filter fabric in place.

E. Stabilized Construction Entrance

1. Stabilized construction entrance shall have a minimum width of 12-feet and a minimum length of 50-feet.
2. An eight (8) inch high diversion ridge shall be constructed 15-feet from the edge of the existing roadway.
3. Stabilized construction entrance shall be graded to drain towards the existing roadway at a two-percent (2%) slope.
4. Rock shall be four-inches to eight-inches (4"-8") coarse aggregate.
5. Rock shall be placed to a depth of at least eight (8) inches.

F. Tree Protection – Chain Link Fence

1. Chain link fence shall be five (5) feet in height.
2. Fence shall be installed around the driplines of the trees to be protected.

G. Tree Protection – Wood Slats

1. Where any exceptions result in a fence being closer than four (4) feet to a tree trunk, protect the trunk with strapped-on-planking two inches by four inches (2"x4") wood slats to a height of eight (8) feet, or to the limits of lower branching in addition to the reduced fencing provided.
2. Trees most heavily impacted by construction activities should be watered deeply once a week during periods of hot, dry weather. Tree crowns should be sprayed with water periodically to reduce dust accumulation on the leaves.
3. Any trenching required for the installation of landscape irrigation shall be placed as far from existing tree trunks as possible.



4. No landscape topsoil dressing greater than four (4) inches shall be permitted within the dripline of a tree. No soil is permitted on the root flare of any tree.

H. Soil Retention Blankets

1. Soil retention blankets shall be installed in all seeded drainage swales and ditches as shown on the Plans or as directed by the Engineer. Only soil retention blankets included on TxDOT's Approved Products List will be considered acceptable for use on this Project.

I. Temporary Mulch

1. Temporary mulch shall be applied to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.

306.6

INSTALLATION

A. Triangular Filter Dike

1. Layout the filter dike following as closely as possible to the contour.
2. Clear the ground of debris, rocks, and plants that will interfere with installation.
3. Place the filter dike sections one (1) at a time, with the skirt on the uphill side towards the direction of flow anchoring each section to the ground before the next section is placed.
4. Anchors should be placed on two (2) foot centers alternating from front to back so that there is actually only one (1) foot in between anchors.
5. Securely fasten the skirt from one (1) section of filter dike to the next.
6. Filter dikes must maintain continuous contact with the ground.
7. After the site is completely stabilized, the dikes and any remaining silt should be removed. Silt should be disposed of in a manner that will not contribute to additional siltation.

B. Rock Berm Installation

1. Layout the rock berm following as closely as possible to the contour.
2. Clear the ground of debris, rocks or plants that will interfere with installation.
3. Place woven wire fabric on the ground along the proposed installation with enough overlap to completely encircle the finished size of the berm.
4. Place the rock along the center of the wire to the designated height.
5. Wrap the structure with the previously placed wire mesh secure enough so that when walked across, the structure retains its shape.
6. Secure with tie wire.
7. The ends of the berm should be tied into existing upslope grade and the berm should be buried in a trench approximately four (4) inches deep to prevent failure of the control.
8. The rock berm should be left in place until all upstream areas are stabilized and accumulated silt removed.



C. Silt Fence Installation

1. Layout the silt fence following as closely as possible to the contour.
2. Clear the ground of debris, rocks, and plants (including grasses taller than two (2) inches) to provide a smooth flow approach surface. Excavate six-inches deep by six-inches wide (6"x6") trench on upstream side of face per Plans.
3. Drive the heavy duty T-post at least 12-inches into the ground and at a slight angle towards the flow.
4. Attach the two-inches by four-inches (2"x4") 12-gauge welded wire mesh to the T-post with 11¹/₂-gauge galvanized T-post clips. The top of the wire to be 24-inches above ground level. The welded wire mesh to be overlapped six (6) inches and tied at least six (6) times with hog rings.
5. The silt fence to be installed with a skirt a minimum of 11-inches wide placed on the uphill side of the fence inside excavated trench. The fabric to overlap the top of the wire by one (1) inch.
6. Anchor the silt fence by backfilling with excavated dirt and rocks.
7. Geotextile splices should be a minimum of 36-inches wide attached in at least six (6) places.

D. Curb Inlet Protection Installation

1. Clear the pavement of debris, rocks, etc. to provide a smooth surface for installation.
2. Place the filter fabric over the inlet and extend to five (5) feet beyond inlet opening, upstream of inlet. Terminate fabric in street gutter with sand bags placed in gutter flowline.
3. Place sandbags on top of filter fabric around the perimeter of the protected area to secure the filter fabric.
4. Care shall be taken insure that the inlet protection will remain in place during periods of heavy runoff and that severe ponding will not occur in the street.

E. Stabilized Construction Entrance Installation

1. Clear the area of debris, rocks or plants that will interfere with installation.
2. Grade the area for the entrance to flow back on to the construction site. Runoff from the stabilized construction entrance onto a public street will not be allowed except for the first 15 feet connecting to the public street.
3. Place geotextile fabric if required.
4. Provide crushed aggregate for long and short-term construction entrances. 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. Use 4- to 8-in. aggregate for Type 1 and 2- to 4-in. aggregate for Type 3.

F. Tree Protection – Chain Link Fence

1. Tree protection fences shall be installed prior to the commencement of any site preparation work (clearing, grubbing or grading).



2. Fences shall completely surround the tree, or clusters of trees; will be located at the outermost limit of the tree branches (dripline), and will be maintained throughout the construction project in order to prevent the following:
 - a. Soil compaction in the root zone area resulting from vehicular traffic, or storage of equipment or materials.
 - b. Root zone disturbances due to grade changes greater than six (6) inches cut or fill or trenching not reviewed and authorized by the City.
 - c. Wounds to exposed roots, trunks or limbs by mechanical equipment.
 - d. Other activities detrimental to trees, such as chemical storage, cement truck cleaning and fire.
3. Exceptions to installing fences at tree driplines may be permitted in the following cases:
 - a. Where permeable paving is to be installed, erect the fence at the outer limits of the permeable paving area.
 - b. Where trees are close to a proposed building, erect the fence no closer than six (6) feet to building.

G. Tree Protection – Wood Slats

1. Any roots exposed by construction activity shall be pruned flush with the soil. Backfill root areas with good quality top soil as soon as possible. If exposed root areas are not backfilled within two (2) days, cover them with organic material in a manner which reduces soil temperature, and minimizes water loss due to evaporation.
2. Prior to excavation or grade cutting within tree dripline, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment, to minimize damage to remaining roots.
3. Pruning to provide clearance for structures, vehicular traffic and equipment shall take place before construction starts.

H. Excelsior Matting

1. The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied.
2. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area.
3. The blankets shall be applied in the direction of water flow, and stapled. Blankets shall be placed a minimum of three (3) rows, of four (4) foot wide (total approx. 12-foot width) within the drainage swale/ditch and stapled together in accordance with Manufacturer's instructions.
4. Side overlaps shall be four (4) inch minimum. The staples shall be made of wire, 0.091-inch in diameter or greater, "U" shaped with legs 10-inches in length and a 1¹/₂-inch crown. The staples shall be driven vertically into the ground, spaced approximately two (2) linear feet apart, on each side, and one (1) row in the center alternately spaced between each size.
5. Upper and lower ends of the matting shall be buried to a depth of four (4) inches in a trench.



6. Erosion stops shall be created every 25-feet by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be four (4) inches below the ground surface. Staple on both sides of fold.
7. Where the matting must be cut or more than one (1) roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of four (4) inches. Overlap lower end of upstream roll four (4) inches past edge of downstream roll and staple.
8. To ensure full contact with soil surface, roll matting with a roller weighing 100-pounds per foot of width perpendicular to flow direction after seeding, placing matting and stapling.
9. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

I. Temporary Mulching

1. Straw mulch shall be applied at rate of 100 lbs/1,000 ft² and tackified with latex acrylic copolymer at a rate of 1 gal/1,000 ft² diluted in a ratio of 30 parts water to one (1) part latex acrylic copolymer mix.

306.7

MAINTENANCE AND INSPECTIONS

A. Inspections

1. Contractor shall make a visual inspection of all sedimentation control devices once per week and promptly after every rain event exceeding 1/2-inch. Inspection reports shall utilize TxDOT Form 2118, or similar form. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas or into the vent trench, Contractor shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device Maintenance

1. Triangular Filter Dikes

- a. Realign berms as needed to prevent gaps between the sections.
- b. Accumulated silt should be removed after each rainfall event, and disposed of in a manner which shall not cause additional siltation.

2. Rock Berm

- a. Remove sediment and other debris when buildup reaches six (6) inches and dispose of the accumulated silt in an approved manner.
- b. Repair any loose wire sheathing.
- c. Reshape as needed.
- d. Replace berm when the structure ceases to function as intended due to silt accumulation among the rocks, washout, construction traffic damage, etc.

3. Silt Fences

- a. Remove accumulated sediment when buildup reaches six (6) inches.
- b. Replace damaged fabric, or patch with a two (2) foot minimum overlap.



- c. Replace or repair any sections crushed or collapsed in the course of construction activity.
 - d. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.
4. Curb Inlet Protection
- a. Repair any damaged fabric, or patch with a two (2) foot minimum overlap.
 - b. Replace any damaged sandbags.
 - c. Remove accumulated sediment.
5. Stabilized Construction Entrance
- a. Periodic top dressing with additional stone may be required as conditions demand to prevent tracking or flowing of sediment onto public rights-of-way.
 - c. Cleanout any measures used to trap sediment as needed.
 - d. All sediment spilled, dropped, washed or tracked on to public rights-of-way should be removed immediately by the Contractor.
 - e. When necessary, wheels should be cleaned to remove sediment prior to entrance onto public rights-of-way.
 - f. When washing is required, it should be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin.
 - g. All sediment should be prevented from entering any storm drain, ditch or water course by using approved methods.
6. Tree Protection – Chain Link Fence
- a. Repair or replace any chain link fence damaged by construction activities.
7. Tree Protection – Wood Slats
- a. Repair or replace any wood slats damaged by construction activities.
8. Excelsior Matting
- a. Replace matting as needed to prevent erosion from occurring.
9. Temporary Mulch
- a. Replace mulch as needed to prevent erosion from occurring.

306.8

REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Plans.



PAYMENT

- A. Silt fence and rock berm will be paid per linear foot installed as listed in the Proposal and Bid Schedule.
- B. Stabilized Construction Entrance will be paid per each installed as listed in the Proposal and Bid Schedule.
- C. Tree protection will be paid per each installed as listed in the Proposal and Bid Schedule.
- D. Erosion Control Blankets will be paid per square yard as listed in the Proposal and Bid Schedule.
- E. Triangular Filter Dikes will be paid per linear foot as listed in the Proposal and Bid Schedule.
- F. No separate payment will be made for all other work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 307. LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL

307.1 SCOPE OF WORK

- A. This specification covers the requirements to provide erosion control and place topsoil, finish grade, apply fertilizer, hydraulically apply seed and mulch and maintain all seeded areas as shown on the Plans and as specified herein, including all areas disturbed by the Contractor.

307.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, samples of all materials to be used and all other pertinent data to illustrate conformance to the specification found within.

307.3 TOPSOIL

- A. Topsoil shall be fertile, friable, natural topsoil typical of topsoil of the locality and shall be obtained from a well drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants or their roots, sticks, clay, peat and other extraneous matter and shall not be delivered to the site or used while in a frozen or muddy condition. Topsoil as delivered to the site or stockpiled shall have pH between 6.0 and 7.0 and shall contain not less than three (3) percent organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees Celsius.

The topsoil shall meet the following mechanical analysis:

	<u>Percentage Passing</u>
1-inch screen opening	100
No. 10 mesh	95 - 100
No. 270 mesh	35 - 75
0.002 mm*	5 - 25

* Clay size fraction determined by pipette or hydrometer analysis.

- B. At least 10 days prior to anticipated start of topsoiling operations, a one (1) pint sample of topsoil material shall be delivered by the Contractor to a laboratory for testing and approval. All testing shall be at the sole expense of the Contractor. Based on tests performed by the laboratory, the topsoil shall be identified as acceptable, acceptable with certain fertilizer and limestone applications or unacceptable. If the topsoil is found acceptable the fertilizer and lime requirements will be as specified or as recommended by the laboratory. If the topsoil is found unacceptable, the Contractor shall be responsible for identifying another source of topsoil and shall incur all expenses associated with testing additional samples. All topsoil incorporated into the site work shall match the sample provided to the laboratory for testing. Topsoil stockpiled under other Sections of these Specifications may be used subject to the testing and approval outlined above. Contractor will be responsible for screening stockpiled topsoil and providing additional topsoil as required at his/her own expense.
- C. Lime shall be ground limestone containing not less than 85-percent calcium and magnesium carbonates and be ground to such fineness that at least 50-percent shall pass a 100-mesh sieve and at least 90-percent shall pass a 20-mesh sieve.



- D. All planting shall be done between May 1 and September 15 except as specifically authorized in writing. If planting is authorized to be done outside the dates specified, the seed shall be planted with the addition of winter fescue (Kentucky 31) at a rate of 100 lbs. per acre.
- E. The seed shall be furnished and delivered premixed in the proportions specified within. A Manufacturer's Certificate of Compliance to the specified mixes shall be submitted by the Manufacturers for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
- F. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.
- G. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air-dry weight content and not contain in excess of 10-percent moisture.
- H. Excelsior matting blanket installed in all drainage swales and ditches shall be in accordance with Section 306- SEDIMENTATION AND TEMPORARY EROSION CONTROL.

307.4

APPLICATION OF TOPSOIL

- A. Unless otherwise shown on the plans, topsoil shall be placed to a minimum compacted depth of four (4) inches on all parts of the site not covered with structures, pavement, or existing woodland.
- B. For all areas to be seeded:
 - 1. Fertilizer (10-20-10) shall be applied at the rate of 30-lbs. per 1,000-sq. ft. or as determined by the soil test.
 - 2. Seed shall be applied at the rate of five (5) lbs. per 1,000-sq. ft.
 - 3. Fiber mulch shall be applied at the rate of 40-lbs. per 1,000-sq. ft.
- C. After the topsoil is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over the loam surface and thoroughly incorporated by heavy raking to at least one half the depth of topsoil.
- D. The application of fertilizer may be performed hydraulically in one (1) operation with hydroseeding and fiber mulching. The Contractor is responsible for cleaning all structures and paved areas of unwanted deposits of the hydroseeded mixture.

307.5

INSTALLATION OF TOPSOIL

- A. Previously established grades, as shown on plans shall be maintained in a true and even condition.
- B. Subgrade shall be prepared by tilling prior to placement of topsoil to obtain a more satisfactory bond between the two layers. Tillage operations shall be across the slope. Tillage shall not take place on slopes steeper than two (2) horizontal to one (1) vertical or where tillage equipment cannot be operated. Tillage shall be accomplished by disking or harrowing to a depth of nine (9) inches parallel to contours. Tillage shall not be performed when the subgrade is frozen, excessively wet, extremely dry or in other conditions which would not permit tillage. The subgrade shall be raked and all rubbish, sticks, roots and stones larger than two (2) inches shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with loam.



- C. Topsoil shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades and elevations indicated. No loam shall be spread in water or while frozen or muddy.
- D. After topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All stiff clods, lumps, roots, litter and other foreign material shall be removed from the loamed area and disposed of by the Contractor. The areas shall also be free of smaller stones, in excessive quantities, as determined by the Engineer or the City. The whole surface shall then be rolled with a hand roller weighing not more than 100-lbs per foot of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be regraded and rolled until a smooth and even finished grade is created.
- E. Seeding shall be done within 10 days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Contractor shall furnish the Engineer with a certified statement as to the number of pounds of materials to be used per 100-gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Contractor's hydroseeder. Upon completion of seeding operations, the Contractor shall furnish the Engineer and the City with a certified statement on the actual quantity of solution applied.
- F. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainageways, the Contractor shall carry out seeding and mulching as soon as he/she has satisfactorily completed a unit or portion of the project. A unit or portion of the project shall be determined by the City or Engineer. When protection of newly loamed and graded areas is necessary at a time which is outside of the normal seeding season, the Contractor shall protect those areas by what ever means necessary as approved by the Engineer and the City and shall be responsible for prevention of siltation in the areas beyond the limit of work.
- G. When newly graded subgrade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, the Contractor shall protect those areas against erosion and washouts in accordance with Section 306- SEDIMENTATION AND TEMPORARY EROSION CONTROL, or by other measures as approved by the Engineer and the City. Prior to application of topsoil, any such materials applied for erosion control shall be removed or thoroughly incorporated into the subgrade by disking. Fertilizer shall be applied prior to spreading of topsoil.
- H. On slopes, the Contractor shall provide against washouts by a method approved by the Engineer and the City. Any washout which occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.

307.6

HYDROMULCHING

- A. Fertilizer: 18-18-5, (Nitrogen, Phosphoric Acid, Potash) slow release granular at a rate of 25-lbs per 1,000-sq. ft.
- B. Water: The Contractor shall provide water necessary for grass planting and maintenance until acceptance by the City.
- C. Planting Seasons: Grass planting by sodding, sprigging, or hydromulching shall normally be done between May 1 and September 15.
- D. Hydromulching General
 - 1. Submit Manufacturer's product specifications and guaranteed purity analysis for fertilizer.



2. Product Delivery, Storage and Handling

- a. Deliver fertilizer to site in original unopened containers bearing Manufacturer's guaranteed chemical analysis, name, trademark and conformance to State Law.
- b. Store fertilizer in a dry location and protect from weather.

3. Guaranty and Replacement

- a. Provide guaranty for a period of one (1) year after final completion and acceptance of project, that the installed grass areas be at least the quality and condition as during acceptance.
- b. Rehydromulch unacceptable areas during the guaranty period. Guaranty shall not include damage or loss of lawn due to acts of God, acts of vandalism or negligence on the part of the City.

E. Native Grass Hydromulching-Products

1. Grass Seed: Common Bermuda grass, hulled, minimum 82% pure live seed. All grass seed shall be free from noxious weed, grade "A" recent crop, recleaned and treated with appropriate fungicide at time of mixing. Seed shall be furnished in sealed, standard containers with dealer's guaranteed analysis.
2. Mulch: Conwed regular wood fiber mulch or approved equal.
3. Fertilizer: 18-18-5, water-soluble or an approved equal.
4. Topsoil: Supply high quality imported topsoil of loamy character to the limits shown on the Plans, high in humus and organic content from local agriculture source. Topsoil to be free from clay, lumps, coarse sands, stones, roots and other foreign matter. There shall be no toxic amounts of acid or alkaline elements. Soil to be used for on-site mixing of backfill.

F. Native Grass Hydromulching-Execution

1. Preparation: Fine grade to final elevation removing any debris and insuring the seedbed is smooth.
2. Installation: Use a hydromulcher (sprayer) and apply the mixture at the following rate. (Mix in accordance with Manufacturer's recommendations.)
 - a. Hydromulch mixture shall contain 2.5-lbs. of common Bermuda grass seed per 1,000-sq. ft. hydromulch applied.
 - b. Mulch – 60-lbs. per 1,000-sq. ft.
 - c. Fertilizer – 25-lbs (18-18-5) per 1,000-sq. ft.
3. General Maintenance
 - a. Water the completed installation as necessary to insure germination of grass.
 - b. Maintain grass areas until complete germination and establishment of all areas.
 - c. Correct defective work as soon as apparent. Maintenance shall include, but not be limited to, weeding and fertilizing.



- d. Clean up: Remove trash and debris from the site.
- e. Acceptance: Substantial completion inspection to determine acceptance of grass areas will be made by the City after complete germination and coverage has been attained.

307.7

MAINTENANCE OF DEVELOPING GRASS

- A. The Contractor shall water and maintain all grassed areas until final acceptance. He shall also re-fertilize at the rate of one (1) pound of nitrogen and one (1) pound of phosphorous per 1,000-sq. ft. every 60 days until the grass is accepted.
- B. Areas which, due to settling or improper leveling, do not have positive drainage shall be re-leveled with topsoil and replanted with grass.
- C. Areas damaged by erosion, vehicle ruts and similar damage shall be re-leveled with topsoil and replanted. Finished ground surface shall be sufficiently smooth and level to facilitate mowing.

307.8

ACCEPTANCE

- A. Work under this section shall be considered acceptable when finish graded surfaces are level and well-drained, when there are no bare spots larger than three (3) square feet, when no more than 10 percent of the total area has bare spots larger than one (1) square foot, when not more than 15 bare spots larger than six (6) inches square and the grass is at least two (2) inches high, and when other requirements listed herein are met.
- B. Acceptance of work normally coincides with final acceptance of the entire project. However, seasonal factors may be cause for delay in grass planting, development, and acceptance.
- C. The City will accept responsibility for normal maintenance when grass is accepted. However, the Contractor shall remain responsible for any subsequent grass damage that he causes and for warranty of materials and workmanship for a period of not less than one (1) year from the time of acceptance.
- D. The Contractor shall furnish full and complete written instruction for maintenance of the seeded areas to the City at the time of acceptance.

307.9

PAYMENT

- A. No separate payment will be made for finish grading, placement of topsoil or grass planting and fertilizing. All related costs shall be included in the proper item of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 308. MISCELLANEOUS WORK AND CLEANUP

308.1 SCOPE OF WORK

- A. This specification covers the requirements to do the miscellaneous work not specified in other sections but obviously necessary for the proper completion of the work as shown on the Plans.

308.2 SUBMITTALS

- A. Within 10 days after the Notice to Proceed, the Contractor shall submit to the Engineer, in triplicate, a breakdown of any lump sum included in the Proposal and Bid Form. This breakdown shall be subject to approval by the Engineer and when so approved shall become the basis for determining progress payments and for negotiation of change orders, if required. In some contracts a lump sum item shall not be provided in the Proposal and Bid Form and shall be subsidiary to the other work items.

308.3 GENERAL

- A. When applicable, the Contractor will perform the work in accordance with other sections of this Specification. When no applicable specification exists the Contractor shall perform the work in accordance with the best modern practice and/or as directed by the Engineer.
- B. The work of this Section includes, but is not limited to, the following:
1. Crossing and Relocating Existing Utilities
 2. Restoring Driveways, Fences and Curbing
 3. Cleaning Up
 4. Incidental Work
 5. Restoring Easements and Rights-of-Way

308.4 CROSSING AND RELOCATING EXISTING UTILITIES

- A. This item includes any extra work required in crossing culverts, water courses including streams and drainage ditches, drains, gas mains, water mains and water services and other utilities. This work shall include but is not limited to the following: bracing, hand excavation and backfill (except screened gravel) and any other work required for crossing the utility or obstruction not included for payment in other items of this specification. Notification of Utility Companies shall be the Contractor's responsibility.
- B. In locations where existing utilities cannot be crossed without interfering with the construction of the work as shown on the Plans, the Contractor shall remove and relocate the utility as directed by the Engineer or Representative of the City or cooperate with the Utility Companies concerned if they relocate their own utility.
- C. At pipe crossings and where designated by the Plans, the Contractor shall furnish and place crushed stone bedding so that the existing utility or pipe is firmly supported for its entire exposed length. The bedding shall extend to the mid-diameter of the pipe crossed.



308.5 RESTORING OF DRIVEWAYS AND FENCES

- A. Existing public and private driveways disturbed by the construction shall be replaced. Paved drives shall be repaved to the limits and thicknesses existing prior to construction. Gravel dirt roads and drives shall be replaced and regraded.
- B. Fences in the vicinity of the work shall be protected from damage. If damaged, fences shall be replaced in condition equal to that prior to being damaged and the work shall be satisfactory to the City.

308.6 CLEANING UP

- A. The Contractor shall remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall restore the site of the work to a neat and orderly condition. All stored materials shall be kept in a neat manner, secured and protected from the public.

308.7 INCIDENTAL WORK

- A. Do all incidental work not otherwise specified, but obviously necessary to the proper completion of the Contract as specified and as shown on the Plans.

308.8 RESTORING THE EASEMENTS AND RIGHTS-OF-WAY

- A. Portions of the work may be within easements through private property. The Contractor shall be responsible for all damage to private property due to his/her operations. The Contractor shall protect from injury all walls, fences, cultivated shrubbery and vegetables, fruit trees, pavement, underground facilities, such as water pipes, or other utilities which may be encountered along the easement. If removal and replacement are required, it shall be done in a workmanlike manner so that replacement is equivalent to that which existed prior to construction.
- B. Existing lawn and sod surfaces damaged by construction in easements shall be replaced. The Contractor may cut and replace the lawn and sod, or may restore the areas with an equivalent depth and quality of loam, seeded and fertilized as specified in Section 307- LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL if acceptable to the owner of the private property and the City. These areas shall be maintained and re-seeded or re-sodded at the option of the owner of the private property and the City, if necessary, until all work under this Contract has been completed and accepted. Any additional work required to restore easements to their original condition shall be performed by the Contractor.

308.9 PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 300 – GENERAL SPECIFICATIONS

ITEM 309. STRUCTURAL EXCAVATION

309.1 SCOPE OF WORK

- A. This specification covers the requirements for excavation for the placing of structures, except pipe, for the disposal of such excavated material, and for the backfilling around completed structures to the level of the original ground.

309.2 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards or requested by the Engineer or the City.

309.3 CONSTRUCTION METHODS

- A. Excavation shall be done in accordance with the lines and depths indicated on the Plans or as established by the City. Unless otherwise specified on the Plans or permitted by the City no excavation shall be made outside a vertical plane three (3) feet from the footing lines and parallel thereto. When caissons are provided, no excavation will be permitted outside the outer faces of the caissons.
- B. To permit the City to judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores to determine the character of the subgrade materials. The maximum depth of soundings or cores will in general, not exceed five (5) feet below the proposed footing grade. It is the intent of this provision that soundings shall be made at the time the excavation in each foundation is approximately complete.
- C. Excavations shall conform to elevations shown on the Plans, or raised or lowered by written order of the City, when such alterations are judged proper. When deemed necessary to increase or decrease the plan depth of footings, the alterations in the details of the structure shall be as directed by the City. The City shall have the right to substitute revised details resulting from consideration of changes in the design conditions.
- D. When a structure is to be placed on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final excavation to grade shall not be performed until just before the footing is placed.
- E. Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for its rehandling during the backfilling operations and with the approval of the City.
- F. For all single and multiple box culverts, pipe culverts, pipe arch culverts, and box sewers of all types, where the soil encountered at established footing grade is a quicksand, muck, or similar unstable material, the following procedure shall be used unless other methods are called for on the Plans:
 - 1. The depth to which unstable material is removed will be determined by the City. The depth will not exceed two (2) feet below the footing of culverts that are two (2) feet or more in height, and will not exceed the height of culverts of those less than two (2) feet high. Excavation shall be carried at least one (1) foot horizontally beyond the limits of the structure on all sides. All unstable soil removed shall be replaced with suitable stable material, in uniform layers of suitable depth for compaction as directed by the City. Each layer shall be wetted; if necessary, and compacted by rolling or tamping as required



to provide a stable foundation for the structure. Soil which has sufficient stability to properly sustain the adjacent sections of the roadway embankment will be considered a suitable foundation material.

2. When in the opinion of the City, it is not feasible to construct a stable footing as outlined above, the Contractor shall construct it by the use of special materials, such as flexible base, cement stabilized base, cement stabilized backfill or other material, as directed by the City.
- G. When the material encountered at footing grade of a culvert is found to be partially rock, or incompressible material, and partially a compressible soil which is satisfactory for the foundation, the incompressible material shall be removed for a depth of six (6) inches below the footing grade and backfilled with a compressible material similar to that used for the rest of the structure.

309.4

BACKFILLING

- A. General: As soon as practicable, all portions of excavation not occupied by the permanent structure shall be backfilled. Back-fill material shall be free from large or frozen lumps, wood or other extraneous material.
1. That portion of backfill which will not support any portion of completed roadbed or embankment shall be placed in layers not more than 10-inches in depth (loose measurement) and shall be compacted to a density comparable with the adjacent, undisturbed material.
 2. That portion of the backfill which will support any portion of the roadbed or embankment or is within two (2) feet of the roadbed or embankment shall be placed in uniform layers not to exceed six (6) inches in depth (loose measurement) and each layer compacted to the density specified for the appropriate material. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to that density by means of mechanical tamps, except that the use of rolling equipment of the type generally used in compacting embankments will be permitted on portions which are accessible to such equipment. All portions of embankment too close to any portion of a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted in the same manner as specified above for backfill material. These provisions require the mechanical compaction, by means of either rolling equipment or mechanical tamps, of all backfill and embankment adjoining the exterior walls and wingwalls of culverts. Unless otherwise provided by the Plans or Special Conditions, hand tamping will not be accepted as an alternate for mechanical compaction. As a general rule, material used in filling or backfilling the portions described in this paragraph shall be an earth free of any appreciable amount of gravel or stone particles more than four (4) inches in greatest dimension and of a gradation that permits thorough compaction. The percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density. When required by the Plans or by written order of the City, cement stabilized material shall be used for backfilling.
 3. All portions of fill and backfill described in the preceding paragraph shall be compacted to the same density requirements specified for the adjoining sections of embankment in accordance with the governing specifications therefore.
 4. Where no embankment is involved on the Project and no specifications therefor are included in the Contract, all backfill shall be compacted to a density comparable with the adjacent undisturbed material.



5. Care shall be taken to prevent any wedging action of backfill against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such action.
6. Backfilling shall not proceed prior to inspection and approval of the inspector.

309.5

PIPE CULVERTS

- A. The following requirements shall apply to the backfilling of pipe culverts in addition to the pertinent portions of the general requirements given in the preceding and in pipe bedding Standards.
 1. Backfilling shall be continued in this manner to the elevation of the top of the pipe. Special care shall be taken to secure thorough compaction of the material placed under the haunches of the pipe. In the case of pipe in trenches, that portion of the backfill above the top of the pipe which supports embankment or the roadbed or is within two (2) feet of the roadbed or embankment shall receive mechanical compacting as specified, and the portion which will not support any portion of embankment or roadbed shall be placed in layers not more than ten (10) inches in depth (loose measurement) and shall be compacted by whatever means the Contractor chooses, to a density comparable with the adjacent, undisturbed material.

309.6

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 401. STORM SEWER MANHOLES

401.1 SCOPE OF WORK

- A. This specification covers the requirements to install precast concrete storm sewer manholes, frames and covers, and appurtenances as shown on the Plans and as specified herein.

401.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, shop drawings, product data, materials of construction, and details of installation shall be submitted in accordance with Section 211- SUBMITTALS. Submittals shall include the following: base sections, riser sections, eccentric conical top sections, flat slab tops, grade rings with notarized certificate indicating compliance with ASTM C478, pipe connection to manhole, manhole frame and cover with notarized certificate indicating compliance with ASTM A48, Class 30, method of repair for minor damage to precast concrete sections, manhole lining system.

B. Design Data

1. Precast concrete structures:

- a. Six (6) copies of sectional plan(s) and elevations showing dimensions and reinforcing steel placement.
- b. Six (6) copies of concrete design mix.

C. Test Reports

1. Precast concrete structures: Six (6) copies of concrete test cylinder reports from an approved testing laboratory certifying conformance with specifications.

401.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Specification for Gray Iron Castings.
2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM C33 - Specification for Concrete Aggregates.
4. ASTM C150 - Standard Specification for Portland Cement.
5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
6. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.

B. American Concrete Institute (ACI)

1. ACI 318 - Building Code Requirements for Reinforced Concrete.
2. ACI 350R - Concrete Sanitary Engineering Structures.



- C. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. Standard Specifications for Highway, Streets and Bridges.
- D. Occupational Safety and Health Administration (OSHA)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

401.4 QUALITY ASSURANCE

- A. All material shall be new and unused.
- B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by Engineer or other City representative. Inspection may be made at place of Manufacture, at work site following delivery, or both.
- C. Materials will be examined for compliance with ASTM specifications, these Specifications and approved Manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions(s), blisters, cracks and soundness.
- D. Materials shall be rejected for failure to meet any Specification requirement. Rejection may occur at place of manufacture, at work site, or following installation. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to City.
- E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by Engineer or the City.

401.5 PRODUCTS

- A. Reference to a Manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials/equipment shall be the end products of one Manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and Manufacturer's service.
- C. Provide lifting lugs or holes in each precast section for proper handling.

401.6 PRECAST CONCRETE MANHOLE SECTIONS

- A. Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall conform to ASTM C478 and meet the following requirements:
 - 1. Bottom slab thickness shall be 12-inches.
 - 2. Top section shall be flat slab with a minimum clear opening of 32 ⁷/₈-inches diameter.
 - 3. Base, riser and transition top sections shall have tongue and groove joints.
 - 4. Sections shall be cured by an approved method.
 - 5. Precast concrete sections shall be shipped after concrete has attained 3,000 psi compressive strength.



6. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum HS-20 loading plus earth load. Calculate earth load with a unit weight of 130 pounds per cubic foot.
 7. Mark date of manufacture, name and trademark of Manufacturer on the inside of each precast section.
 8. Construct and install precast concrete base as shown on the Plans.
 9. Provide integrally cast knock-out panels in precast concrete manhole sections at locations, and with sizes shown on Plans. Knock-out panels shall have no steel reinforcing.
- B. Manhole diameter shall be as shown on the Plans, but not less than the diameter of the largest connecting pipe plus two (2) feet.
- C. Pipe Sections: Pipe sections shall conform to current specifications for Precast Reinforced Manhole Sections, ASTM Designation C478, with the following additions:
1. Pipe shall be machine made by a process which will provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which will assure a dense concrete in the finished product.
 2. Aggregates for the concrete shall consist of limestone aggregates in the proportion of at least 75% by weight of the total aggregates.
 3. Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM C76 for Class III pipe.
- D. Joints: Joints shall conform to the joint specifications in ASTM C478, C76, and ASTM C443. All manhole sections, including the bottom section, shall be furnished with "O-ring" type rubber gasket joints. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with mortar or an approved non-shrink grout on the inside and the outside of the manhole. Grade rings shall be mortared to each other and on the inside and outside to provide a waterproof seal.
- E. Manhole Steps: Unless specifically approved by the City, manhole steps shall not be provided.

401.7

MANHOLE FRAME AND COVER

- A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.
- B. Manhole covers shall have a diamond pattern, pickholes and the words STORM SEWER as appropriate cast in three (3) inch letters. Manhole frame and covers shall be Neenah Foundry, Western Iron Works, Vulcan Foundry, or equal. Model numbers refer to Western Iron works products:
1. Manhole Frame and cover - WRM-36.

401.8

JOINTING PRECAST MANHOLE SECTIONS

- A. Seal tongue and groove joints of precast manhole sections with rubber "O"-ring gasket. O-ring gasket shall conform to ASTM C443.
- B. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.



401.9

PIPE CONNECTIONS TO MANHOLE

A. Connect pipe to manhole in the following ways:

1. Flexible sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PSX Press-Seal Gasket or equal.
2. Compression gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok, or equal.

401.10

INSTALLATION

A. Manhole Installation

1. Manholes shall be constructed to the dimensions shown on the Plans and as specified herein. Protect all work against flooding and flotation.
2. Place manhole base on a bed of screened gravel eight (8) inches in depth as shown on the Plans. Set manhole base so that a maximum grade adjustment of eight (8) inches is required to bring the manhole frame and cover to final grade.

Use precast concrete grade rings to adjust manhole frame and cover to final grade.

3. Set precast concrete barrel sections plumb with a 1/4-inch maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber "O" ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with non-shrink grout to the satisfaction of the Engineer and the City.
4. Allow joints to set for 14 hours before backfilling unless a shorter period is specifically approved by the Engineer or the City.
5. Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.
6. Core holes in precast sections to accommodate pipes prior to setting manhole sections in place to prevent jarring which may loosen the mortar joints.
7. Backfill carefully and evenly around manhole sections.

B. Manhole Pipe Connections: Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.

C. Setting Manhole Frame and Cover: Set manhole covers and frames in a full mortar bed. Utilize precast concrete grade rings, a maximum of eight (8) inches thick, to assure frame and cover are set to the finished grade. Set manhole frame and cover to final grade prior to placement of permanent paving.

401.11

TESTS

A. Test each manhole in accordance with Section 213- TESTING OF PIPELINES AND MANHOLES. Engineer or the City's representative shall observe each test.



401.12

CLEANING

- A. Thoroughly clean all new manholes of all silt, debris and foreign matter of any kind, prior to final inspections.

401.13

PAYMENT

- A. Payment for furnished and installed manholes shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the reinforced concrete pipe including but not limited to excavation, bedding, backfill, connection to pipe, etc. shall be subsidiary to this item.

END OF SECTION



SECTION 400 - DRAINAGE SPECIFICATION

ITEM 402. REINFORCED CONCRETE PIPE

402.1 SCOPE OF WORK

- A. This specification covers the requirements for the placing of reinforced concrete pipe and for the material and incidental construction requirements for reinforced concrete pipe sewers. The culvert pipe shall be installed in accordance with the requirements of these specifications to the lines and grades shown on the Plans, and shall be of the classes, sizes and dimensions shown thereon. The installation of pipe shall include all joints or connections to new or existing pipe, headwalls, etc., as may be required to complete the work. The locations of private driveway and side road pipe may be varied as deemed necessary by the Engineer or the City.

402.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including pipe Manufacturer, joint material, bedding material, fittings, geotextile fabric, and all pertinent data to illustrate conformance to the specification found within.

402.3 MATERIALS

- A. The pipe shall be of the Class specified on the Plans. The shell thickness, the amount of circumferential reinforcement and the strength of the pipe shall conform to the specified Class as summarized in ASTM Designation: C76 for Circular Pipe: C506 for Arch Pipe or C507 for Horizontal Elliptical Pipe.
1. All precast concrete pipe shall be machine made or cast by a process which will provide for uniform placement of the concrete in the form and compaction by mechanical devices which will assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete will not be acceptable for use in precast pipe.
 2. Unless otherwise approved by the City, not more than two (2) holes may be placed in the top section of precast pipe for lifting and placing. The holes may be cast, cut, or drilled in the wall of the pipe. The holes shall not exceed three (3) inches in diameter at the inside of surface of the pipe wall. Not more than one (1) longitudinal wire or two (2) circumferential wires may be cut per layer of reinforcing steel when locating lift holes in the pipe wall. After the pipe is in place, lift holes shall be filled with concrete or mortar or precast concrete plugs to the satisfaction of the Engineer.
 3. The Contractor has the option of using portland cement or portland cement plus fly ash. When fly ash is used, then "cement" shall also be defined as "cement plus fly ash". "Cement plus fly ash" shall be composed of portland cement of the type specified and 20 to 35 percent fly ash by absolute volume. Type B fly ash shall not be used when Type II cement is shown on the plans. When portland cement is partially replaced, blended or otherwise modified by a pozzolan, the pozzolan is defined and limited to fly ash conforming to TxDOT Department Materials Specification D-9-8900, "Fly Ash".
- B. Jointing Materials
1. Cold Applied, Plastic Asphalt Sewer Joint Compound shall be suitable for jointing concrete pipe. It shall consist essentially of natural and/or processed asphalt base, suitable volatile solvents, and inert filler. The consistency is to be such that the ends of



the pipe can be coated with a layer of the compound up to one-half ($1/2$) inch thick by means of a trowel. It shall cure to a firm, stiff plastic condition after application. The material shall be of a uniform mixture and any small separation occurring in the container before use must be readily stirred back to form a uniform mix.

2. Mortar for joints shall consist of one (1) part cement, two (2) parts sand and sufficient water to make a plastic mix. The sealing of joints with mortar shall be in accordance with TxDOT Item 464 of the Standard Specifications for Construction of Highways, Streets and Bridges.
 3. Rubber gaskets shall conform to ASTM C361 or C443. The design of the joints and permissible variations in dimensions shall be in accordance with ASTM C443. The Contractor shall furnish the Engineer the Manufacturer's Certificate of Analysis. Rubber gaskets shall be installed according to the recommendations of the Manufacturer. Water tight joints will be required when using rubber gaskets. Backfilling may begin when approved by the City.
 4. Cold applied preformed plastic gaskets shall be suitable for sealing joints of tongue and groove concrete pipe in accordance with TxDOT Item 464 of the Standard Specifications for Construction of Highways, Streets and Bridges.
- C. Rubber Gaskets shall conform to ASTM Designation: C361 or C443, with the provision that the Contractor shall furnish the City the Manufacturer's Certificate of Analysis.
- D. Cold Applied Preformed Plastic Gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross-section. The size of the plastic gasket joint sealer shall be in accordance with the Manufacturer's recommendations and sufficient to obtain the squeeze-out as described under "Jointing", The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half.
- E. All fittings and wyes shall be manufactured and not constructed on the project unless prior approval is granted by the City.
- F. All joints that are not sealed with a watertight connection shall be wrapped with MARFI-140-N geotextile fabric or equivalent. The joint shall be wrapped with 18-inch wide fabric splitting the joint (nine (9) inches on each side).

402.4

CONSTRUCTION METHODS

- A. Excavation. All excavation shall be in accordance with the requirements of Section 309-STRUCTURAL EXCAVATION. Before pipe is laid in a trench, the completed and shaped trench to receive the pipe shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of the backfill and bedding material under and around the pipe. The Contractor shall make such temporary provisions as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.
- B. Bedding. The pipe shall be bedded in accordance with the details shown on the Plans. Where the soil encountered at the established grade is quicksand, muck, or similar unstable material, unless special construction methods are called for on the Plans or in the special provisions, such unstable soil shall be removed and replaced in accordance with the requirements of Section 309-STRUCTURAL EXCAVATION.



- C. Laying Pipe. Unless otherwise authorized by the City, the laying of pipe on the prepared foundation shall be started at the outlet end with the spigot or tongue end pointing downstream and shall proceed toward the inlet. Where bell and spigot pipe are used, cross trenches shall be cut in the foundation to allow the barrel of the pipe to rest firmly upon the prepared bed. These cross trenches shall be not more than two (2) inches larger than the bell ends of the pipe. Proper facilities shall be provided for hoisting and lowering the sections of pipe into the trench without disturbing the prepared foundation and the trench. The ends of the pipe shall be carefully cleaned before the pipe is placed. As each length of pipe is laid, the mouth of the pipe shall be protected to prevent the entrance of earth or bedding material. The pipe shall be fitted and matched so that when laid in the bed shall form a smoother, uniform conduit. When elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, the pipe shall be laid in the trench in such position that the markings "Top" or "Bottom", shall not be more than five (5) degrees from the vertical plane through the longitudinal axis of the pipe.

Multiple installations of reinforced concrete pipe shall be laid with the centerlines of individual barrels parallel. When not otherwise indicated on the Plans, the following clear distances between outer surfaces of adjacent pipe shall be used.

Diameter of Pipe	18"	24"	30"	36"	42"	48"	54"	60" - 84"
Clear Distance Between Pipes	0' -9"	0' -11"	1' -1"	1' -3"	1' -5"	1' -7"	1' -11"	2' -0"

- D. Jointing. All piping, if specified by the Plans, Details, or the City,
1. Joints sealed with Portland cement mortar shall be made as follows: mortar, composed of one (1) part portland cement and two (2) parts sand, so placed as to form a durable water-tight joint. The ends of the pipe shall be cleaned thoroughly and wetted before making the joint. After any section of pipe is laid and before any succeeding section is laid the lower half of the bell or groove of the pipe last laid shall be plastered thoroughly by troweling on an even layer of mortar. Next, mortar shall be applied to the upper portion of the tongue or spigot of the pipe section being laid.

The spigot or tongue end of the next section of pipe shall then be inserted and the joint pulled up tight, taking care that the inner surfaces of the abutting pipe section are flush and even. After the section is laid and uniformly matched and the sections have been fitted as close as the construction of the pipe will permit, the lower half of the inner circumference of the joints of pipe over 18-inches in diameter shall be sealed and packed with mortar and finished smooth and even with the adjacent section of pipe. Before this mortar has attained initial set, additional mortar then shall be applied from the outside and forced into the unfilled portion of the bell or grooved to fill completely the annular space around the spigot or tongue. For bell and spigot pipe, a bead shall be formed on the outside by troweling on mortar downward at an angle of 45 degrees from the outer edge of the bell to the spigot of the last laid section. For tongue and groove pipe, a bead shall be formed extending at least one (1) inch on either side of the joint and of approximately semicircular cross-section or triangular cross-section. If the triangular cross-section is used, it shall be formed by placing the mortar approximately 45 degrees outward from the extreme edges of the bead. For pipe too small to permit finishing of the inside surface of the joint, a tight stopper of burlap or other equivalent materials shall be dragged through the pipe past the new joint to remove any fins of mortar. Special care shall be exercised in placing adjacent pipe sections to avoid movement of the pipe in



place and the breaking of the mortar bond at completed joints. After the initial set, the mortar on the outside shall be protected from air and sun with a thoroughly wetted earth or burlap cover or acceptable equivalent which shall be kept wet for a minimum of 48 hours or until the backfill has been completed. No jointing shall be done when the atmospheric temperature is at or below 40° F, and when necessary, because of a sudden drop in temperature, joints shall be protected against freezing for at least 24 hours. After placing, any pipe which is not in true alignment or which shows any undue settlement after laying or is damaged, shall be taken up and relayed or replaced without extra compensation.

At the Contractor's option, and with the approval of the City for pipes which are large enough for a man to enter and perform the required work efficiently, pipe may be furnished with the groove not less than one-half ($1/2$) of an inch and not more than three-fourths ($3/4$) of an inch longer than the tongue. Such pipe may be laid without mortar joints and backfilled. Care shall be exercised to avoid displacing the joints during the backfilling operations. After the backfilling has been completed, the space between the end of the tongue and the groove shall be cleaned of all foreign material, thoroughly wetted and filled with mortar around the entire circumference of the pipe. Mortar for this use shall be of such consistency that it can be packed in the joint completely filling the space between adjacent pipes. The City will inspect this process to ascertain that the joints are being completely filled. If the City finds that this is not being accomplished, it may void this process and require that for the remainder of the project the pipe be jointed and backfilled in accordance with the provisions of the first paragraph of this section.

The Contractor shall make available for the use of the City an appropriate rolling device similar to an automobile mechanic's "Creeper" for conveyance through the small size pipe structures.

No mortar banding on the outside of pipe will be required for side drain culverts. No joint material will be required for temporary culverts.

Mortar joints will be required for irrigation wells, vents and similar vertical structures.

2. Joints using Cold Applied, Plastic Asphalt Sewer joint compound shall be made as follows: Both ends of the pipes shall be clean and dry and shall be coated with a suitable primer of the type recommended by the Manufacturer where they will be in contact with the joint material. Under no circumstance shall this type of joint be attempted on wet pipe. After the pipe has been set to proper line and grade in the trench, a one-half ($1/2$) of an inch thick layer of the compound shall be troweled or otherwise placed on the groove end of the pipe covering not less than two-thirds ($2/3$) of the joint face around the entire circumference. Next the tongue end of the next pipe shall be shoved home with sufficient pressure to make a tight joint. After the joint is made, any excess mastic projecting into may proceed as soon as the joint has been inspected and approved by the City. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.
3. Joints using rubber gaskets shall be made as follows: Where rubber gasket pipe joints are required by the Plans, the joint assembly shall be made according to the recommendations of the gasket Manufacturer. Watertight joints will be required when using rubber gaskets.
4. Joints using cold applied preformed plastic gaskets shall be made as follows: A suitable primer of the type recommended by the Manufacturer of the gasket joint sealer shall be brush applied to the tongue and groove joint surfaces and the end surfaces and allowed to dry and harden. No primer shall be applied over mud, sand or dirt or sharp cement protrusions. The surface to be primed must be cleaned and dry when primer is applied.



Before laying the pipe in the trench, the plastic gasket sealer shall be attached around the tapered tongue or tapered groove near the shoulder or hub of each pipe joint. The paper wrapper shall be removed from one (1) side only of the two (2) piece wrapper on the gasket and pressed firmly to the clean, dry pipe joint surface. The outside wrapper shall not be removed until immediately before pushing the pipe into its final position.

When the tongue is correctly aligned with the flare of the groove, the outside wrapper on the gasket shall be removed and the pipe shall be set with sufficient force and power, (Back hoe shovel, chain hoist, ratchet hoist or winch), to cause the evidence of squeeze-out of the gasket material on the inside or outside around the complete pipe that would tend to obstruct the flow shall be removed. (Pipe shall be set in a straight line with all parts of the pipe on line and grade at all times). Backfilling of pipe laid with plastic gasket joints may proceed as soon as the joint has been inspected and approved by the City. Special precautions shall be taken in placing and compacting backfill to avoid damage to the points.

When the atmospheric temperature is below 60° F, plastic joint seal gaskets shall either be stored in an area warmed to above 70° F, or artificially warmed to this temperature in a manner satisfactory to the City. Gaskets shall then be applied to pipe joints immediately prior to placing pipe in trench, followed by connection to previously laid pipe.

- E. Backfilling. After the pipe has been placed, bedded and jointed as specified, filling and/or backfilling shall be done in accordance with the applicable requirements of Section 309-STRUCTURAL EXCAVATION. When mortar joints are specified, no fill or backfill shall be placed until the jointing material has been cured for at least six (6) hours. Special precautions shall be taken in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Joints consisting of material other than mortar may be backfilled immediately.
- F. Protection of Pipe. Unless otherwise shown on the Plans or permitted in writing by the City, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of four (4) feet of permanent or temporary, compacted fill has been placed thereon. Pipe damaged by the Contractor's equipment shall be removed and replaced by the Contractor at no additional cost.

402.5

PAYMENT

- A. Payment for furnished and installed reinforced concrete pipe shall be paid according to the unit price per linear foot in the proper item of the Proposal and Bid Schedule. All work and materials to complete the reinforced concrete pipe including, but not limited to, excavation, bedding, backfill, connection to structures, etc., shall be subsidiary to this item.

END SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 403. HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

403.1 SCOPE OF WORK

- A. This specification covers the requirements for the placing of high density polyethylene (HDPE) solid and profile wall pipe and for the material and incidental construction requirements for HDPE pipe sewers. The culvert pipe shall be installed in accordance with the requirements of these specifications to the lines and grades shown on the Plans, and shall be of the classes, sizes and dimensions shown thereon. The installation of pipe shall include all joints or connections to new or existing pipe, headwalls, etc., as may be required to complete the work. The locations of private driveway and side road pipe may be varied as deemed necessary by the Engineer or the City.

403.2 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

403.3 SUBMITTALS

- A. Conform to requirements of Section 211 - SUBMITTALS.
- B. Submit shop drawings showing design of pipe and fittings, laying dimensions, fabrication, fittings, flanges, and special details.
- C. Provide manufacturer's certificate of conformance to Specifications.

403.4 QUALITY CONTROL

- A. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.
- B. City Engineer reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.
- C. Manufacturer's Notification: Should City Engineer wish to witness manufacture of specific pipes, manufacturer shall provide City Engineer with minimum three weeks notice of when and where production of those specific pipes will take place.
- D. Failure to Inspect. Approval of products or tests is not implied by City Engineer's decision not to inspect manufacturing, testing, or finished pipes.

403.5 MATERIALS

- A. General
 - 1. For sewer pipe provide HDPE pipe as follows:
 - a. New Construction Pipe Products
Gravity Sanitary Sewer
Direct Bury



INSTALLATION SPEC NO.	GENERIC NAME	TRADE NAME OR MANUFACTURER	ASTM OR AASHTO	SDR (NUMERIC MAXIMUM)	PIPE STIFFNESS (NUMERIC MINIMUM)	SIZE RANGE
02505	Solid Wall Polyethylene (HDPE)	Chevron Plexco Phillips 66 Quail Poly Pipe	ASTM F-714	DR 17 DR 21	115 46	8" - 10" 12" - 48"
02531	Polyethylene Profile Wall	Spirolite	ASTM F-894	n/a	46	18" - 120"

b. Rehabilitation Construction Pipe Products
Sliplining of Sanitary Sewer

INSTALLATION SPEC NO.	GENERIC NAME	TRADE NAME OR MANUFACTURER	ASTM	SDR (NUMERIC MAXIMUM)	PIPE STIFFNESS (NUMERIC MINIMUM)	SIZE RANGE
02550	Solid Wall Poly	Chevron Plexco Quail Poly Pipe AmeriFlow by NAPCO AmeriFlow by KWH	F-714	DR 21	46	8" - 48" <u>3" - 12"</u> <u>14" - 63"</u>
02550	Polyethylene Profile Wall	Spirolite	F-894	n/a	46	18" - 120"

2. For Residential Driveway Culverts provide HDPE as follows:
 - a. N-12 and N-12 HC by Advanced Drainage Systems, Inc. (ADS).
 - b. Sure-Lok F477 by Hancor, Inc.
3. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.
4. Furnish profile-wall gravity sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.
5. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings.
6. Furnish corrugated polyethylene pipe (CPP) for gravity storm sewer pipe. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. Suitable joints are:



- a. Integral Bell and Spigot. Bell shall overlap minimum of two corrugations of spigot end when fully engaged.
- b. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.

B. Jointing

1. Gaskets

- a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.
- b. Pipes allowed to be installed in potentially contaminated areas, where free product is found near elevation of proposed sewer, shall have the following gasket materials for noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

C. Materials For Sanitary Sewer

- 1. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification in accordance with ASTM D 3350 are also suitable for making pipe products under these specifications.
- 2. Other Pipe Materials: Materials other than those specified in Paragraph 2.02A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

D. Materials For Residential Driveway Culverts

- 1. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in AASHTO M 294, AASHTO MP7 and ASTM D 3350.
- 2. Types: CPP shall meet one or both of following:
 - a. Type S: Outer corrugated wall with smooth inner liner.
 - b. Type D: Inner and outer smooth walls braced circumferentially or spirally with projections or ribs.
- 3. Lubricant: Use lubricant for assembly of gasketed joints, which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.



TESTINGA. Sanitary Sewer

1. Conditioning. Conditioning of samples prior to and during tests are subject to approval by City Engineer. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.
2. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in suitable press until internal diameter has been reduced to 40 percent of original inside diameter of pipe. Rate of loading shall be uniform and at 2 inches per minute. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles.
3. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to pipe's outer contour.
4. Purpose of Tests. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

B. Residential Culverts

1. Pipe stiffness at 5% deflection, when determined in accordance with ASTM D 2412, shall be as specified in Section 7.4 of AASHTO M 294.
2. Minimum inner wall thickness shall be as specified in Section 7.2.2 of AASHTO M 294.

MARKING

- A. Mark each standard and random length of pipe in compliance with these Specifications with following information:
1. Pipe size.
 2. Pipe class.
 3. Production code.
 4. Material designation.

CONSTRUCTION METHODS

- A. Excavation. All excavation shall be in accordance with the requirements of Section 309-STRUCTURAL EXCAVATION. Before pipe is laid in a trench, the completed and shaped trench to receive the pipe shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of the backfill and bedding material under and around the pipe. The Contractor shall make such temporary provisions as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.
- B. Bedding. If no undesirable foundation material is found, a minimum of 6-inches of bedding shall be placed and compacted on the foundation to equalize load distributions along the invert of the pipe. A stable and uniform bedding shall be provided for the pipe and any protruding features of its joints and/or fittings. The middle of the bedding, under the pipe invert, equal to 1/3 of the pipe O.D. should



be loosely placed, with the remainder compacted to minimum standard proctor density per the manufacturer's recommendations.

- C. Installation. Installation of the pipe shall be in accordance with the manufacturer's recommendations. HDPE pipe is NOT approved in applications requiring augering of pipe.
- D. Jointing. All piping shall be jointed in accordance with the manufacturer's recommendations.
- E. Backfilling. After the pipe has been placed, bedded and jointed as specified, filling and/or backfilling shall be done in accordance with the applicable requirements of Section 309-STRUCTURAL EXCAVATION and manufacturer's recommendations. Special precautions shall be taken in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints.

403.9

PAYMENT

- A. Payment for furnished and installed manholes shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the HDPE pipe including but not limited to excavation, bedding, backfill, connection to pipe, etc. shall be subsidiary to this item.

END OF SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 404. VORTEX SEPARATORS

404.1 SCOPE OF WORK

- A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the Hydrodynamic Vortex Separator (HVS) stormwater treatment system as shown on the drawings and specified herein.
- B. The manufacturer shall design and supply the equipment listed herein and the Contractor shall install the equipment in accordance with the manufacturer's Handling, Storage, and Installation Instructions.

404.2 GENERAL REQUIREMENTS

- A. The HVS shall use an induced vortex to separate pollutants from stormwater runoff. The system shall be self-activating with no mechanical parts or external power requirements.
- B. Upon request, independently certified performance data and references shall be made available to the Engineer of Record for use in determining that the HVS meets the design criteria and performance requirements stated herein.

404.3 SUBMITTALS

- A. Submittals shall be provided and shall include the following:
 - 1. Site plan showing location and orientation of proposed pipe sizes, connections and excavation limits.
 - 2. Product installation drawings showing plan and elevation views with water elevations for the flow conditions specified herein.
 - 3. Performance data as required in Subsection 404.7.
 - 4. Inspection and maintenance procedures with accompanying maintenance video and upon request, three references for verifying successful completion of the maintenance procedures and associated costs.

404.4 QUALITY ASSURANCE

- A. The HVS shall be manufactured under the direction of an ISO 9001 Certified Company.
- B. Inspection. The HVS shall be subject to inspection by the Engineer of Record or the owner's representative at either the place of manufacture or the project site. Any and all observed defects shall be repaired to the satisfaction of the owner or owner's representative or replacement shall be made available.
- C. Warranty. The manufacturer shall guarantee the HVS from defects in materials and workmanship for a period of two years following installation. If during the warranty period defects in materials or workmanship are noted, then the manufacturer shall be promptly notified. The decision to repair or replace affected units shall be made at the discretion of the manufacturer.
- D. Patent Indemnity. Upon request, the manufacturer shall warrant that the HVS does not infringe upon or violate any patent, copyright, trade secret or any other proprietary right of any third party and shall indemnify the Owner against any loss, cost, expense or liability arising out of such claim whether or not such claim is successful.



- E. Certificate of Compliance. Upon request, the manufacturer shall provide a “Letter of Certification” to certify that the HVS adheres to the specifications required herein and complies with the project’s stormwater management permit.

404.5

MANUFACTURER

- A. The HVS shall be supplied by a manufacturer regularly engaged in such work who has furnished similar installations that have been in successful and continuous operation for a minimum period of five years. The manufacturer shall be a Stormwater Equipment Manufacturer Association (SWEMA) member.
- B. The HVS shall be certified by an acceptable State agency, such as a State Department of Environmental Protection (DEP) or industry verification or assessment agency (e.g.: ETV, NJCAT, NETE).

404.6

STORMWATER HVS

- A. The HVS shall use a tangential inlet pipe to establish rotational flow within a cylindrical vortex chamber or be able to treat the Water Quality Flow Rate stated herein without re-suspending and releasing captured pollutants. The HVS shall not release captured floating pollutants during surcharge conditions.
- B. The HVS shall not exceed the pressure drop (headloss) for the design flow rates specified herein as determined by ASTM C1745 / C1745M – 11.
- C. The HVS shall fit within the limits of excavation (area and depth) as shown in the project plans and will not exceed the dimensions for the design flow rates specified herein.
- D. The storage capacities for pollutants that settle (sediment) and float (oil) shall not be less than the volumes listed in Table 1. The HVS shall operate as intended and perform as specified herein as pollutants accumulate. The storage capacity for pollutants that settle shall not reduce the volume required in the HVS for separation and for preventing re-suspension and washout, or reduce the floatables storage volume capacity.
- E. Minimum 24-inch openings shall provide access to the sediment storage volumes from the surface for inspection and maintenance. Two access openings shall be provided for systems larger than 4 feet in diameter or 4 feet square. Removal of pollutants from the HVS shall be possible without requiring confined space entry.

404.7

Performance

- A. Performance of the HVS shall be based on independent full-scale laboratory and/or field testing and shall adhere to the Performance Specifications listed in Table 1. The laboratory testing used as the basis of product performance shall be undertaken in accordance with testing protocols approved or endorsed by SWEMA or acceptable State agency, such as a State Department of Environmental Protection (DEP) or recognized verification agency (e.g.: ETV, NJCAT, NETE).
- B. Performance of the HVS shall be based on treating the Water Quality Flow rate (WQF) without internally bypassing and without re-suspension and washout of captured pollutants (scour). The Maximum Treatment Flow Rate(s) (MTFR-50 and/or MTFR-100) shall be greater than or equal to the WQF. The HVS shall remove greater than or equal to 80% of TSS based on the Target Particle Size (TPS) of 50 microns and/or 100 microns at MTFR-50 and MTFR-100, respectively.



- C. The HVS shall treat all flows without internally bypassing up to the Peak Treatment Flow Rate (PTFR). Full-scale independent laboratory scour testing shall demonstrate effluent control of less than or equal to 20 mg/L for all flows up to 150% of MTFR-100 without internal or external bypass.
- D. The HVS shall be capable of capturing and retaining fine silt and sand size particles. Analysis of captured sediment from full-scale field installations shall demonstrate particle sizes predominately in the 20-micron range.
- E. The HVS shall capture and retain 100% of all floating trash and debris and remove greater than 80% of hydrocarbons up to its rated storage capacities under conditions of a catastrophic spill such as might be experienced in an automobile or truck accident spill like conditions.

Table 1.

Hydrodynamic Vortex Separator Performance Specifications								
Diameter	Max Depth ¹	MTFR-50 ²	MTFR-100 ²	Scour Flow Rate ³	PTFR ⁴	Headloss ⁵	Oil Storage Capacity ⁶	Sediment Storage Capacity ⁶
(feet)	(feet)	(cfs)	(cfs)	(cfs)	(cfs)	(feet)	(gal.)	(gal.)
4	4.1	1.2	1.6	2.4	3	0.68	70	141
6	5.9	3.4	4.3	6.5	8	0.95	216	424
8	7.7	6.9	8.8	13.3	15	1.1	540	939
10	9.4	12	15	23.3	25	1.2	1,050	1,757
12	11.2	19	24	38	38	1.4	1,770	2,970

Notes:

1. Depth measurement is from the outlet invert to top of the bottom slab.
2. MTFR-50 and MTFR-100 are the Maximum Treatment Flow Rates for removing target particle sizes of 50 microns and 100 microns, respectively.
3. Scour Flow Rates are based on testing that demonstrates retention of captured sediment having a D50 of 100. Effluent concentrations shall not exceed 20 mg/L.
4. PTFR or Peak Treatment Flow Rate is based on the HVS maintaining positive removal efficiencies and headlosses no greater than those listed above for each model.
5. Headlosses are the difference in water elevations upstream and downstream of the HVS as determined by ASTM C1745 / C1745M – 11. The headlosses listed above for any particular model are for that HVS operating at the Peak Treatment Flow Rate.

404.8

EQUIPMENT

- A. The HVS shall be manufactured with materials typically used in stormwater drainage systems that have a minimum life expectancy of 30 years.
 1. Materials of construction shall be cross-linked polyethylene (XLPE) and/or Type 304 stainless steel or carbon steel powder coated in accordance with ASTM 775/ ASTM A775M with a resulting thickness of 8-12 mils. All components shall be designed to withstand all normal loadings associated with fabrication, shipping, site installation, and normal operation of the equipment.
 2. Precast shall be manufactured with concrete that has attained a compressive strength of 4,000 psi after 28 days. The structure shall be reinforced to withstand an HS20-44 loading. Shiplap joints shall be sealed with butyl rubber mastic sealant conforming to ASTM C990. Slab tops shall be suitably reinforced and provided with manhole openings and covers as required. The



cast iron manhole frames and covers shall be sized as per the manufacturer's drawings and shall be in accordance with ASTM A48, CL.35B and AASHTO M105. The masonry fixing bolts shall be Type 304 stainless steel.

3. All piping connections and ancillary items not listed herein shall be provided by the Contractor.

404.9

EQUIPMENT DELIVERY

- A. The HVS components shall be delivered within six weeks of date of approved technical submittal.
- B. The HVS components shall be preassembled and delivered to the site fully fabricated and ready for the final assembly.
- C. Off-loading, storage, and installation shall be by the Contractor.
- D. The Contractor shall inspect and provide signed acceptance of equipment prior to unloading, or notify the manufacturer of any damage to equipment to effect proper remedial action. Failure to notify the manufacturer of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

404.10

EQUIPMENT INSTALLATION

- A. The system shall be installed in strict accordance with the site plans, and the manufacturer's general arrangement drawings and Handling, Storage and Installation Instructions. The Contractor shall be responsible for installing the equipment and all necessary site connections.
- B. The Manufacturer shall be notified immediately of any equipment which is damaged during unloading, storage, or installation. The damaged equipment shall be repaired or replaced at the discretion of the manufacturer and entirely at the Contractor's expense.
- C. The precast concrete structure shall be set on a granular or compacted sand sub-base in accordance with local requirements for standard manhole installation. In no instances shall the compacted sub-base material have a thickness of less than 12 inches.
- E. The precast concrete structure shall be set level and plumb to within 0.5%. E. Non-shrink grout or hydraulic cement conforming to ASTM C 595 shall be used to provide a water tight seal in the lift holes, any drain holes and around the concrete knock-outs for the inlet and outlet pipes.
- F. The Contractor shall, at the discretion of the owner or owner's representative, test the concrete structure for water tightness before backfilling.

404.11

PAYMENT

- A. Payment for furnished and installed HVS stormwater treatment systems shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule. All work and materials to complete the installation of each HVS, including, but not limited to, excavation, bedding, backfill, connection to structures, etc., shall be subsidiary to this item.

END OF SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 405. GABIONS AND REVET MATTRESSES

405.1 SCOPE OF WORK

- A. The work to be performed under this specification shall include furnishing, assembling, filling, and tying rock-filled wire mesh compartmented gabions and revet mattresses in accordance with the lines, grades, and dimensions shown on the Drawings or otherwise established in the field by the Engineer or designated representative. The type of construction (i.e. twisted woven mesh, welded mesh or both) and wire sizes [i.e. 13.5 gage (2.2 mm), 12 gage (2.7 mm) or 10 gage (3.4 mm)] shall be as defined in the Drawings or otherwise established by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

405.2 MATERIALS

- A. Gabions and revet mattresses shall be constructed of galvanized steel wire with polyvinylchloride (PVC) flexible coating. The gabions and revet mattresses shall be of the construction and sizes specified in the Drawings and shall meet the specifications presented herein. Unless otherwise specified in the Drawings or approved by the Engineer or designated representative, the gabions and revet mattresses may be constructed of either double twist woven mesh or welded wire mesh.
- B. Gabions shall be furnished in the specified dimensions within a tolerance of ± 5 percent. Revet mattresses shall be furnished in the specified dimensions within a tolerance of 5 percent for the length and width and 10 percent for the height. For each individual gabion or revet mattress, the same mesh style shall be used for the base, front, ends, back, diaphragms and lid panels. Each gabion or revet mattress shall be manufactured and divided into cells of equal length, no greater than 3 feet (0.9 meter), by diaphragm panels.
1. Gabion and Revet Mattress Wire shall be galvanized steel, Class 3 or A coating, soft temper conforming to ASTM A 641, and shall specifically meet the requirements given below for gabions (12 gage wire) and/or revet mattresses (13.5 wire gage) as called for in the Drawings. PVC coating of the wire may be fusebonded or extruded onto the wire. Galvanization of welded wire shall be performed either before or after welding.

Table 1: Requirements – Mesh Wire for Gabions and Revet Mattress Units

Characteristic	Gabions	Revet Mattresses
Wire Gage	12 gage	13.5 gage
Maximum Tensile Strength (ASTM 641)	70,000 psi (483 mPa)	75,000 psi (517 mPa)
Nominal Wire Diameter (ASTM A641)	0.106 inch (2.7 mm)	0.0866 inch (2.2 mm)
Minimum Diameter (ASTM A 641, Table 3)	0.102 inch (2.6 mm)	0.0826 inch (2.9 mm)
Galvanized Zinc (ASTM A 641, Table 1)	0.80 oz/ft ² (245 gr/m ²)	0.70 oz/ft ² (215 gr/m ²)



2. Gabion Mesh

- a. Woven Mesh shall be of a uniform nonraveling, double twist hexagonal pattern nominally of dimensions 3.25 inches by 4.5 inches (83 mm by 114 mm). Selvage wire shall be 10 gage (nominal diameter of 3.4 mm).
- b. Welded Mesh. Mesh opening shall be nominally 3 inches by 3 inches (75 mm by 75 mm). Strength of welds shall meet the following requirements when tested in accordance with section 13.4 of ASTM A-974:

Table 2: Minimum Weld Strength Requirements

Type of Structure	Wire Size (Diameter)	Minimum Average Weld Shear Strength
	Gage	English Units (SI Units)
Gabions	12 (2.7)	472 lbf (2.10 kN)
Revet Mattress	13.5 (2.2)	292 lbf (1.30 kN)

- c. Manufacturing. Twisted wire mesh gabions shall be manufactured in conformance with ASTM A-975, while welded wire mesh gabions shall be manufactured in conformance with ASTM A-974.

C. Revet Mattresses

- 1. Woven Mesh shall be of a uniform nonraveling, double twist hexagonal pattern, nominally of dimensions 2.5" x 3.25" (64 mm by 83 mm). Selvage wire shall be 12 gage (nominal diameter of 2.7 mm).
- 2. Welded Mesh. Mesh opening shall be nominally 1.5" x 3.0" (38 mm by 76 mm). Strength of welds shall meet the requirements listed in Table 2 for 13.5 gage (2.2 mm) wire, when tested in accordance with section 13.4 of ASTM A-974:
- 3. Manufacturing. Twisted wire mesh revet mattresses shall be manufactured in conformance with ASTM A-975, while welded wire mesh revet mattresses shall be manufactured in conformance with ASTM A-974.

D. PVC Coating

- 1. All wire used in fabrication of the gabions, revet mattresses and wiring operations during construction shall, after zinc coating, have a fusebonded or extruded coating of PVC. The coating shall be gray in color. The thickness shall be nominally 0.020 inch (0.5 mm), and shall not be less than 0.015 inch (0.38 mm) in thickness. It shall be capable of resisting deleterious effects of natural weather exposure, and immersion in salt water.
- 2. For PVC-coated welded wire fabric panel, cutting of the panels shall not be allowed closer than 1/4 inch (1/8 inch (6 mm (3.18 mm) after fabrication in order to prevent exposure near the welds.



3. Initial Properties:

- a. Woven Mesh: The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-975:
 - i. Specific Gravity: The specific gravity as determined in accordance with ASTM D-792 shall be between 1.3 to 1.35.
 - ii. Durometer Hardness: The hardness as determined in accordance with ASTM D-2240 shall be between 50 to 60, Shore D.
 - iii. Tensile Strength: The tensile strength when tested in accordance with ASTM D-412 shall not be less than 2985 psi (20.6 mPa).
 - iv. Modulus of Elasticity at 100% Elongation: The Modulus of Elasticity when determined in accordance with ASTM D-412 shall not be less than 2700 psi (18.6 mPa).
 - v. Resistance to Abrasion: The percentage loss in weight (mass) during abrasion testing in accordance with ASTM D-1242 shall be less than 12%.
 - vi. Brittleness Temperature: The brittleness temperature shall not be higher than 150F (-9.00C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 150F (80C) below the minimum temperature at which the gabion will be handled or filled.

- b. Welded Mesh: The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-974:
 - i. Specific Gravity: The specific gravity as determined in accordance with ASTM D-792 shall be between 1.20 and 1.40.
 - ii. Durometer Hardness: The hardness as determined in accordance with ASTM D-2240 shall not be less than 75, Shore A.
 - iii. Tensile Strength: The tensile strength when tested in accordance with ASTM D-638 shall not be less than 2275 psi (15.7 mPa).
 - iv. Modulus of Elasticity: The Modulus of Elasticity when determined in accordance with ASTM D-638 shall not be less than 1980 psi (13.7 mPa).
 - v. Resistance to Abrasion: The percentage loss in weight (mass) shall be less than 12 % during abrasion testing in accordance with ASTM D-1242, Method B, at 200 cycles, CSI-A abrader tape, 80 grit.
 - vi. Brittleness Temperature: The brittleness temperature shall not be higher than 150F (-9.00C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 150F (80C) below the minimum temperature at which the gabion will be handled or filled.



- vii. Adhesion: The PVC coating on the wire shall adhere to the wire such that the coating breaks rather than separates from the wire, when tested in accordance with the PVC Adhesion Test described in Section 13.3 of ASTM A-974.
- viii. Mandrel Bend: The PVC-coated wire, when subjected to a single 3600 bend at 00F (-180C) around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating.

405.3

TESTING

- A. Performance Tests: The PVC coating shall have the demonstrated ability to withstand the specified exposure testing.
 - 1. Exposure to Salt Spray: The PVC shall show no effect after 3000 hours of salt spray exposure in accordance with ASTM Test Method B-117.
 - 2. Exposure to Ultraviolet Rays: The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3000 hours, using apparatus Type E and 145°F (63°C), when tested in accordance with ASTM Practice D-1499 and G-23.
- B. Properties after exposure tests: after conclusion of the salt spray and exposure to ultraviolet light tests, the PVC shall not show cracks, blisters or splits, or any noticeable change in color. In addition the PVC coating shall not show cracks or breaks after the wires are twisted in the fabrication of the mesh, nor shall there be any moisture intrusion under the PVC coating as a result of the test.

After completion of the exposure tests the following criteria shall also be met:

- 1. Woven Mesh:
 - a. The Specific Gravity shall not change more than 6% of its initial value.
 - b. The Durometer Hardness shall not change more than 10% of its initial value.
 - c. The Tensile Strength shall not change more than 25% of its initial value.
 - d. The Resistance to Abrasion shall not change more than 10% of its initial value.
- 2. Welded Mesh:
 - a. The Specific Gravity shall not change more than 6% of its initial value.
 - b. The Modulus of Elasticity shall not change more than 25% of its initial value.
 - c. The Tensile Strength shall not change more than 25% of its initial value.
 - d. The Resistance to Abrasion shall not change more than 10% of its initial value.
- 3. Salt Spray Resistance for Fastener:
 - a. The fasteners for twisted mesh wire gabions and revet mattresses shall be subjected to Salt Spray Test of Test Method B-117 for a period of not less than 48 (1 hour cycle length. After testing the fasteners, the selvedge, or mesh wire confined by the fasteners shall show no rusty spots on any part of the surface excluding the cut ends.



C. Stone

1. Gabion Basket Stones

- a. Stone fill shall be durable and of suitable quality to ensure permanence in the structure. The stone used to fill the gabion baskets shall be a clean, sound, and durable rock meeting the following requirements. It shall have a wearing loss less than 35 percent when the stone is tested with the Los Angeles Abrasion Machine in accordance with ASTM Test Method C535 (TxDOT Test Method Tex-410A). The loss of material experienced during five cycles of magnesium sulfate exposure conducted in accordance with TxDOT Test Method Tex411A for Rock RipRap shall not exceed 18 percent. The stone shall be well graded to produce a dense fill, angular in texture, while meeting the following gradation requirements:

Table 3: Gabion Stone Gradation Requirements

Sieve Size		Percent by Weight (Mass) % Passing Each Individual Sieve
US	(SI)	
8 Inch	(200 mm)	100
4 Inch	(100 mm)	0 - 5
3 Inch	(75 mm)	0

The minimum unit weight (unit mass) of a rockfilled gabion shall be 120 pcf [1.92 megagrams (mg) per cubic meter]. Verification of unit weight (mass) shall be performed when ordered by the Engineer, by constructing a test gabion with materials supplied for construction with the same effort and method intended for production gabions.

- D. Revet Mattress Stone: The stone used to fill the revet mattresses shall be as specified for gabions except that it shall have a maximum dimension of 5 inches (125mm) and a minimum dimension of 3 inches (75 mm). The majority of the stone shall be in the 3 to 4 inch (75 to 100 mm) range; cubical or rounded in shape. A tolerance of 5% shall be allowed on the upper and lower dimensions of the rock.

405.4

CONNECTIONS

- A. Wire: Lacing wire and connecting wire shall be 13.5 gage [0.087 inch (2.20 mm)] PVC coated galvanized steel, Class 3, soft temper, conforming to ASTM A-641. During testing, any separation of 2 inches (50 mm) or more between connecting wires shall be considered as a failure.
- B. Spiral Binder for Welded Wire Mesh: Spiral binders shall consist of 0.106 inch (2.7 mm) PVC coated wire for the gabion and 0.087 inch (2.2 mm) PVC coated wire for the revet mattresses. Spiral binders shall have a 3.0 inch (75 mm) maximum separation between continuous successive loops (3 inch or 75mm pitch).

The binder shall be made of galvanized steel, Class 3, soft temper, conforming to ASTM A-641.

- C. Alternate Fasteners for Twisted Woven Mesh: Alternate fasteners, acceptable for use by the intended gabion basket manufacturer, may be submitted to the Engineer for consideration and approval prior to construction. The fasteners may consist of split ring or interlocking fasteners. Alternate fasteners systems shall produce a joint that meets the requirements of ASTM A-975, Section 7, Table 2.



405.5

FASTENER SYSTEM

The Contractor shall provide a complete description of the fastener system, including the number of fasteners required for all vertical and horizontal connections for single- and multiple-basket joinings, as well as the number and size wires the fastener is capable of properly joining. The Contractor shall provide a description of a properly installed fastener, including test reports, drawings and/or photographs. Properly formed fasteners shall meet the requirements of ASTM A-974 for welded wire mesh or ASTM A-975 for twisted woven mesh.

- A. Each interlocking fastener shall be locked and closed.
- B. Each overlapping ring fastener shall be closed and the free ends shall overlap an average of 1 inch (25 mm).
- C. Spiral binders shall be screwed into position such that they pass through each mesh opening along the joint. In order to prevent unraveling, both ends of the spiral shall be crimped back around itself.
- D. Wire fasteners shall not be used to join more wires, or larger wires, than tested and approved for the application.

405.6

PANEL TO PANEL JOINT STRENGTH

The minimum strength of the joined panels shall be as specified in Section 7.3 of ASTM A-974 for Welded wire panels or Section 7.3 of ASTM A-975 for twisted woven mesh.

405.7

MISCELLANEOUS

Aggregate bedding, geotextiles or other materials shall conform to the requirements established on the Drawings.

405.8

CERTIFICATE OF COMPLIANCE

The Contractor shall submit Certificates of Compliance for all materials proposed for use to the Engineer for review and approval one week prior to construction.

405.9

CONSTRUCTION

- A. Twisted wire mesh Gabon's and revote mattresses shall be supplied in the forms allowed in ASTM A-975, while welded wire mesh Gabon's and revote mattresses shall be supplied in a form allowed in ASTM A-974.
- B. The Gabon/revote mattress manufacturer/supplier will be required to have a qualified representative on site at the start of gabion/revet mattress construction. The Contractor shall submit work experience documentation of the representative for review/approval by the Engineer or designated representative. The representative shall be available for consultation as needed throughout the gabion construction.
- C. Gabions and revet mattresses shall be constructed to the lines and grades shown on the Drawings. Individual or groups of gabions or revet mattresses, which deviate from line and grade, shall, at the direction of the Engineer or designated representative, be removed and replaced at no cost to the owner. Gabions or revet mattresses, which are constructed with bulges, and/or underfilled, loosely filled, or otherwise lacking a neat and compact appearance shall, at the direction of the Engineer or designated representative, be repaired/replaced at no cost to the owner. Underfilling of gabion/revet mattress corners to facilitate insertion of spirals shall not be permitted.



FOUNDATION PREPARATION

- A. The foundation shall be excavated to the extent shown on the Drawings or as directed by the Engineer or designated representative. All loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. The depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free draining materials.
- B. Any buried debris protruding from the foundation that will impede the proper installation and detrimentally impact the final appearance of the gabion, shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to gabion or revet mattress placement, the prepared foundation surface shall be inspected and approved by the Engineer and no material shall be placed thereon until that area has been approved.
- C. Placement of filter material and/or filter fabric shall be as shown on the Drawings or directed by the Engineer.

GABION/RENET MATTRESS BASKET ASSEMBLY

- A. No work shall take place using PVC coated materials unless both the ambient air temperature and the temperature of the PVC materials are at least 15°F (8°C) above the brittleness temperature of the PVC materials.
- B. Assembly of gabions and revet mattresses shall consist of shaping and tying each individual basket. Baskets shall be assembled by connecting all untied edges including diaphragms with lacing wire, spirals or approved fasteners. The connections for the completed assemblies shall conform to the requirements of Section 7 of ASTM specifications A-974 (welded wire) and Section 7.3 and Table 2 of A-975 (double twisted).
- C. Assembly of baskets, connection of baskets together and lid closures shall be accomplished in accordance with one of the following approved procedures:
 - 1. Lacing Wire: Using lacing wire of appropriate length, secure one end of the wire onto the basket corner by looping and twisting the lacing wire together. Proceed along the joint by tying with double loops every other mesh opening at intervals not more than 6 inches (150 mm) apart, while pulling the basket elements tightly together. Secure the other end of the lacing wire again by looping and twisting the wire around itself.
 - 2. Spiral Binders for Welded Wire Mesh: Spiral binders, meeting the minimum acceptance criteria of article 594S.2(6)(c) shall be screwed into position such that they pass through each mesh opening along the joint. To prevent unraveling, each end of the spiral binder shall be crimped back against itself.
 - 3. Alternate Fasteners for Twisted Woven Mesh:
 - a. Interlocking fasteners meeting the minimum acceptance criteria of article 594S.2(6)(c), shall be installed with, as a minimum, one interlocking fastener in every other opening.
 - b. Ring fasteners meeting the minimum acceptance criteria of 594S.2(6)(c), shall be installed with, as a minimum, one split ring fastener in every opening, having a minimum 1 inch (25 mm) total overlap and securing only the number and diameter of wires for which tested.
 - c. Placing of gabions and revet mattresses shall consist of installing baskets to the lines and grades shown on the Drawings. Gabions and revet mattresses shall be securely fastened to each adjoining unit along the vertical and top reinforced



edges of all contact surfaces. Overlying rows of baskets shall be staggered appropriately. Empty sections stacked on a filled line of gabions and revet mattresses shall be securely fastened to the bottom unit along the front, back and ends.

- d. Prior to the placement of rock, the baskets used in the front vertical exposed faces of retaining walls shall be aligned. To facilitate alignment, tension may be applied to empty units at the direction of the Engineer or designated representative.

405.12

FILLING OF GABIONS AND REVET MATTRESSES

- A. The gabions and revet mattresses may be filled by machine, in maximum lifts of 12 inches (300 mm). The machine work shall be supplemented with handwork to avoid bulges and provide a compact mass with a minimum of voids. Care will be exercised so as not to damage the gabion/revet mattress elements or wire coating by limiting height of drop during filling to 3.0 feet (0.9 meter) for Gabions and 1.5 feet (0.5 meter) for revet mattresses. Undue deformation or bulging of the mesh shall be corrected prior to further stone filling. Where specified on the Drawings, select large stone shall be hand placed on vertical outside faces to achieve a desired neat appearance.
- B. During placement, the depth of stone in any cell shall not exceed the depth in an adjoining cell by more than one foot (300 mm). Stone smaller than the mesh opening found against vertical faces shall be removed.
- C. Two connecting wires in each direction for end units and two parallel connecting wires perpendicular to the exposed face for exposed face units shall be installed at every 12 inch (300 mm) lift. The connecting wires shall loop around two mesh openings, and the ends of wires shall be securely twisted with a minimum of three twists after looping. Prefabricated connecting wire may be used in lieu of connecting wire.
- D. Connecting wires associated with 18inch (450 mm) gabions shall be installed when and as specified on the Drawings or as recommended by the gabion/revet mattress manufacturer.
- E. The gabion or revet mattress unit shall be overfilled by 1 1/2 to 2 inches (37.5 to 50 mm) and the lid shall be bent and stretched until it meets the perimeter edges of the front and end panels. The stretching shall be accomplished using an approved lid closing tool in order to prevent damage to the PVC coating. Crow bars or similar single point leverage devices will not be allowed. The lid shall then be securely tied with lacing wire, spirals or approved fasteners to the fronts, ends and diaphragms. Excessive deformation of the lid panel to facilitate closing of a bulging gabion or revet mattress will not be permitted.
- F. All backfill shall be placed and compacted in sequence with the filling of the baskets; however, care shall be exercised in compacting the fill behind a single row of baskets since excessive compaction effort can displace the gabions/revet mattresses from the desired alignment.
- G. Gabion or revet mattress units may be cut or shaped to fit odd length or odd shaped areas. They shall be cut at least 6" to 8" (150 mm to 200 mm) larger than the opening to allow sufficient material for overlap and lacing. All edges or faces formed in this manner shall be adjusted to present a finished and pleasing appearance.
- H. At all times, care shall be taken to turn all loose and projecting ends of wire into the gabion units to prevent injury.



405.13 WORKMANSHIP

Wire of proper grade and quality, when fabricated and installed in the manner herein required, shall result in a strong, serviceable mesh-type product having substantially uniform openings. It shall be fabricated and finished in a workmanlike manner, as determined by visual inspection, and shall conform to this specification.

405.14 MEASUREMENT

Measurement of acceptable "Gabions and Revet Mattresses", complete in place, will be made on the basis of volume determined by the actual length, width and height.

405.15 PAYMENT

The Gabion and revet mattress quantities, measured as described above, will be paid for at the unit bid prices per cubic yard (cubic meter: 1 cubic meter equals 1.308 cubic yards) of the various types indicated. The price shall include full compensation for furnishing, hauling and placing all materials, including filter fabric, wire containers, connectors, reinforcement stones and backfill; for all labor, tools, equipment and incidentals needed to complete the work.

Excavation and all subgrade preparation required for shaping the foundation for the wire containers shall be included in the unit bid price for "Gabions and Revet Mattresses".

Payment will be made under one of the following:

Gabions, Twisted Woven Wire	Per Cubic Yard
Gabions, Welded Wire	Per Cubic Yard
Revet Mattresses, Twisted Woven Wire	Per Cubic Yard
Revet Mattresses, Welded Wire	Per Cubic Yard

END OF SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 406. PILE RESTORATION

406.1 SCOPE OF WORK

- A. This Section specifies requirements for restoring deteriorated piles using Fiber-Reinforced Laminate (FRL) encasement. The work shall consist of using a fiber-reinforced laminate to create a helical jacket around the pile to be restored, and filling the annulus between the jacket and the pile with underwater resin.
- B. Contractor shall provide all labor, materials, tools, and equipment required for the completion of the following Work, as shown on the Contract Documents and specified herein:
1. Prepare existing areas, as defined by these specifications and related Contract Drawings, designated to receive pile restoration
 2. Design, furnish, fabricate, and install all jackets, shores, and bracing
 3. Prepare installation and placement shop drawings listed below
 4. Prepare design drawings for shores, and bracing if required
 5. Furnish all submittals required by this Section of the Specifications
 6. Coordinate all work with other trades on site.

406.2 REFERENCES

- A. The latest edition and addenda of the following publications in effect on the date of Contract Award are part of this Specification and, where referred to by title or basic designation only, are applicable to the extent indicated by the specific reference:
- SOCIETY FOR PROTECTIVE COATINGS
 - SSPC SP-12 WJ-2 Surface Preparation and Cleaning of Metals by Water Jetting

406.3 SUBMITTALS

- A. Comply with pertinent provisions of Section 211, Submittals.
- B. Details shall be carried out in accordance with the local building codes, and as shown on plans.
- C. Product Data:
1. Fiber-Reinforced Laminate catalog cuts showing material properties and strength.
 2. Fill resin catalog cuts showing material properties and strength.
 3. Adhesive resin catalog cuts showing material properties and strength.
 4. Fill and Adhesive Resin MSDS sheets.
 5. Miscellaneous fasteners, anchors, straps, spacers, etc. catalog cuts showing material properties.



- D. Shop Drawings
 - 1. Submit shop drawings that shall detail FRL jacket construction and support; overlap size; spacer size, arrangement and attachment; and sealing details.
- E. Design Data
 - 1. Overlap of laminate to ensure required confinement pressure.
 - 2. Resin selection to ensure required bearing strength.
 - 3. Size of annular space to ensure full resin encasement and bearing.
- F. Certifications
 - 1. Material certification for FR laminates to show date of fabrication.
 - 2. Material certification for fill and adhesive resin to show date of manufacture.
- G. Quality Assurance Documents
 - 1. Daily installation reports showing air and water temperatures
 - 2. Daily installation reports showing lot numbers of FR laminates and resins used on each pile

406.4

MATERIALS FOR FR LAMINATE ENCASEMENT

- A. Fiber-Reinforced Laminate
 - 1. The laminate shall be a high-strength Fiber Reinforced Polymer (FRP) laminate constructed with bidirectional carbon or glass fabrics that provides strength in both longitudinal and transverse directions.
 - 2. The laminate shall have the following properties per ASTM D3039
 - a. In the longitudinal direction Tensile Strength shall be a minimum of 62 ksi, Modulus of Elasticity shall be a minimum of 3,500 ksi, with the Ultimate elongation of 1.31 %
 - b. In the transverse direction Tensile Strength shall be a minimum of 60 ksi, Modulus of Elasticity shall be a minimum of 3,650 ksi with the Ultimate Elongation of 1.06 %
 - 3. The thickness of the laminate shall be between 0.025 to 0.030 inches;
 - 4. Barcol Hardness (ASTM D 2583) shall be a minimum of 50
 - 5. Water Absorption (ASTM D 570) shall be a maximum of 0.8 %
 - 6. FRP Laminate shall be PileMedic™ PLG60.60 (www.PileMedic.com; 2055 E. 17th St., Tucson, AZ 85719 U.S.A.; Tel: +1.520.791.7000) or approved equal



B. Adhesive Resin

1. The adhesive resin shall be a two-component high-strength structural epoxy designed for underwater applications. It shall have an immediate high tack consistency both in air and water and shall trowel easily.
2. The adhesive resin shall be a 100% solids formulation with low toxicity and low odor during cure.
3. The adhesive resin's tensile strength shall be a minimum of 4,360 psi (ASTM D-638)
4. The adhesive resin's compressive strength shall be a minimum of 11,700 psi (ASTM D-695)
5. The adhesive resin's flexural strength shall be a minimum of 8,900 psi (ASTM D-790)
6. The adhesive resin's tensile elongation shall be a maximum of 5%
7. The adhesive resin shall be QuakeBond™ 220UR or approved equal

C. Fill Resin

1. The fill resin shall be a two-component, high-strength, low-viscosity structural epoxy. The resin shall cure underwater and shall provide excellent durability and chemical resistance. The resin shall be a 100% solids formulation with low toxicity and low odor during cure.
2. The fill resin's viscosity when mixed at 77 F shall be 780 cps (ASTM D-1290)
3. The fill resin's tensile strength shall be a minimum of 7,900 psi (ASTM D-638)
4. The fill resin's compressive strength shall be a minimum of 11,200 psi (ASTM D-695)
5. The fill resin's density when mixed shall be 1.11
6. The adhesive resin's tensile elongation shall be a maximum of 5%
7. The fill resin's Hardness, Shore D shall be a minimum of 86 (ASTM D-2240)
8. Add pigment to fill resin so that its color could show through the glass laminate
9. The fill resins shall be QuakeBond™ 320 LV Low Viscosity Resin or approved equal

D. Miscellaneous Anchors, Spacers and Fasteners

1. An epoxy adhesive compound capable of being installed underwater shall be used to secure any anchors, threaded rods, or reinforcing steel to existing concrete surfaces. The following products, or approved equal, shall be used to secure anchors, threaded rods, or reinforcing steel to existing concrete surfaces:
 - a. Hilti HIT RE500
 - b. Rockwater RockEpoxy Capsules
2. Self-tapping screws used for initially securing the laminate during the adhesive cure time shall be of the non-reactive type.



3. Spacers used to create an annulus around the pile shall be of the non-reactive type.

406.5

JOINTS AND EMBEDDED ITEMS

A. Construction and Expansion Joints

1. No construction or expansion joints shall be permitted. Each encasement shall be placed in a continuous manner from start to finish. Horizontal construction joints are prohibited.

B. Other Embedded Items

1. All inserts, anchors, dowels and other embedded items, including those required for adjoining work, or for its support, shall be in place prior to encasement. Anchor dowels and other items of miscellaneous metal shall be installed by the Contractor in accordance with manufacturer's recommendations and procedures.
2. All Work required to be installed before encasement shall be verified prior to placement of the jacket.
3. Dowel anchoring systems shall be maintained free from any deformation; and free from loose rust, loose scale, oil, mud, and any other deleterious substances.
4. Contractor shall provide all templates and devices necessary for the accurate positioning and setting of all embedded items specified herein or in other Sections of the Specification, and/or as indicated on the Contract Documents.

406.6

PREPARATION

A. Timber Piles

1. All timber piles scheduled to receive FRL encasements shall be cleaned using high pressure waterjetting with rating of 5000 psi. Contractor shall take precautions in order not to remove intact timber section from the existing timber piles during preparation activities. The purpose of this preparation is to remove all marine growth and any soft surface layer that may have accumulated on the piles. Severely deteriorated timber may be removed with water blast.
2. The elapsed time between the cleaning of a timber pile and the installation of the encasement on that timber pile shall not exceed 72 hours. If this time frame is exceeded contractor shall re-clean the pile prior to encasement.
3. Contractor shall remove any marine growth that has accumulated on the pile prior to the installation of the FRL jacket.

B. Concrete

1. All loose and deteriorated concrete shall be removed using hydraulic or air pressurized hand tools.
2. Contractor shall take precautions not to damage non-spalled or cracked concrete at location of schedule repair.
3. After loose concrete is chipped away, all concrete extension surfaces scheduled to receive encasements shall be cleaned using high pressure water-jetting with rating of 5000 psi.



The purpose of this preparation is to remove all marine growth and any soft surface layer that may have accumulated on the extension. The elapsed time between the cleaning of the concrete surface and the installation of the FRL encasement shall not exceed 72 hours. If this time frame is exceeded contractor shall re-clean the pile prior to encasement.

4. Contractor shall remove any marine growth that has accumulated on the concrete surface prior to encasement.

406.07

APPLICATION

A. FR Laminate

1. The laminate jacket shall be uniform, smooth and free of deformations, gaps or kinks.
2. The laminate jacket shall be tight and shall provide a still water environment in the space to be filled with resin. Side forms shall extend above top of the resin as required. A diver shall be engaged by the Contractor to monitor the placement of the resin continuously and shall caulk any joints or leaks which show evidence of loss of resin such as in the form of a cloud of discoloration emanating from the jacket. No resin shall be permitted to escape the jacket during placement of the fill resin
3. Set spacers on the pile in order to create an annular space of the approved size. Fasten spacers to the piles per approved methods. Spacers shall be installed such as NOT to block the path of the fill resin during resin placement.

B. Adhesive Resin

1. The adhesive resin shall be mixed in small batches at the point of installation. Great care shall be given to application of the adhesive resin to the laminate. Thoroughly clean the laminate surface per manufacturer's recommendation prior to the application of the adhesive resin. Air, water and laminate surface temperature shall be between 50 and 90 degrees F. DO not begin application if air, water or laminate surface temperature is below 50 or expected to fall below 50 F within 12 hours of application. Do not begin application if the dew point is within 5 F of the temperature. Adhere strictly to Manufacturer's Recommendations.

C. Fill Resin

1. Mix fill resin at the point of installation. Introduce fill resin at the bottom of the annular space using tubes of the appropriate size. Minimum application temperature shall be 45 F. All epoxy components shall be conditioned to a temperature between 65 and 85 F prior to the time of mixing. Adhere strictly to Manufacturer's Recommendations.

D. Fill Resin Placement Equipment

1. Mixing and placement equipment used in mixing and handling of the fill resin shall be as recommended by the resin's manufacturer and approved by the Owner's Engineer. All oil and other rust inhibitors shall be removed from the mixing drums, stirring mechanisms and other portions of the equipment that would be in contact with the resin before the mixers are used.

E. Embedded Dowels

1. All dowels and anchoring systems which will be embedded in resin shall be cleaned of all debris, marine growth, loose rust and oily deposits.



F. Application

1. The fill resin of each encasement shall be placed in a continuous manner from start to finish over its full height. Horizontal construction joints are not permitted. Fill resin placement shall begin from the bottom of the laminate jacket until it reaches the top of the jacket.
2. A diver shall monitor the placement of the resin into the jacket.
3. Allow fill resin to overtop the jacket until all water and laitance has been removed from the inside of the jacket.

406.8

INSPECTION

1. The Work to be provided in accordance with this Section of the Specification shall be subject to inspection by Owner at any time(s) during the progress of the Work. Contractor shall provide access and any labor, materials, tools, and equipment required by Owner to complete inspection of the Work as specified herein.
2. Completed installations shall be visually inspected to confirm the integrity of the laminate encasement and the resin fill. Any deficiencies shall be corrected at the Contractor's expense. The Contractor shall propose a repair method and submit it to the Engineer for approval prior to implementing said repair.
3. Acceptance of structure shall be contingent on the Work meeting all of the requirements of the Contract Documents as indicated by the results of all testing, inspection, and other quality assurance procedures required by Owner.

406.9

PAYMENT

- A. Payment for pile restoration shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule. All work and materials to complete the pile restoration shall be subsidiary to this item.

END SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 407. RESTRAINT AND BLOCKING

407.1 SCOPE OF WORK

This specification governs Portland Cement concrete restraint and blocking used to anchor underground pipe. Restraint and blocking shall be constructed as indicated on the Drawings or as directed by the Engineer or designated representative in accordance with these specifications.

407.2 SUBMITTALS

The submittal requirements of this specification item include:

- A. Class D Portland cement concrete mix design.
- B. Construction details (i.e. reinforcing steel, curing membrane).

407.3 MATERIALS

- A. Portland Cement Concrete
 - 1. The concrete materials used in construction under this item shall conform to Class D, Section 802 – CONCRETE FOR STRUCTURES.
- B. Reinforcement
 - 1. Reinforcement shall conform to Section 807 – REINFORCING STEEL.

407.4 CONSTRUCTION METHODS

- A. Prior to placement of Portland cement concrete, excavation for restraint and blocking shall be made to proper section and depth. If considered necessary by Engineer or designated representative, the bottom of the excavation shall be hand tamped and sprinkled. The excavated area for concrete restraint and blocking shall be moist when the Portland cement concrete is placed.
- B. After the Portland cement concrete has been placed, consolidated and shaped to conform to the dimensions indicated on the Drawings and after sufficiently set, it shall be given a moderately rough finish by floating with a wood float.
- C. No mortar or concrete work shall be undertaken, when the ambient temperature is below 35°F (1°C) and Work shall be protected from freezing. After completion of the concrete retard, exposed surfaces shall be covered with burlap, cotton mats or other approved covering and kept moist for a minimum period of 3 days. White pigmented curing compound conforming to Section 806 – MEMBRANE CURING, Type 2, will be permitted when applied to exposed surfaces.
- D. Unless directed otherwise by the Engineer or designated representative, the material excavated during trenching shall be disposed of at a permitted site.



407.5

MEASUREMENT

Concrete restraint and blocking will be measured either by the cubic yard per Drawing dimensions or on a unit basis complete in place.

407.6

PAYMENT

- A. Work performed and materials furnished as prescribed by this Standard Specification item, measured as provided under the "Measurement" section will be paid for by the cubic yard or the unit price bid for "Concrete Restraint and Blocking", as indicated in the Contract Documents. The bid pay item price shall include full compensation for excavation, reinforcing, furnishing, hauling and placing all materials required in the construction, the disposal of excavated material and any manipulation, labor, tools, equipment and incidentals necessary to complete the work.
- B. This item shall also govern any pumping, bailing and dewatering or drainage necessary to complete the work when concrete restraint and blocking are indicated on the Drawings or required by the Engineer or designated representative.

END OF SECTION



SECTION 400 – DRAINAGE SPECIFICATIONS

ITEM 408. RIPRAP FOR SLOPE PROTECTION

408.1 SCOPE OF WORK

This item shall govern the excavation of all materials encountered for placing riprap, disposal of excess material and backfilling around the completed riprap to the grade indicated on the Drawings. The work shall include all pumping and bailing, furnishing and placing riprap of rock or concrete in accordance with the details and to the dimensions indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses. The work conducted under this item pertains to riprap for protection of slopes, cuts, fills, drainage facilities and other features susceptible to erosion.

408.2 SUBMITTALS

The submittal requirements for this specification item shall include:

- A. The type, size, gradation and source of riprap material (rock or broken concrete),
- B. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix,
- C. Proposed proportioning of materials for the mortar mix,
- D. Type, details and installation requirements for reinforcement, joint material, tie backs and anchors,
- E. Description of filter fabric including characteristics, test data and manufacturer's recommendations for installation.
- F. The type, size, gradation and source of granular filter material.

408.3 MATERIALS

- A. Rock used for riprap shall be hard, durable, and angular in shape and consist of clean field rock or rough unhewn quarry rock as nearly uniform in section as practicable. The rocks shall be dense, resistant to weathering and water action, free of overburden, spoils, shale and organic material; and shall meet the gradation requirements for the rock size specified. Neither the width nor the thickness of a single stone should be less than one third of its length. Shale, chalk and limestone with shale or chalk seams are not acceptable. Rounded rock (river rock) shall not be acceptable. Minimum density for acceptable dry rock riprap shall be 150 pounds per cubic foot or a specific gravity of 2.4.

The rock shall be suitable in all respects for the purpose intended. The sources from which the stone will be obtained shall be selected well in advance of the time when the stone will be required and pre-approved by the Engineer. Control of gradation and material adequacy will be accomplished by visual inspection and field measurement as needed for rock sizes that cannot be analyzed via sieve or mechanical sorting machines. The contractor shall provide two samples of rock meeting the gradation for the size class specified. The samples shall be used as frequent reference for judging the gradation of the riprap supplied. Any difference of opinion between the engineer and the contractor shall be resolved by dumping two random truckloads of stone and performing manual field measurements of individual stones to compute a gradation. Any measured rock size dimensions shall be based on the length of the intermediate axis of each stone.



Labor, equipment and site location needed to assist in checking gradation shall be provided by the contractor at no additional cost to the owner.

- B. Concrete. Cast in place concrete shall be Class A Concrete and shall conform to Section 802 – CONCRETE FOR STRUCTURES.
- C. Grout and Mortar. Grout and mortar shall consist of 1 part Portland Cement and 3 parts sand, thoroughly mixed with water. Mortar shall have a consistency such that it can be easily handled and spread by trowel. Grout shall have a consistency such that it will flow into and completely fill all joints.
- D. Reinforcement shall conform to Section 807 – REINFORCING STEEL.
- E. Joints. Premolded expansion joint material shall conform to Section 801 – CONCRETE STRUCTURES.
- F. Tie Backs and Anchors. Galvanized tie backs and anchors shall be as indicated on the Drawings.
- G. Filter Fabric Filter Fabric shall conform to Section 306 – SEDIMENTATION AND EROSION CONTROL.
- H. Granular Filter. Aggregate used for granular filters shall conform to Section 801- CONCRETE STRUCTURES.

408.4

Construction Methods

Prior to commencement of this work, all required erosion control and tree protection shall be in place and utilities located and protected as set forth in the "General Conditions". Construction equipment shall not be operated within the drip line of trees unless indicated on the Drawings. Construction materials shall not be placed under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees until tree wells are constructed. Spalls and small stones used to fill open joints and voids in rock riprap shall be rocked and wedged to provide a tight fit.

Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor and it shall become his sole responsibility to dispose of this material in an environmentally sound manner off the limits of the right of way at a permitted disposal site.

Areas to be protected by rock riprap shall be free of brush, trees, stumps and other objectionable materials and be graded to a smooth compacted surface. All soft or spongy material shall be removed and replaced with appropriate material to the depths shown on the plans or as directed by the engineer. Fill Areas, unless otherwise specified will be compacted in accordance with Section 503 - EMBANKMENT. Unacceptable subgrade conditions shall be reworked according to the Engineer's recommendations. Excavation areas shall be maintained until the riprap is placed.

408.5

Dry Rock Riprap

The mass of rock riprap shall be placed as to be in conformance with the required gradation mixtures, to the lines, grades and layers thickness that is shown on the drawings. The range of rock sizes for the mixture shall conform to the following recommended gradation requirements relative to the specified median rock size (D50).



Relative Stone Size (inches)	Percent of Gradation Smaller than	Stone Size Designation
1.7 - 2.0 * D50	100	D100
1.3 - 1.7 * D50	85	D85
1.0 - 1.3 * D50	50	D50
0.5 - 1.0 * D50	15	D15

At least 50% of the rocks shall weigh more than the D50 rock size. When the riprap will be placed on an erodible soil, as determined by the Engineer or designated representative, a layer of geotextile filter fabric or a granular filter layer shall be placed, prior to placement of the riprap material. In some cases multiple layers of granular filter material of varying gradations may be required. The median rock riprap size (D50), rock riprap layer thickness, filter type, when applicable the number of granular filter layers, granular filter aggregate gradations (grade/size classification), granular layer thicknesses shall be specified on the plans. The minimum granular filter layer thickness shall be 4 inches (102 mm). Geotextile filter fabric shall conform to Section 306 – SEDIMENTATION AND EROSION CONTROL and be installed with sufficient anchoring and overlap between seams according to the manufacturer's recommendations to ensure full filter barrier protection of the subgrade after riprap installation. When specified on the plans a four (4) inch minimum thickness granular cushion layer of gravel or sand may be placed over the filter fabric to prevent damage the fabric during placement of rock riprap.

Rock riprap shall be machine placed and distributed such that there will be no large accumulations of either larger or smaller sizes. Placing rock riprap by dumping into chutes or similar methods shall not be permitted. The rocks shall be placed in a single layer with close joints. The rock riprap layer thickness shall be no less than the maximum stone size (D100) or 1.5 times the D50, which ever produces the greater thickness. In areas exposed to flowing water the rock riprap layer thickness should be no less than 2.0 times the D50. The upright axis of the rocks shall make an angle of approximately 90 degrees with the embankment slope. The courses shall be placed from the bottom of the embankment upward, with the larger rocks being placed on the lower courses. Open joints shall be filled with spalls. Rocks shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches (75 mm). Rocks that project more than the allowable amount in the finished work shall be replaced, embedded deeper or chipped.

408.6

Mortared Rock Riprap

Rock for this purpose, as far as practicable, shall be selected as to size and shape in order to secure fairly large, flat-surfaced rock which may be laid with a true and even surface and a minimum of voids. Fifty percent of the mass rock shall be broad flat rocks, weighing between 100 and 150 pounds (45 and 69 kilograms) each, placed with the flat surface uppermost and parallel to the slope. The largest rock shall be placed near the base of the slope. The spaces between the larger rocks shall be filled with rocks of suitable size, leaving the surface smooth, reasonably tight and conforming to the contour required on the Drawings. In general, the rocks shall be placed with a degree of care that will insure plane surfaces with variation from the true plane of no more than 3 inches in 4 feet (no more than 60 mm per meter). Warped and curved surfaces shall have the same general degree of accuracy as indicated for plane surfaces.

Before placing mortar, the rocks shall be wetted thoroughly and as each of the larger rocks is placed, it shall be surrounded by fresh mortar and adjacent rocks shall be shoved into contact. After the larger rocks are in place, all of the spaces or opening(s) between them shall be filled with mortar and the smaller rocks then placed by shoving them into position, forcing excess mortar to the surface and insuring that each rock is carefully and firmly embedded laterally. After the work described above has been completed, all excess mortar forced up shall be spread uniformly to completely fill all surface voids. All surface joints then shall be pointed up roughly, either with flush joints or with shallow, smooth raked joints.



408.7

MEASUREMENT

Measurement of acceptable riprap will be made on the basis of the (a) area in square yards (square meters: 1 square meter equals 1.196 square yards) indicated on the Drawings, complete in place or (b) the volume of concrete placed in cubic yards (cubic meters: 1 cubic meters equals 1.308 cubic yards), complete in place as indicated on the Drawings for the thickness specified.

Concrete toe walls will not be measured separately but shall be included in the unit price bid for riprap of the type with which it is placed.

408.8

PAYMENT

The riprap quantities, measured as provided above, will be paid for at the unit bid prices per square foot or per cubic yard as indicated for riprap of the various classifications. The Unit Bid Price shall include full compensation for furnishing, hauling and placing all materials, including toe walls, geotextile filter fabric, granular filter material, granular cushion, reinforcement and premolded expansion joint material and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment for excavation of toe wall trenches and for all necessary excavation below natural ground or the bottom of excavated drainage channels will be included in the unit bid price for riprap. Excavation, grading and fill materials required to shape drainage channels shall not be included in the unit bid price for riprap.

Payment for excavation required for shaping of slopes for riprap shall be included in the unit bid price for riprap, except for the situation when the header banks upon which the riprap is to be placed are built by prior contract. In this specific case the excavation for shaping of slopes, will be paid for conforming to Section 309 – STRUCTURAL EXCAVATION.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 501. HOT MIX ASPHALTIC CONCRETE PAVEMENT

501.1 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing hot mix asphaltic concrete as shown in the Plans and specified within. Construction shall include a base course, a level-up course, a surface course or any combination of these courses as shown on the Plans, each course being composed of a compacted mixture of aggregate and asphalt mixed hot in a mixing plant, in accordance with the details shown on the Plans and the requirements herein.

501.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including mix design, aggregate source, aggregate gradation, aggregate type, and all other pertinent data to illustrate conformance to the specification found within.

501.3 MATERIALS

- A. The mineral aggregate shall be composed of a course aggregate, a fine aggregate, and if required, a mineral filler. Coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall be stone, crushed slag, crushed gravel, or gravel. Fine aggregate shall be that part passing the No. 10 sieve and shall consist of sand or screenings. Mineral filler shall consist of dry stone dust, Portland cement, or fly ash. Mineral aggregate shall meet the requirements of Item 340 (or 3268 for wide roadways or high speed roadways), Texas Department of Transportation (TxDOT), Standard Specifications for Construction of Highways, Streets and Bridges. The plasticity index of fine aggregate portion passing the No. 40 sieve shall not be more than six (6).

501.4 ASPHALTIC MATERIAL

- A. Asphalt for the paving mixture shall meet the requirements of TxDOT Item 300 (or 3268 for wide roadways or high speed roadways) of the Standard Specifications for Construction of Highways, Streets and Bridges. The grade of asphalt used shall be designated by the Engineer or the City after design tests have been made using the mineral aggregate to be used in the job.

501.5 TACK COAT

- A. Tack coat shall be in accordance with TxDOT Item 300 (or 3268 for wide roadways or high speed roadways) of the Standard Specifications for Construction of Highways, Streets and Bridges. Asphaltic material shall be approved by the Engineer or the City.

501.6 TYPES OF ASPHALTIC CONCRETE

- A. The mixture shall be designed and tested in accordance with the current TxDOT Item 340 (or 3268 for wide roadways or high speed roadways) of the Standard Specifications for Construction of Highways, Streets and Bridges, Type D, and will have a laboratory density of not less than 94.5% nor more than 97.5%, and a stability of not less than 35.
- B. The asphaltic material shall form from four to eight (4–8) percent of the mixture by weight or from nine to nineteen (9-19) percent of the mixture by volume.



EQUIPMENTA. Spreading and Finishing Machine

1. The spreading and finishing machine shall be a type approved by the Engineer, shall be capable of producing a surface that will meet the requirements of the typical cross section and the surface test, when required, and when the mixture is dumped directly into the finishing machine, shall have adequate power to propel the delivery vehicles in a satisfactory manner. The finishing machine shall be equipped with a flexible spring and/or hydraulic-type hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.
2. The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel in such a manner as to obtain the desired lines and grades without resorting to hand-finishing will not be allowed. Unless otherwise permitted by the Plans, vehicles of the semi-trailer type are specifically prohibited from dumping directly into the finishing machine while in contact with the finishing machine. Vehicles dumping directly or indirectly into the finishing machine shall be so designed and equipped that unloading into the finishing machine can be mechanically and/or automatically operated in such a manner that overloading the finishing machine being used cannot occur and the required lines and grades will be obtained without resorting to hand-finishing.
3. Dumping of the asphaltic mixture in a windrow and then placing the mixture in the finishing machine with loading equipment will be permitted, provided that the loading equipment is constructed and operated in such manner that substantially all of the mixture deposited on the roadbed is picked up and loaded in the finishing machine without contamination of foreign material of the mixture, and excessive temperature loss is not encountered. The loading equipment will be so designed and operated that the finishing machine being loaded will obtain the required line, grade, and surface without resorting to hand-finishing. Any operation of the loading equipment resulting in the accumulation and subsequent shedding of this accumulated material into the asphaltic mixture will not be permitted.

B. Rolling Equipment

1. Rolling equipment shall consist of pneumatic tire rollers, two-axle tandem roller weighing not less than eight (8) tons, three-wheel roller weighing not less than 10-tons, three-axle tandem roller weighing not less than 10-tons, and trench rollers having a 20-inch wheeldrive and producing 325 pounds per linear inch of roller width at a speed of 1.8 miles per hour in low gear.

C. Straight Edges and Templates

1. The Contractor shall provide an acceptable 10-foot straight edge for surface testing.

CONSTRUCTION METHODS

- A. The prime coat, tack coat or the asphaltic mixture, when placed with a spreading and finishing machine, shall not be placed when the air temperature is below 50 degrees F and is falling, but it may be placed when the air temperature is above 40 degrees F and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the prime coat, tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the Engineer or the City, are suitable.



B. Prime Coat

1. A prime coat is required, and shall be applied at the rate determined by the Engineer but not less than 0.2-gallons per square yard of AEP or MC-30 asphalt. The asphaltic concrete shall not be applied on a previously primed flexible base until the primed base has completely cured to the satisfaction of the Engineer and the City. Water-based prime coat is prohibited.

C. Transporting Asphaltic Concrete

1. The asphaltic mixture, prepared as directed above, shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered may be placed, and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers and insulating of the truck bodies may be required. The inside of the truck body may be given a light coating of oil, lime slurry or other material satisfactory to the Engineer and the City, if necessary, to prevent mixture from adhering to the body.
2. Contractor shall provide automated ticket printout for each truckload of material where payment is determined by weight. Each loading ticket must show the ticket number, truck number, gross weight, tare weight, and net weight, per TxDOT Item 520.

D. Placing

1. Asphalt shall be applied when the air temperature is above 50° F and rising. Asphalt shall not be applied when the air temperature is 60° F and falling. In all cases, asphalt shall not be applied when the surface temperature is below 60° F. Generally, the asphaltic mixture shall be dumped and spread on the approved prepared surface with the specified spreading and finishing machine, in such manner that when properly compacted, the finished pavement will be smooth, of uniform density, and will meet the requirements of the typical cross-sections and the surface tests. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures. When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer or the City, provided a satisfactory surface can be obtained by other approved methods.

E. Compacting

1. Rolling: The pavement shall be compressed thoroughly and uniformly with the specified roller and/or other approved rollers. Rolling with the three-wheel and tandem rollers shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the rear wheel. Alternate trips of the roller shall be slightly different in length. Rolling with pneumatic-tire roller shall be done as directed by the Engineer. Rolling shall be continued until no further compression can be obtained and all roller marks are eliminated. One (1) tandem roller, one (1) pneumatic-tire roller, and at least one (1) three-wheel roller, as specified above, shall be provided for each job. If the Contractor elects, he may substitute the three-axle tandem roller for the two-axle tandem roller and/or the three-wheel roller; but in no case shall less than three rollers be in use on each job. Additional rollers shall be provided if needed. The motion of the roller shall be slow enough at all times to avoid displacement of the mixture. If any displacement occurs, it shall be corrected at once by the use of rakes and of fresh mixtures where required. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. All rollers must be in good mechanical condition. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease, or other foreign matter on the pavement, either when the



rollers are in operation or when standing. Regardless of the method used for compaction, all rolling to achieve specified density shall cease when the Hot Mix Asphaltic Mixture drops below 175°F (80°C).

2. In-Place Density: The Hot Mix Asphaltic mixture shall be tested daily at the project site for conformance to specification requirements. Unless directed otherwise by the Engineer or designated representative, a bag sample and a core or section will be obtained for each 2,000 square yards or portion of paving each day, with a minimum of three bag samples and three cores for each day's paving.

Bag samples shall be taken during lay-down operations. The primary sampling point for the bag samples shall be from the windrow if a windrow elevator is used. If a windrow elevator is not used, the sample shall be taken from the middle of the paving machine hopper. Gradation, asphalt content and stability value of the hot mix asphaltic mixture shall be reported for each of the bag samples. The stability value reported for each of the bag samples shall be the average of three (3) tests per bag.

Pavement thickness and in-place density shall be determined from the field cores or sections. The average of all hot mix asphaltic concrete pavement core or section thicknesses shall meet the minimum thickness per the street classification as defined in Construction Standard T-06. No individual core or section thickness deficiency may be greater than 0.2 inches. Pavement that does not meet the thickness specification shall be removed and replaced as outlined below. The in-place density tests are intended for compaction-control tests and will be tested according to Test Method Tex-207-F. The core or section densities shall average from 91.0% to 96.0% of the maximum theoretical density except that the minimum acceptable density of an individual sample is 89.0% or the maximum acceptable density of an individual sample is 97.0%. There will be no two consecutive cores or section densities below 91.0% or above 96.0%. Asphalt pavement represented by a density less than 89.0%, more than 97.0% or two consecutive densities less than 91.0% or greater than 96.0% shall be removed and replaced.

Any pavement to be removed and replaced will be removed and replaced from curb to curb or edge of asphalt to edge of asphalt at the contractor's expense. Additional density tests shall be used to delineate the limits of the in-place hot mix asphaltic pavement that does not meet the density specification and the results of the tests shall not be used in the calculation of the overall average density. Protocol to assess the area of asphalt pavement removal and replacement shall start between the failing density or two consecutive densities that are less than 91.0% and the next passing density to either side of the failing pavement. Additional cores or sections will be required to quantify the area of replacement back to an in-place density of 91.0%. Backscattering (nuclear densities) shall not be used to determine the actual density of asphaltic pavement.

Pavements with low-density results may be retested; but the pavement shall not receive any additional compactive effort.

Final acceptance of the pavements shall be the responsibility of the Engineer.

3. Hand-Tamping: The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller or in such position as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

F. Surface Tests

1. The surface of the pavement, after compaction, shall be smooth and true to the established line, grade, and cross-section, and when tested with a 10-foot straightedge placed parallel to the centerline of the roadway or tested by other equivalent and acceptable means, except as



provided herein, the maximum deviation shall not exceed 1/4-inch in 10-feet, and any point in the surface not meeting this requirement shall be corrected.

501.09 INSPECTION

- A. If the TxDOT Item 340 specification is used for furnishing and installing hot mix asphaltic concrete, then 1B inspection per TxDOT shall be required.
- B. If the TxDOT Item 3268 specification is used for furnishing and installing hot mix asphaltic concrete, then 1A and 1B inspection per TxDOT shall be required.

501.10 ROADS DAMAGED BY CONSTRUCTION

- A. The Contractor shall reconstruct existing asphalt paved roads which are damaged as a result of construction of this project at no additional cost to the City. Reconstruction shall consist of reconstructing the road to an "as new condition" to the existing pavement cross section. The Contractor may use existing base material, adding new base material as needed. Contractor shall compact and reshape road subgrade to existing grade. The subbase and base shall be compacted in accordance with these specifications. The Contractor shall install at least the minimum depth of hot-mix asphalt pavement per the street classification as defined in Construction Standard T-06 and in accordance with these specifications.

501.11 PAYMENT

- A. Payment for furnished and installed hot mix asphaltic concrete pavement shall be paid according to the unit price per square yard or per ton in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the hot mix asphaltic concrete shall be subsidiary to this item.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 502. ROADWAY EXCAVATION

502.1 SCOPE OF WORK

- A. This specification covers the requirements for shaping and finishing of all earthwork on the entire length of roadway, and approaches to same, in conformity with the required lines, grades and typical cross sections and in accordance with specification requirements herein outlined. Compaction shall conform to the method of “Density Control” and/or “Ordinary Compaction” as shown on the Plans and Specifications.

502.2 SUBMITTALS

- A. None required unless specifically called for in the Plans, Standards, or requested by the City or Engineer.

502.3 CONSTRUCTION METHODS

- A. All roadway excavation and corresponding embankment construction shall be performed as specified herein and in Section 503- EMBANKMENT, and the completed roadway shall conform to the established alignment, grades and cross sections. Construction of roadway excavation shall be in accordance with TxDOT Item 110 of the Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.
- B. Roadway excavation shall be extended to a minimum of two (2) feet behind the proposed back of curb for all street types.
- C. All suitable excavated materials shall be utilized, insofar as practicable, in constructing the required roadway sections. Unsuitable roadway excavation and roadway excavation in excess of that needed for the construction of the roadway shall be disposed of outside the limits of the right-of-way. Unsuitable material encountered below subgrade elevation in roadway cuts, shall be removed and replaced, as directed by the Representative of the City with material from the roadway excavation or with other suitable material.
- D. During construction, the roadbed and ditches shall be maintained in such condition as to insure proper drainage at all times and ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section.

NOTE: ALL UNDERGROUND UTILITIES SHALL BE INSTALLED PRIOR TO ANY LIME TREATMENT OR FLEXIBLE BASE PLACEMENT.

NOTE: Blue-tops will be set on the center and crown of the streets or roads at every 50-foot station. These grade stakes will be to finished grade and visible for inspection before flexible base is applied.

502.4 PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification. Select back fill shall be paid for according to the unit price per cubic yard according to the appropriate item, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 503. EMBANKMENT

503.1 SCOPE OF WORK

- A. This specification covers the requirements for the placement and compaction of all materials obtained from roadway, borrow, channel and structural excavation for utilization in the construction of roadway embankments, levees and dikes (berms).

503.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including the source of the material, equipment and all other pertinent data to illustrate conformance to the specification found within.

503.3 MATERIALS

- A. Where fill material is required for embankment, the material shall conform to the following class:

Class A (Select Borrow) – Class A Borrow material shall consist of suitable granular material, free from vegetation or other objectionable matter and reasonable free from lumps of earth. When tested by standard TxDOT laboratory methods Tex-104-E, Tex-106-E and Tex-107-E, the Class A, Select Borrow shall meet the following requirements:
 - 1. Liquid Limit shall not exceed 45.
 - 2. Plasticity index shall not exceed 15.
 - 3. Bar linear shrinkage shall not be less than 2.
- B. Class B – Materials such as rock, loam, clay, or other approved materials.
- C. Class C – Material meeting the specification requirements shown on the plans.
- D. Class D - Material from required excavation areas shown on the plans.

503.4 CONSTRUCTION METHODS

- A. Construction of embankment shall be in accordance with this specification and TxDOT Item 132 of the Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.
- B. Prior to placing any embankment, all “Preparing Right of Way” operations shall have been completed on the excavation sources and areas over which the embankment is to be placed. Stump holes or other small excavations in the limits of the embankments shall be backfilled with suitable materials and thoroughly tamped by approved methods before commencing embankment construction. The surface of the ground, including plowed loosened ground or surface roughened by small washes or otherwise shall be restored to approximately its original slope by blading or other methods. Where indicated on the Plans, the ground surface thus prepared shall be compacted by sprinkling and rolling.
- C. Unless otherwise indicated on Plans, the surface of the ground of all unpaved areas other than rock which are to receive embankment shall be loosened by scarifying or plowing to a depth of not less than six (6) inches. The loosened material shall be recompacted with the new embankment as hereinafter specified.



- D. Where directed the surface of hillsides to receive embankment shall be loosened by scarifying or plowing to a depth of not less than six (6) inches, or cut into steps before embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side in part width layers and increasing the widths as the embankment is raised. The material which has been loosened shall be recompacted simultaneously with the embankment material placed at the same elevation.
- E. Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than six (6) inches and the embankment built up in successive layers, as hereinafter specified, to the level of the old roadbed before its height is increased. Then, if directed, the top of the old roadbed shall be scarified and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible depth of layer.
- F. Trees, shrubs, roots, vegetation or other unsuitable materials shall not be placed in embankment.
- G. Except as otherwise required by the plans, all embankment shall be constructed in layers approximately parallel to the finished grade of the roadbed and unless otherwise specified, each layer shall be so constructed as to provide a uniform slope of ¼-inch per foot from the center line of the roadbed to the outside, except that on superelevated curves each layer shall be constructed to conform to the superelevation required by the governing standard.
- H. Embankments shall be constructed to the grade established by the Engineer or the City and completed embankments shall correspond to the general shape of the typical sections shown on the plans and each section of the embankment shall correspond to the detailed section or slopes established by the Engineer. After completion of the roadway, it shall be continuously maintained to its finished section and grade until the project is accepted.

503.5

EARTH EMBANKMENTS

- A. Earth embankments shall be defined as those composed principally of material other than rock, and shall be constructed of accepted material from approved sources.
- B. Except as otherwise specified, earth embankments shall be constructed in successive layers for the full width of the individual roadway cross section and in such lengths as are best suited to the sprinkling and compaction methods utilized.
- C. Layers of embankment may be formed by utilizing equipment (which will spread the material as it is dumped, or formed by being spread by blading or other acceptable methods from piles or windrows dumped from excavating or hauling equipment in such amounts that material is evenly distributed.)
- D. Minor quantities of rock encountered in constructing earth embankment shall be incorporated in the specified embankment layers, or may be placed in accordance with the requirements for the construction of rock embankments in the deeper fills within the limits of haul shown on the Plans, provided such placement of rock is not immediately adjacent to structures. Also, rock may be placed in the portions of embankments outside the limits of the completed roadbed width where the size of the rock prohibits their incorporation in the normal embankment layers.
- E. Each layer of embankment shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be feather edged for at least 100-feet or the material shall be so mixed as to prevent abrupt changes in the soil. No material placed in the embankment by dumping in a pile or windrow shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, disking or similar methods to the end that a uniform material of uniform density is secured in each layer.



- F. Water required for sprinkling to bring the material to the moisture content necessary for maximum compaction shall be evenly applied and it shall be the responsibility of the Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary.
- G. In order to facilitate uniform wetting of the embankment material, the Contractor may apply water at the material source if the sequence and methods used are such as not to cause an undue waste of water. Such procedure shall be subject to the approval of the Representative of the City.
- H. All earth cuts, full width or part width cuts in side hill, which are not required to be excavated below subgrade elevation for base and backfilled, shall be scarified to a uniform depth of at least six (6) inches below grade, and the material shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with the requirements outlined above for earth embankments and to the same density as that required for the adjacent embankment.
- I. Compaction of embankments shall be obtained by the method hereinafter described as “Ordinary Compaction” or the method hereinafter described as the “Density Control” method.

503.6 ORDINARY COMPACTION (outside of Roadway Pavement)

- A. When the “Ordinary Compaction” method is specified, the following provisions shall govern: Each layer shall not exceed eight (8) inches of loose depth, and shall be compacted until there is no evidence of further compaction. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content ordered by the Representative of the City, and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

503.7 DENSITY CONTROL

- A. When the “Density Control” method compaction is specified, each layer shall be compacted to the required density by any method, type and size of equipment which will give the required compaction. The depth of layers, prior to compaction, shall depend upon the type of sprinkling and compacting equipment used. However, maximum depth 16-inches loose and 12-inches compacted shall not be exceeded unless approved by a representative of the City. Prior to and in conjunction with the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.
- B. For each layer of earth embankment and select material, it is the intent of this specification to provide the density as required in the table below, unless otherwise shown on the Plans.

Field Density Control Requirements

Description	Density	Moisture Control
	Tex-115-E	
PI ≤ 15	≥ 98% Max. Dry Density	
15 < PI ≤ 35	98% ≤ Max. Dry Density ≤ 102%	≥ Optimum Moisture Content
PI > 35	95% ≤ Max. Dry Density ≤ 100%	≥ Optimum Moisture Content

Field density determinations will be taken every 750 square yards of roadbed surface at the Contractor’s expense.

- C. After each layer of earth embankment or select material is complete, tests will be required. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain specified density. Such procedure shall be determined by, and subject to, the approval of the Representative of the City.
- D. The Representative of the City may order proof rolling to test the uniformity of compaction of the embankment layers. All irregularities, depressions, weak or soft spots which develop shall be



corrected immediately by the Contractor at his expense.

- E. Should the subgrade, due to any reason or cause, lose the required stability, density or finish before the pavement structure is placed, it shall be recompacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent layer or granular material. Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is more than four (4) percent below the optimum for compaction ratio density.

503.8

ROCK EMBANKMENTS

- A. Rock Embankments shall be defined as those composed principally of rock, and shall be constructed of accepted material from approved sources.
- B. Except as otherwise specified, rock embankments normally shall be constructed in successive layers for the full width of the individual roadway cross section and of 18-inches or less in depth.
- C. The maximum dimension of any rock used in embankment shall be less than the depth of the embankment layer. All oversized rock which is otherwise suitable for construction shall be broken to the required dimensions and utilized in embankment construction where proposed by Plans.
- D. Unless otherwise provided, the upper or final layer of the embankment shall contain no stones larger than four (4) inches in their greatest dimension, and, insofar as such is available by selection from the excavation, shall be composed of material so graded that the density and uniformity of the surface layer may be secured by the methods and requirements as set forth for “Ordinary Compaction” or “Density Control” method.
- E. When the “Ordinary Compaction” method of compaction is specified, each embankment layer shall be rolled as directed, and where the embankment materials require, shall be sprinkled when and to the extent directed by the Representative of the City.
- F. When the “Density Control” method of compaction is specified, each layer shall be compacted to the required density as outlined for “Earth Embankment”, except in those layers where rock will make density testing difficult, the Representative of the City may require the layer to be proof rolled to insure proper compaction.

503.9

AT CULVERTS AND BRIDGES

- A. Embankments adjacent to culverts and bridges which cannot be compacted by use of the blading and rolling equipment used in compacting and adjoining sections of embankment shall be compacted in the manner prescribed under Section 309- STRUCTURAL EXCAVATION and Section 304- TRENCHING, BACKFILLING AND COMPACTION.
- B. Embankments placed around spill-through type abutments, shall be constructed in six (6)-inch loose layers of uniform suitable material placed in such manner as to maintain approximately the same elevation on each side of the abutment, and all materials shall be mixed, wetted and compacted as specified above.
- C. As a general rule, embankment material placed adjacent to any portion of any structure and in the first two (2) layers above the top of any culvert or similar structure shall be an earth, free of any appreciable amount of gravel or stone particles more than four (4) inches in greatest dimension and of such gradation as to permit thorough compaction. When, in the opinion of the Representative of the City, such material is not readily available, the use of rock or gravel mixed with earth will be permitted, in which case no particles larger than 12-inches in greatest dimension and six (6) inches in least dimension may be used and the percentage of fines shall be sufficient to fill all voids and insure a uniform and thoroughly compacted mass of proper density.



503.10

SELECTION OF MATERIALS

- A. In addition to the requirements in the excavation items of the specifications covering the general selections and utilization of materials to improve the roadbed, embankments shall be constructed in proper sequence to receive the select material layers shown on the plans, with such modifications as may be directed by the Representative of the City. The layer of embankment immediately preceding the upper layer of select material shall be constructed to the proper section and grade within a tolerance of not more than 0.10 foot from the established section and grade when properly compacted and finished to receive the select material layer.

NOTE: ALL UNDERGROUND UTILITIES SHALL BE INSTALLED PRIOR TO ANY LIME TREATMENT OR FLEXIBLE BASE PLACEMENT.

NOTE: Bluetops will be set on the center, crown, and back of curb of the streets or roads every 50-foot station. These grade stakes will be to finished grade and visible for inspection before flexible base is applied.

503.11

PAYMENT

- A. No separate payment will be made for work performed in accordance with this specification, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 504. FLEXIBLE BASE (Crushed Stone)

504.1 SCOPE OF WORK

- A. This specification covers the requirements for the use of “Flexible Base (Crushed Stone)” for this project.

504.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including binding material, additives, aggregate source, aggregate type, aggregate gradation and all other pertinent data to illustrate conformance to the specification found within.

504.3 GENERAL

- A. “Flexible Base (Crushed Stone)” shall consist of a foundation course for surface course or for other base courses; shall be composed of crusher-run broken stone; and shall be constructed as herein specified and as specified in TxDOT Item 247 of the Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges in one or more courses in conformity with the typical sections shown on Plans and to the lines and grades as established by the Plans.

504.4 MATERIAL

- A. The material shall be crushed and shall consist of durable particles of stone mixed with approved binding material. The material source shall be approved by the Representative of the City, and conform to the requirements as follows:
- B. When properly slaked and tested by standard Texas Department of Transportation laboratory methods, the flexible base material shall meet the following requirements:
- C. Physical requirements

1. General. All types shall meet the physical requirements for the specified grade(s) as set forth in Table 1. When material meeting the requirements of Table 1 is unavailable within a 5-mile radius of the City of Killeen, alternate materials may be submitted to the Department of Public Works for review.

Additives, such as, but not limited to, lime, cement or fly ash, shall not be used to alter the soil constants or strengths shown in Table 1, unless otherwise shown on the Plans.

Unless otherwise shown on the Plans, the base material shall have a minimum Bar Linear Shrinkage of two (2) percent as determined by Test Method Tex-107-E, Part II.

2. The flexible base shall be:
- a. Type A. Type A material shall be crushed stone produced from oversized quarried aggregate, sized by crushing and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable for Type A material. No blending of sources and/or additive materials will be allowed in Type A material.
- b. Grade 2 or better. Aggregate shall be of Grade 2 or better physical requirements as



specified in Table 1.

TABLE 1 – Type A, Grade 2
PHYSICAL REQUIREMENTS

Grade 2		Grade 2*	
Triaxial Class 1: Min. compressive strength, psi: 45 at 0 psi lateral pressure and 175 at 15 psi lateral pressure		Max LL.....	40
Master Grading		Max PI.....	12
1-3/4"	0-10	Wet Ball Mill	
7/8"	-	Max.....	50
3/8"	-	Max increase in	
No. 4	45-75	passing	
No. 40	60-85	No. 40.....	20

* Wet Ball Mill, % Max modified from TxDOT Item 247 requirements for Grade 2

1. Gradation requirements are percent retained on square sieves.
2. When a magnesium soundness value is shown on the Plans the material will be tested in accordance with Test Method Tex-411-A.

Sieve Analysis	Tex-110-E
Moisture-Density Determination	Tex-113-E
Roadway Density	Tex-115-E
Wet Ball Mill	Tex-116-E
Triaxial Tests (Part I or II as selected by the Engineer)	Tex-117-E
Particle Count	Tex-460-A, Part I

Samples for testing the base material for triaxial class, soil constants, gradation and wet ball mill will be taken prior to the compaction operations.

504.5

TOLERANCES

- A. The limits establishing reasonably close conformity with the specified gradation and plasticity index are defined by the following:
- B. The City may accept the material, providing not more than two (2) out of 10 consecutive gradation tests performed are outside the specified limit on any individual or combination of sieves by no more than five (5) percent and where no two (2) consecutive tests are outside the specified limit.
- C. The City may accept the material providing not more than 2 out of 10 consecutive plasticity index samples tested are outside the specified limit by no more than two (2) points and where no two (2) consecutive tests are outside the specified limit.
- D. When material meeting Type A, Grade 2 (as defined in TABLE 1 above) or better requirements is unavailable within a 50-mile radius of the City of Killeen (101 N. College Street, Killeen, Texas 76541), alternate materials may be submitted to the Public Works Director or his designee for review.



CONSTRUCTION METHODSA. Preparation of Subgrade

1. The roadbed shall be excavated and shaped in conformity with the typical sections, lines and grades as shown on the Plans. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All holes, ruts and depressions shall be filled with approved material, and if required, the subgrade shall be thoroughly wetted with water and reshaped and rolled to the extent directed in order to place the subgrade in an acceptable condition to receive the base material. The surface of the subgrade shall be finished to line and grade as established and in conformity with the typical section shown on the Plans, and any deviation in excess of ½-inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of work.

B. First Course

1. Immediately before placing the base material, the subgrade shall be checked as to conformity with grade and section. Subgrade shall be at optimum moisture or above prior to placing the base material.
2. The material shall be delivered in approved vehicles of a uniform capacity and it shall be the charge of the Contractor that the required amount of specified material shall be delivered in each 100-foot station. Material deposited upon the subgrade shall be spread and shaped the same day unless otherwise directed by the City in writing. In the event inclement weather or other unforeseen circumstances render impractical the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the City. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to typical sections as shown on the Plans. The base layer shall be constructed in lifts not less than four (4) inches and not exceeding eight (8) inches compacted thickness with each course being of equal thickness. All areas and “nests” of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by the City.
3. The course shall be compacted by the method of compaction hereinafter specified as the “Density Control” method of compaction.
 - a. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as hereinafter specified under “Density”. In addition to the requirements specified for density, the full depth of flexible base shown on the Plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base is completed, density tests shall be taken every 750 square yards of roadbed surface or every 250 linear feet, whichever is the least. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical section shown on the Plans and to the established lines and grades. In that area on which pavement is to be placed, any deviation in excess of ¼-inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling. Should the base course, due to any reason or cause, lose the required stability, density and finish



before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the Contractor. The base material shall be placed at the optimum moisture contents to $\pm 3\%$.

C. Succeeding Courses

1. Construction methods and testing shall be the same as prescribed for the first course.

D. Density

1. Each course of flexible base shall be compacted to 95% of the maximum density as determined by ASTM D1557 (Method D) at $\pm 2\%$ of optimum moisture.

E. Curing

1. Cure the finished section until the moisture content is at least 2 percentage points below optimum or as directed before applying the next successive course or prime coat.

504.7

NOTES

- A. Invoices showing total amount of flexible base delivered to each street or road shall be furnished to the City before asphalt is applied.
- B. Bluetops will be set on the center, crown and back of curb of the streets or roads every 50-foot station or sufficient to maintain line and grade. These grade stakes will be to finished grade and visible for inspection before asphalt is applied.

504.8

PAYMENT

- A. Payment for furnished and installed flexible base shall be paid according to the unit price per square yard in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the installation of flexible base shall be subsidiary to this item.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 505. STRIPING

505.1 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing pavement markings as shown on the Plans and specified within.

505.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including material type, test data, and all other pertinent data to illustrate conformance to the specification found within.

505.3 MATERIALS

- A. Unless otherwise shown on the Plans, all permanent pavement markings shall be thermoplastic type materials (Type I) that require heating to elevated temperatures for application in accordance with TxDOT Items 662, 666, 668, 672, 677, and 678 of the Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. They shall conform to Texas Department of Transportation Materials Specification D-9-8220. Each container of thermoplastic material shall be clearly marked to indicate the color, weight, type of material, Manufacturer's name and the lot/batch number.
- B. Work zone pavement markings shall be provided in accordance with TxDOT Item 662.
- C. Temporary pavement markings (Type II) shall be provided in accordance with TxDOT DMS-8200, "Traffic Paint."
- D. All pavement markings shall include drop-on glass beads conforming to TxDOT DMS-8290, "Glass Traffic Beads."
 - 1. Type I Markings. Furnish Type III drop-on glass beads. Furnish Type II or double-drop of Type II and Type III drop-on glass beads where each type bead is applied separately in equal portions (by weight), only when specified in the plans. When furnishing a double-drop system, apply the Type III beads before applying the Type II beads.
 - 2. Type II Markings. Furnish Type III drop-on glass beads or other beads specified on the plans.

505.4 EQUIPMENT

- A. All equipment used to place pavement markings shall be maintained in a satisfactory condition. The equipment shall be able to place markings at a rate that will produce a uniform product meeting all the requirements set within TxDOT Item 666 of the Standard Specifications for Construction of Highways, Streets and Bridges. It shall be capable of placing linear markings up to eight (8) inches in width in a single pass and able to place a center line and no passing barrier line configuration of one (1) broken line with two (2) solid lines at the same time to the alignment and spacing shown on the Plans. Equipment shall be capable of placing lines with clean edges of a uniform cross section within a tolerance of $\frac{1}{8}$ of an inch per four (4) inches width of marking. It shall have an automatic cut-off device with manual operating capabilities to provide clean, reasonably square marking ends to the satisfaction of the Engineer or the City and provide a method of applying broken line in an approximate stripe-to-gap ratio of 10 to 30. The length of the stripe shall not be less than 10-feet or more than 10.5-feet. The total length of any stripe-gap cycle shall not be less than 39.5-feet or more



than 40.5-feet. It shall provide a continuous mixing and agitation of the pavement marking material. The use of pans, aprons or similar appliances will not be permitted for longitudinal striping applications. Beads shall be applied by an automatic bead dispenser that is attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly as the marking is placed on the pavement surface. The bead dispenser shall have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment. A hand held thermometer shall be kept on the project during the placement of pavement markings capable of measuring the temperature of the pavement marking material.

505.5

CONSTRUCTION METHODS

- A. Pavement marking shall be applied with an approximate stripe-to-gap ratio of 10 to 30 when the application is broken line striping. The length of the broken stripe shall not be less than 10-feet nor more than 10.50-feet. The total length of any stripe-gap cycle shall not be less than 39.50-feet nor more than 40.50-feet.
- B. With prior approval from the City of Killeen, pavement markings may be placed on roadways open to traffic. When markings are to be placed under traffic, a minimum of interference to the operation of the traffic flow shall be maintained. Traffic control shall be maintained as shown on the approved Traffic Control Plan. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement.
- C. The deviation rate in pavement marking alignment shall not exceed one (1) inch per 200-feet of roadway and the maximum deviation shall not exceed two (2) inches nor shall any abrupt deviations be acceptable.
- D. Markings shall have a uniform cross section. The density and quality of the markings shall be uniform throughout their thickness. The applied markings shall have no more than five (5) percent, by area, of holes or voids and shall be free of blisters.
- E. Markings shall be reflectorized both internally and externally. Glass beads shall be applied to the materials at a uniform rate sufficient to achieve uniform and distinctive retroreflective characteristics when observed in accordance with Test Method Tex-828-B.
- F. Pavement markings that are not in alignment or sequence, as shown on the Plans or Standards, shall be removed and replaced at the sole expense of the Contractor.

505.6

SURFACE PREPARATION

- A. New Portland cement concrete surfaces shall be cleaned to remove curing membrane, dirt, grease, loose and/or flaking existing construction markings and other forms of contamination.
- B. Older Portland cement concrete surfaces and asphalt surfaces that exhibit loose and/or flaking existing markings shall be cleaned to remove all loose and flaking markings.
- C. All pavement on which pavement markings are to be placed shall be completely dry.

505.7

APPLICATION

- A. Unless otherwise shown on the Plans, Portland cement concrete surfaces and asphaltic surfaces that are three (3) years old or older shall be sealed by the use of paint type striping. The paint type markings shall be placed a minimum of two (2) and a maximum of 30 calendar days in advance of placing the thermoplastic type pavement markings. If the paint type markings become dirty for any reason prior to placing the thermoplastic type markings, they shall be cleaned by washing, brushing, compressed air or other means approved. The pavement and paint type marking shall both be thoroughly dry before any thermoplastic type markings are placed. The color of the paint type markings shall be the same as the thermoplastic type markings.



- B. Pavement markings shall not be applied when the temperature and moisture limitations are beyond the Manufacturer's recommendation. The minimum thickness for thermoplastic markings shall be 0.060-inches (60-mil) for edgeline markings and 0.090-inches (90-mil) for stop bars, legends, symbols, gore and centerline/no passing barrier line markings, when measured in accordance with Test Method Tex-854-B. The maximum thickness of all thermoplastic type markings shall be 0.180-inches (180 mil).
- C. All markings which do not meet the specifications found within or are not satisfactory to the striping plan, installation of the markings, or do not meet the requirements of the project, shall be removed and replaced at the sole expense of the Contractor. In the event that damage is done to the pavement surface in the replacement operation, the damage shall be corrected to the satisfaction of the City at the sole expense of the Contractor.

505.8

MEASUREMENT AND PAYMENT

- A. Payment for furnished and installed pavement markings shall be paid according to the unit price per linear foot in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the pavement markings shall be subsidiary to this item.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 506. LIME TREATMENT FOR MATERIALS IN PLACE

506.1 SCOPE OF WORK

- A. This specification covers the requirements for the preparation and treatment of the subgrade, existing subbase or existing base by pulverizing the existing materials; furnishing and applying lime; mixing; mellowing for a minimum of 12 hours and compacting the mixed material to the required depth and density. This item applies to treatment of natural ground, embankment or existing pavement structure and shall be constructed as specified herein and in conformity with the typical sections, lines and grades on the drawings or as directed by the Engineer or designated representative. If the type of lime to be placed is not indicated on the drawings, the Contractor shall use Type B, Commercial Lime Slurry or Type C quick lime pebbles for all applications on areas larger than 100 square feet (10 square meters).

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

506.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including material type, test data, and all other pertinent data to illustrate conformance to the specification found within. Items required for submittal shall include, but are not limited to the following:
1. Mix design information (TxDOT Item 260, “Lime Treatment (Road-Mixed)”),
 2. Type of lime and rate of lime application, and
 3. Equipment proposed for use in proof rolling, pulverizing, mixing, placement and compaction operations.

506.3 MATERIALS

- A. Lime.
1. The lime shall meet the requirements of TxDOT Item 260, “Lime Treatment (Road-Mixed)” for the type of lime specified in the drawings or as directed by the Engineer or designated representative.
 2. When Type B, Commercial Lime Slurry, is specified, the Contractor shall select the “Dry Solids” content to be used in the slurry prior to construction and shall notify the Engineer in writing 5 working days before changing the “Dry Solids” content.
 3. When dry placement of Type C quicklime pebbles are indicated on the Drawings or approved by the Engineer or designated representative, the pebbles shall conform to TxDOT Grade DS (TxDOT Item 264) and shall have a gradation suitable for dry placement.
 4. If lime is furnished in bags, each bag shall bear the manufacturer's certified weight (mass). Bags varying more than 5 percent from that weight (mass) may be rejected and the average weight (mass) of bags in any shipment, as shown by weighing 10 bags selected at random, shall not be less than the manufacturer's certified weight (mass).



- B. Water. The water shall meet the material requirements of TxDOT Item No. 204, “Sprinkling”
- C. Asphalt. The asphalt shall conform to the requirements of TxDOT Item No. 300, “Asphalts, Oils and Emulsions”

506.4

EQUIPMENT

- A. The pulverizing, mixing and proof rolling machinery, tools and equipment, which are necessary for the proper execution of the work, shall be approved by the Engineer or designated representative. The equipment shall be located on the project site prior to the initiation of construction operations.
- B. During the conduct of the Work all in-use machinery, tools and equipment shall be maintained in a satisfactory and workmanlike manner.
- C. Hydrated lime shall be stored and handled in closed, weatherproof containers up to the time that mixing is initiated to form a slurry for distribution on the areas to be treated. If storage bins are used, they shall be completely enclosed. Hydrated lime in bags shall be stored in weatherproof buildings with adequate protection from ground dampness.
- D. If lime is furnished in trucks, each truck shall have the weight (mass) of lime certified on public scales or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer or designated representative.

506.5

CONSTRUCTION METHODS

- A. General
 - 1. Prior to commencement of the work, all required erosion control and tree protection measures shall be in place and the utilities located and protected as specified in the City of Killeen Standard Contract Document Section 205, “Site Conditions” and Section 206 “Contractor Use of Premises”. Construction equipment shall not be operated within the drip line of trees unless otherwise indicated on the drawings or directed by the Engineer or designated representative. Construction materials shall not be stockpiled under the canopies of trees. Excavation or embankment materials shall not be placed within the drip line of trees until appropriate tree wells are constructed.
 - 2. The placement of lime shall not be allowed to adversely impact vegetation, drainageways or waterways, storm water inlets or overflow channels. Structures shall be screened, blocked or protected to prevent lime from entering any structure or waterway.
 - 3. It is the primary requirement of this specification to secure a completed course of treated material, which contains a uniform lime mixture at the rate specified on the drawings or directed by the Engineer or designated representative, is free from loose or segregated areas, exhibits uniform density and moisture content, is well bound for its full depth and displays a smooth surface suitable for placement of subsequent courses. It shall be the responsibility of the Contractor to: regulate the sequence of his work, use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.
- B. Preparation of Subgrade or Existing Base.
 - 1. Unless indicated otherwise on the drawings or directed otherwise by the Engineer or designated representative, the Contractor shall proof roll the roadbed/subgrade in accordance with TxDOT Item No. 216, “Proof Rolling” prior to pulverization or scarification of the existing material and/or subgrade. Any unstable or spongy subgrade



areas identified by proof rolling shall be corrected either by additional re-working, drying and compaction, or by removal and replacement of unsuitable materials. When specifically directed by the Engineer or designated representative, the Contractor shall re-work the subgrade in accordance with TxDOT Item 251, "Reworking Base Courses".

2. Prior to treatment of existing material and/or subgrade the layer to be treated shall be constructed shaped to conform to the typical sections, lines and grades as indicated on the Drawings or as established by the Engineer or designated representative. This work shall be done in accordance with the provisions of applicable bid items. When shown on the Drawings, any existing asphaltic concrete pavement shall be removed and the work will be paid for in accordance with the applicable bid items.
3. When the Contractor elects to use a cutting and pulverizing machine that will process the material to the specified depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided, which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.
4. The material, either before or after lime is applied, shall be excavated to the secondary grade (i.e. proposed depth of lime treatment) and removed or windrowed to expose the secondary grade. The secondary grade shall be blue topped at the edge, 1/4 points and along the centerline at not more than 50-foot (15.25 meters) centers. Any wet or unstable materials, located below the secondary grade, shall be corrected, as directed by the Engineer or designated representative, by removing the unstable material or by scarifying, adding lime and compacting until uniform stability is attained.
5. The Contractor shall instruct their crews in the proper handling of lime to ensure that the workers and the public are adequately protected during lime handling and application operations.

C. Premixing Surface

When any material is uncovered during the premixing operation that exhibits properties different from the anticipated material, the Engineer or designated representative shall secure a sample of the material for appropriate testing to establish a suitable rate of lime application for the material.

D. Lime Application

The percentage of lime to be added by weight (mass) in pounds per square yard (kilograms per square meter) shall be as prescribed by a qualified geotechnical report and may be varied by the Engineer or designated representative if conditions warrant.

Unless otherwise approved by the Engineer or designated representative, the lime operation shall not be started when the air temperature is below 41°F (5°C) and falling, but may be started when the air temperature is above 35°F (2°C) and rising. The temperature will be taken in the shade and away from artificial heat.

Lime shall not be placed when weather conditions in the opinion of the Engineer or designated representative are unsuitable.

Lime shall only be applied to those areas that can be properly processed during the same working day.

The application and mixing of lime with the existing material shall be accomplished by the methods hereinafter described as "Dry Placement" or "Slurry Placement." Dry placement will only be



permitted for small isolated areas as indicated on the drawings or as directed by the Engineer or designated representative. The minimum rate of lime solids application shall be seven (7) percent by weight (mass), unless indicated otherwise on the Drawings or as directed by the Engineer or designated representative.

Any lime exposed to the air for more than six (6) hours and any lime lost or damaged before application due to rain, wind or other cause will be rejected and replaced by the Contractor at its own expense.

1. Dry Placement

The lime shall be spread by a spreader approved by the Engineer or designated representative or by bag distribution at the rates shown on the Drawings or as directed by the Engineer or designated representative.

The lime shall be distributed at a uniform rate and in such manner as to reduce the scattering of lime by wind. Lime shall not be applied when the wind conditions, in the opinion of the Engineer or designated representative, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic. A motor grader will not be used to spread Type A Hydrated lime but may be used to spread Type C Quicklime Grade "DS" pebbles.

The material shall be sprinkled, as approved by the Engineer or designated representative, until the proper moisture content has been secured.

2. Slurry Placement

The lime shall be mixed with water in a mixer or trucks with approved distributors to form a slurry with a solids content approved by the Engineer or designated representative. Application of the slurry shall be attained by successive passes over a measured section of roadway until the proper moisture and lime content has been secured. The distributor truck shall be equipped with an agitator, which will keep the lime and water in a uniform mixture.

E. Mixing

The mixing procedure shall be the same for "Dry Placement" or "Slurry Placement" as herein described.

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

In addition to the above, when Type C Quicklime, Grade "DS", is used under "Dry Placing", the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water, shall be moist cured for two (2) to seven (7) days, as approved by the Engineer or designated representative. After curing, mixing shall continue until the material and lime are thoroughly blended to the satisfaction of the Engineer or designated representative.

The material and lime shall be thoroughly mixed by road pulverizer equipment approved by the Engineer or designated representative. The material and lime shall be brought to the proper moisture content and the mixing shall be continued until a homogeneous, friable mixture of material and lime is obtained. The lime-material mixture shall be free from all clods or lumps so that, when all non-slaking aggregates retained on the #4 (4.75 mm) sieve are removed, the



remainder of the material shall meet the following pulverization requirements, when tested in accordance with TxDOT Test Method Tex-101-E, Part III:

	Percent
Minimum Passing the 1 3/4 inch (45 mm) Sieve	100
Minimum Passing the 3/4 inch (19 mm) Sieve	85
Minimum Passing the No. 4 (4.75 mm) Sieve	60

When the lime-material mixture satisfies the requirements above, the mixture shall be allowed to “mellow” for a minimum of 12 hours prior to the initiation of compaction.

F. Compaction

Prior to initiation of compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. The lime-conditioned materials shall then be shaped and uniformly compacted to the sections; lines and grades indicated on the drawings or as directed by the Engineer or designated representative. Compaction shall continue until the entire depth of mixture is uniformly compacted as shown on the Drawings, as specified herein, or as directed by the Engineer or designated representative.

When shown on the Drawings or approved by the Engineer or designated representative, multiple lifts will be permitted; however the 12-hour “mellowing” procedure is required for each lift. Individual lift thickness should not exceed 8 inches (200 mm).

The course shall be sprinkled as required and compacted to the extent necessary to provide the density specified below:

Description	Density, Percent
For lime-conditioned subgrade, existing subbase or existing base that will receive subsequent subbase or base courses.	Not less than 95% of ‘optimum density’ or as otherwise indicated on the drawings.
For lime-conditioned existing base that will receive surface courses	Not less than 98% of ‘optimum density’ or as otherwise indicated on the drawings.

Testing for the ‘optimum density’ used for compaction control shall conform to TxDOT Test Method Tex-115-E. In addition to the requirements specified for density, the full depth of the material indicated shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed and proof rolled in accordance with Specification Section No. 236S, in place compaction tests will be conducted, as necessary, by the Engineer or designated representative in accordance with TxDOT Test Method, Tex 115-E. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout the entire operation the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the Drawings or as established by the Engineer or designated representative.

If the lime-conditioned material, due to any reason or cause, loses the required stability, density and finish before the next course is placed, it shall be re-compacted and refinished at the sole expense of the Contractor.



G. Reworking a Section

When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the original specified rate of lime application during the reworking operation.

Reworking shall include loosening, road mixing as approved by the Engineer or designated representative, compacting and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with TxDOT Test Method Tex-115-E.

506.6

FINISHING, CURING AND PREPARATION FOR SURFACING

A. After the final layer or course of the lime conditioned subgrade, subbase or base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections indicated on the drawings. The completed section shall then be “finished off” by rolling with a pneumatic tire or other suitable roller, approved by the Engineer or designated representative, that is sufficiently light in loading to prevent hair cracking.

B. The Contractor shall set blue tops at edges, 1/4 point, and along the centerline at not more than 50 foot (15.25 meter) spacing. The completed section shall be maintained in a moist cured condition for the time specified in the table below either by maintenance of moist conditions by water sprinkling or by the prevention of moisture loss due to drying by the addition of an asphalt prime coat as indicated on the drawings or as directed by the Engineer or designated representative at the rate of 0.05 to 0.20 gallons per square yard (0.2 to 0.9 liters per square meter) before further courses are added or any through traffic is permitted, unless otherwise directed by the Engineer or designated representative. Curing shall continue for a minimum of seven (7) days before further courses are added or traffic is permitted access, unless a shorter curing period is approved by the Engineer or designated representative.

Minimum Curing Requirements Before Placing Subsequent Courses

Untreated Material	Curing (Days)
PI ≤ 35	2
PI > 35	5

C. If the drawings require the lime-conditioned material to be sealed or covered by other courses of material, the seal or other course shall be applied within 14 days after final mixing is completed, unless otherwise directed by the Engineer or designated representative. If the 14 day limit cannot be achieved because of insufficient strength gain or other problem with the lime-treated layer, the Contractor shall rework the section in accordance with Section 203S.5(G) above.

506.7

SAMPLING AND TESTING

A. The lime-conditioned mixture shall be tested daily at the Project site for conformance to specification requirements. The Engineer or designated representative shall determine sample locations based on the Contractor’s anticipated production. Each day’s anticipated production shall be sectioned into three (3) equal, single-pass, sub-area lots. Each day’s sample locations shall be equally distributed over the three (3) sub-areas. Also, no more than one location of the three (3) sub-areas is to be located in an irregular shaped area such as a cul-de-sac.

B. When, in the opinion of the Engineer or designated representative, test results appear unrepresentative, additional testing may be authorized. Retesting due to failures or to resolve unrepresentative results will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original testing was erroneous, the original test results will be discarded.



C. The Engineer will obtain samples of completed work to conduct the following tests:

Testing Requirement	TxDOT Test Procedure
Optimum Moisture Density	Test Method Tex-115E
In-Place Density of Lime Conditioning	Test Method Tex 115-E
Thickness of Lime Conditioning	Test Method Tex-140-E & Tex-600-J
PI Reduction	Test Method Tex-106-E

The contractor shall repair areas disturbed while obtaining samples.

506.8

TOLERANCES

A. In-Place Density

The Work may be accepted provided no more than one (1) out of the most recent five (5) density tests performed is below the specified density, provided that the failing test is not more than 3 pounds per cubic foot (50 kilograms per cubic meter) below the specified density.

B. Dimensional

Areas of lime conditioning which do not meet the tolerances specified below will be delineated and shall be corrected to drawing dimensions by scarifying, remanipulating and recompacting the deficient areas at the Contractor's sole expense.

1. Thickness Requirements:

Under thickness shall not exceed 3/4 inch (19 mm). Overthickness will be waived at no additional cost to the City.

2. Widths Requirements:

Roadway under width shall not exceed 6 inches (150 mm). Shoulder underwidth shall not exceed 3 inches (75 mm). If lime conditioning for both roadway and shoulder is constructed at the same time, the 6-inch (150-mm) underwidth tolerance shall apply. Overwidth will be waived at no additional cost to the City.

506.9

MEASUREMENT

A. Lime-conditioning of the type, grade and rate of application on the subgrade, existing subbase and existing base shall be measured by the square yard (square meter: 1 square yard equals 0.836 square meters) to neat lines as shown on the typical sections.

B. Reworking a section to provide the proper compaction shall be measured by the square yard (square meter: 1 square yard equals 0.836 square meters).



PAYMENT

- A. Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for as follows:
- "Lime Treated Subgrade," "Lime Treated Existing Subbase" and "Lime Treated Existing Base" will be paid for at the unit bid price per square yard.
- B. The unit bid prices shall include full compensation for: preparing the roadbed; furnishing all materials; all freight involved; public scales weighing charges or furnishing scales and labor involved in weighing the material; loosening, mixing, pulverizing, spreading, drying, furnishing and application of lime, sprinkling, rolling, shaping, proof rolling, maintenance and all manipulations, reworking, labor, equipment, fuels, tools and incidentals necessary to complete the work.
- C. Reworking a section shall include full compensation for: loosening lime treated layer, furnishing and application of additional lime, road mixing, sprinkling, rolling, shaping, proof rolling, maintenance and all manipulations, labor, equipment, fuels, tools and incidentals necessary to complete reworking.

END OF SECTION



SECTION 500 – TRANSPORTATION SPECIFICATIONS

ITEM 507. GEOGRID

507.1 SCOPE OF WORK

- A. This specification governs the materials, composition, quality, sampling, and testing of synthetic geogrid. Install geogrid in accordance with the lines and grades shown on the plans. Two grades of geogrid, Types 1 and 2, are specified for different loads.

507.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the TxDOT approved Materials Producer List (MPL) or submit to the Engineer or City Staff for approval, technical product literature including material type, test data, and all other pertinent data to illustrate conformance to the specification found within. Items required for submittal shall include, but are not limited to the following:
1. Aperture Size, (in.),
 2. Percent Open Area, %,
 3. Thickness (in.) of MD ribs, CMD ribs, and Junctions,
 4. Tensile Modulus @ 2% elongation (lb./ft.) of MD & CMD
 5. Junction Efficiency, % of rib ultimate tensile strength for MD & CMD

507.3 MATERIALS

- A. Geogrid.
1. The structure should be capable of maintaining dimensional stability during placement and under normal construction traffic.
 2. The geogrid should be resistant to damage during construction, including ultraviolet degradation, and it should have long-term resistance to chemical and biological degradation caused by the materials being reinforced.
 3. The geogrid supplied must meet the requirements listed in Table 1 when sampled and tested in accordance with Tex-621-J.



**Table 1
Geogrid Requirements**

Property	Type 1	Type 2
Aperture Size, mm (in.)	25-51 (1.0-2.0)	25-51 (1.0-2.0)
Percent Open Area, %	70 minimum	70 minimum
Thickness, mm (in.)		
MD ribs	0.77 (0.03 minimum)	1.27 (0.05) minimum
CMD ribs	0.64 (0.025 minimum)	1.15 (0.045) minimum
Junctions	1.50 (0.06) minimum)	2.54 (0.10) minimum
Tensile Modulus @ 2% elongation ¹ , N/m (lb./ft.)		
MD & CMD	204,260 minimum	291,000 minimum
CMD	(14,000) minimum	(20,000) minimum
Junction Efficiency, % of rib ultimate tensile strength		
MD & CMD	90 minimum	90 minimum

507.4 CONSTRUCTION METHODS

A. General

1. Prepare the subgrade as indicated on the plans or as directed. Set string lines for alignment if directed. Install geogrid in accordance with the lines and grades as shown on the plans. Place base material in lift thicknesses and compact as shown on the plans or as directed. Do not operate tracked construction equipment on the geogrid until a minimum fill cover of 6 in. is achieved. Rubber tire construction equipment may operate directly on the geogrid at speeds of less than 5 mph if the underlying material will support the loads. Where excessive substructure deformation is apparent, correct grid placement operations as recommended by the manufacturer or as directed.
 - a. Fabric Placement. Orient the geogrid length as unrolled parallel to the direction of roadway. Overlap geogrid sections as shown on the plans or as directed. Use plastic ties at overlap joints or as directed. Placement of geogrid around corners may require cutting and diagonal lapping. Pin geogrid at the beginning of the backfill section as directed. Keep geogrid taut at the beginning of the backfilling section but not restrained from stretching or flattening.
 1. Longitudinal Joints. Overlap longitudinal joints by a minimum of 1 ft. Space longitudinal ties 10 ft. to 20 ft. or as directed.
 2. Overlap transverse joints by a minimum of 1 ft. Space transverse ties 4 ft. to 5 ft. or as directed.
 - b. Damage Repair. As directed, remove and replace contractor damaged or excessively deformed areas without additional compensation. Lap repair areas a minimum of 3 ft in all directions. Tie each side of repair grid in at least 3 locations but do not exceed normal construction spacing; tie spacing for odd shapes will be as directed. Repair excessively deformed materials underlying the grid as directed.

507.5 TOLERANCES

A. Basis for Rejection

If any individual sample selected at random from 100 rolls or fraction thereof fails to meet any specification requirement, that roll will be rejected. Two additional samples will be taken, one



from each of two other rolls selected at random from the same 100-roll lot or fraction thereof. If either of the additional samples fails to comply with any portion of the Specification, the entire quantity of rolls represented by that sample will be rejected.

507.6 MEASUREMENT

- A. Geogrid base reinforcement will be measured by the square yard of roadway placement as shown in the plans with no allowance for overlapping at transverse and longitudinal joints.

507.7 PAYMENT

- A. Work performed and materials furnished as prescribed by this item and measured as provided under “Measurement” will be paid for at the unit price bid for “Geogrid Base Reinforcement” of the type specified. This price is full compensation for furnishing, preparing, hauling and placing materials including labor, materials, freight, tools, equipment and incidentals.

END OF SECTION



SECTION 600 - WATER

ITEM 601. DUCTILE IRON PIPE AND FITTINGS

601.1 SCOPE OF WORK

- A. This specification covers the requirements to furnish and install ductile iron pipe and ductile iron pipe fittings including bracing, pipe laying, jointing, testing, blocking, and any other work that is required or necessary to complete the installation as shown on the Plans and as specified herein.

601.2 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, technical product literature including the name of the pipe and fitting suppliers and a list of materials to be furnished, completely detailed working drawings and schedules of all ductile-iron pipe and fittings required, prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified herein.

601.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength.
- B. American Water Works Association (AWWA)
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pressure Pipe and Fittings.
 2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
 3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-in for Water and Other Liquids.
 4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. AWWA C115 - Standard for Flanged Ductile-Iron Pipe with Threaded Flanges.
 6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 7. AWWA C153 - Ductile-Iron Compact Fittings, 3-inch Through 16-inch for Water and Other Liquids.
 8. AWWA C600 - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
 9. AWWA C651 - Disinfection Water Mains
- C. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.



- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

601.4

QUALITY ASSURANCE

- A. All ductile-iron pipe and fittings of a given size range shall be from a single Manufacturer. All ductile-iron pipe to be installed under this Contract may be inspected at the foundry for compliance with these Specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of foundry inspection of disapproved pipe will be borne by the Contractor.
- B. Inspection of the pipe will be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

601.5

MATERIALS

- A. Ductile iron pipe shall conform to AWWA C151, be manufactured from metal having a minimum tensile strength of 60,000 psi, a minimum yield strength of 42,000 psi, and a minimum elongation of 10 percent (60-42-10), and be provided in the following minimum pressure classes:
1. 12-inch and smaller, Class 350.
 2. 14-inch through 20-inch, Class 250.
 3. 24-inch, Class 200.
 4. 30-inch and larger, Class 150.
- B. Ductile iron fittings shall conform to AWWA C110 or C153.
- C. All pipe and fittings shall have a bituminous outside coating in accordance with AWWA C151 and C110, respectively. All pipe and fittings shall be cement-mortar lined and seal coated in accordance with AWWA C104. Cement mortar lining shall be double thickness.
- D. Ductile iron pipe with push-on or mechanical joints shall be centrifugally cast pipe in accordance with AWWA C150 and C151.
- E. Restrained joints shall be restrained push-on joints, TR Flex by U.S. Pipe and Foundry; Lok-Fast by American Cast Iron Pipe Company, or equal. Joints shall be suitable for 250 psi working pressure and be fabricated of heavy section ductile iron casting. Bolts and nuts shall be low carbon steel conforming to ASTM A307, Grade B.
- F. Sleeve type couplings shall be of steel and shall be Style 38 by Dresser Manufacturing Division, Smith-Blair or equal. Couplings shall be furnished with black steel bolts and nuts and with pipe stop removed. Gaskets shall be of a material suitable for exposure to liquid within the pipe.



601.6

POLYETHYLENE ENCASEMENT

- A. All buried ductile iron pipe and metallic fittings shall be encased with 8 mil, Type I, Grade E-1, polyethylene film conforming to AWWA C105. Class usage shall be:
 - 1. Class A - Natural Color where exposure to weather (including sunlight) is less than 48 hours total before burial.
 - 2. Class C - Black where exposure to weather (including sunlight) may be more than 48 hours.
- B. Exposure to weather shall be kept to a minimum, and in no case shall it exceed 10 days. The Class of polyethylene used shall be approved by the Engineer.
- C. Polyethylene encasement shall not be paid for separately, but the cost there of shall be included in the appropriate item of the Proposal and Bid Schedule.

601.7

LAYING DUCTILE IRON PIPE AND FITTINGS

- A. Unless otherwise specified on the Plans, pipe shall be installed to clear all utility lines and shall have 42" minimum cover. For water lines to be constructed under a future roadway, the cover may be increased to allow for future paving grades. The depth of cover, where shown on the Plans, is that distance from the top of the pipe to the approximate proposed grade line.
- B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the Engineer. Handling and laying of pipe and fittings shall be in accordance with the Manufacturer's instruction and as specified herein.
- C. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when laid, shall conform to the lines and grades required. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Ductile iron pipe and fittings shall be installed in accordance with the requirements of AWWA C600 except as otherwise provided herein. All piping on this project regardless of size or class shall be placed in the embedment as shown on the detail sheets in the Plans. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.
- C. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the Manufacturer. Fittings, in addition to those shown on the Plans, shall be provided, if required, for crossing utilities which may be encountered upon opening the trench. Solid sleeves shall be used only where approved by the Engineer and the City.
- E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be joined with a bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.
- F. Joints shall be protected by eight (8) mil. Polyethylene film prior to placing concrete. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint.

601.8

PUSH-ON JOINTS

- A. Push-on joints shall be made in accordance with AWWA C111 and the Manufacturer's instructions. Pipe shall be laid with bell ends in the direction of trenching. A rubber gasket shall be inserted in the



groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be laid shall then be aligned and inserted in the bell of the pipe to which it is to be joined and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

601.9 MECHANICAL JOINTS

- A. Mechanical joints shall be made in accordance with Appendix "A" of AWWA C111 and the Manufacturer's instructions. Thoroughly clean and lubricate the joint surfaces and rubber gasket with soapy water before assembly. Bolts shall be tightened to the specified torque.

601.10 RESTRAINED JOINTS

- A. Restrained joints shall be installed where shown on the Plans. The joint assemblies shall be made in accordance with the Manufacturer's recommendations.

601.11 SLEEVE TYPE COUPLINGS

- A. Couplings shall be installed where shown on the Plans. Couplings shall not be assembled until adjoining push-on joints have been assembled. After installation, apply a heavy bitumastic coating to bolts and nuts.

601.12 POLYETHYLENE ENCASEMENT

- A. The polyethylene encasement shall be installed in accordance with either method specified in AWWA C105.

601.13 CONCRETE AND BLOCKING

- A. 2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline, in such manner as will substantially brace the pipe against undisturbed trench walls. Concrete blocking, made from Type I cement, shall have been in place four (4) days prior to testing the pipeline as hereinafter specified. Test may be made in two (2) days after completion of blocking if Type III cement is used.
- B. At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.
- C. Concrete blocking will not be measured or paid for as a separate item but the cost thereof shall be included in the proper items listed in the Proposal and Bid Schedule.

601.14 CLEANING

- A. At the conclusion of the work thoroughly clean all of the new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If obstructions remain after this cleaning, the obstructions shall be removed.

601.15 CONNECTIONS AND APPURTENANCES

- A. The Contractor shall make the alterations and the necessary connections to existing water mains as shown on the Plans. Such connection shall be made at such time and in a manner approved by the City; in each case, when the work is started, it shall be prosecuted expeditiously and continuously until completed.
- B. Fittings, bends, plugs and valves shall be of standard manufacture and mechanical joint type to fit AWWA pipe specifications in Classes A, B, C and D, unless otherwise shown on the Plans.



- C. Payment for fittings and gate valves will be made separately under the appropriate bid items listed in the Proposal and Bid Schedule.

601.16

LEAKAGE TESTING AND STERILIZATION

- A. All Ductile Iron Pipe shall be leak tested and sterilized according to Section 213 – TESTING OF PIPELINES AND MANHOLES.

601.17

PAYMENT

- A. The pipeline, complete in place, including cleanup, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all fittings, specials, valves, etc., and no deduction in length shall be made for such appurtenances. Installation of the pipeline will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals and performing all work that is necessary for the installation, testing, and sterilization of the pipe, fittings, connections, blocking, embedment or placing in encasement pipe and all other appurtenances in accordance with the Plans and the provisions of the Specifications.

END OF SECTION



SECTION 600 – WATER SPECIFICATIONS

ITEM 602. POLYVINYL CHLORIDE (PVC) PIPE-WATER

602.1 SCOPE OF WORK

- A. This specification covers the requirements to install polyvinyl chloride (PVC) water pipe and ductile iron fittings for the water line, including excavation, sheeting, shoring, dewatering, pipe laying, jointing, testing, backfilling and any other work that is required or necessary to complete the installation as shown on the Plans and as specified herein.

602.2 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, technical product literature including the name of the pipe and fittings suppliers, a list of materials to be furnished, shop drawings and schedules of all PVC pipe and fittings required, prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was Manufactured and tested in accordance with the ASTM Standards specified herein.

602.3 QUALITY ASSURANCE

- A. All PVC pipe and fittings of a given size range shall be from a single Manufacturer. The supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 and/or ASTM F758 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of plant inspection of disapproved pipe, will be borne by the Contractor.
- B. Inspections of the pipe may also be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

602.4 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Polyvinyl chloride pipe for water lines, unless otherwise specifically shown on the Plans, or approved in writing, shall be AWWA C900, C905, or C909 with a dimension ratio of 18 (DR-18), for water lines and shall be extruded, be of rubber gasket type, and be furnished in 20-foot nominal laying lengths. All such pipe shall bear a mark denoting approval by the Underwriters' Laboratories of Chicago, Illinois, so that it will be acceptable to the Texas State Fire Insurance Commission for use in fire protection lines without penalty. All joints shall be of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Each size of polyvinyl chloride pipe shall have the same outside diameter as the corresponding size of cast iron pipe.
- B. Fittings shall be ductile iron, mega-lugged or flanged type and shall be Class 250 in accordance with AWWA Specifications C110-77, C-111-80, C115-75 and C153. Flanges shall be faced and drilled in accordance with ASA Standard B16.1, Class 125 unless otherwise shown on the Plans or in the Special Conditions. All fittings shall be tar coated on the outside surface and shall have an interior cement lining with seal coat per AWWA Specifications C104-80 unless otherwise shown or specified.
- C. The Contractor shall obtain installation instructions, including support spacing and solvent welding, from the supplying Manufacturer, shall comply with the instructions, and shall meet the requirements of ASTM D-2855, Standard Recommended Practice for making Solvent Cemented Joints with PVC



Pipe and Fittings. The PVC solvent cement shall comply with ASTM D-2564 and shall be furnished by the pipe and fitting Manufacturer for the class and type of pipe supplied to the project.

602.5

HANDLING AND CUTTING PIPE

- A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction.
- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. All pipe ends shall be square after cutting.
- D. While stored, pipe shall be adequately supported from below at not more than three (3) foot intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

602.6

JOINTING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. PVC pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.

602.7

INSTALLING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Unless otherwise specified on the Plans, polyvinyl chloride pipe shall be installed to clear all utility lines and shall have 42" minimum cover. For water lines to be constructed under a future roadway, the cover may be increased to allow for future paving grades. The depth of cover, where shown on the Plans, is that distance from the top of the pipe to the approximate proposed grade line.
- B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the Engineer. Handling and laying of pipe and fittings shall be in accordance with the Manufacturer's instruction and as specified herein.
- C. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than $\frac{1}{16}$ -inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.
- D. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.
- E. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.
- F. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying.



- G. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, embedment material shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Embedment material shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the embedment material under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Embedment material shall then be placed to 12-inches above the top of the pipe. Next, the varying depths of select material backfill above the embedment material backfill shall be placed according to the Plan Details and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient select material backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the varying depths of select material backfill shall be approved by the pipe Manufacturer's representative prior to use. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell.
- H. Perforated PVC Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM F758 and as specified herein. As soon as the excavation for the trench is complete to normal grade of the bottom of the trench, geotextile fabric shall be laid and then the pea gravel bedding shall be carefully placed (so not to damage the geotextile fabric) and graded to provide uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. Before the perforated pipe is laid on the trench, the perforated pipe shall be wrapped around and closed according to the Manufacturer's closure recommendations with the geotextile fabric. The pipe shall be laid accurately to the lines and grades indicated on the Plans. Blocking under the perforated PVC pipe will not be permitted. Pea gravel shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to gently place the pea gravel under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Making sure not to damage the geotextile fabric, pea gravel shall then be carefully placed above the top of the perforated pipe varying from two to three (2-3) feet depending on the Plans. Once the remaining pea gravel has been placed, overlap or close the geotextile fabric according to the Manufacturer's recommendations or six (6) inches minimum overlap. Then one (1) foot of topsoil shall be placed over the pea gravel to the ground level with proper grass sodding on top.
- I. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.
- J. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- K. Precautions shall be taken to prevent flotation of the pipe in the trench.
- L. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and backfill or embedment material. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, embedment material shall be placed to fill any voids created and the embedment material and backfill shall be recompacted to provide uniform side support for the pipe.



602.8

CONCRETE AND BLOCKING

- A. 2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline, as shown in the Standard Details and in such manner as will substantially brace the pipe against undisturbed trench walls. In no event shall this quantity of concrete blocking be less than those shown in the Plans. Concrete blocking, made from Type I cement, shall have been in place four (4) days prior to testing the pipeline as hereinafter specified. Tests may be made in two (2) days after completion of blocking if Type III cement is used.
- B. At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.
- C. Concrete blocking will not be measured or paid for as a separate item but the cost thereof shall be included in the various items listed in the Proposal and Bid Schedule.

602.9

TESTING AND ALLOWABLE LEAKAGE

- A. All PVC pipe and fittings shall be leak tested and sterilized according to Section 213- TESTING OF PIPELINES AND MANHOLES.

602.10

PAYMENT

- A. The pipeline, complete in place, including cleanup, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all fittings, specials, valves, etc., and no deduction in length shall be made for such appurtenances. Installation of the pipeline will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals and performing all work that is necessary for the installation, testing, and sterilization of the pipe, fittings, connections, blocking, embedment or placing in encasement pipe and all other appurtenances in accordance with the Plans and the provisions of the Specifications.

END OF SECTION



SECTION 600 – WATER SPECIFICATIONS

ITEM 603. VALVES, HYDRANTS AND APPURTENANCES

603.1 SCOPE OF WORK

- A. This specification covers the requirements to provide all buried valves, valves in manholes and underground vaults, hydrants and appurtenances complete with actuators and all accessories as shown on the Plans and as specified herein.

603.2 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, technical product literature including Manufacturer's literature, illustrations, specifications and engineering data which includes dimensions, size, materials of construction, weight, protection coating, and all other pertinent data to illustrate conformance to the specification found within. The Contractor shall also submit four (4) copies of all certified shop test results specified herein, complete operation and maintenance manuals including all copies of all approved shop drawings, and certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests, and certification of proper installation.

603.3 REFERENCE STANDARDS

- A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. American Water Works Association (AWWA)
1. AWWA C500 - Gate Valves, three (3)-inch through 48-inch NPS, for Water and Sewage Systems.
 2. AWWA C502 - Dry-Barrel Fire Hydrants.
 3. AWWA C509 - Resilient-Seated Gate Valves, three (3) inch through 12-inch NPS, for Water and Sewage Systems.
- C. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
 2. ANSI C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- D. American Society for Testing and Materials (ASTM)
1. ASTM A48 - Gray Iron Castings.
 2. ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings
 3. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 4. ASTM A276 - Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes.



- 5. ASTM A536 - Ductile Iron Castings.
- E. Steel Structures Painting Council (SSPC)
 - 1. SSPC SP-6 - Commercial Blast Cleaning
- F. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

603.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site to ensure uninterrupted progress of the work.
- B. Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.
- C. Provide covers for all openings.
 - 1. All valves three (3) inches and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
 - 2. All valves smaller than three (3) inches shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.
- D. Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of City acceptance shall be removed, or the valve shall be removed from the job.
- E. Store all equipment in covered storage off the ground.

603.5 COORDINATION

- A. Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation and site utilities.
- B. Contractor shall coordinate the location and placement of concrete thrust blocks when required.

603.6 GENERAL

- A. All valves shall open counter-clockwise.
- B. The use of a Manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C. Valves shall be of the size shown on the Plans or as noted, and as far as possible equipment of the same type shall be identical and from one Manufacturer.
- D. Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.
- E. Unless otherwise noted, valves shall have a minimum working pressure of 200 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.



- F. Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.
- G. Valves shall be constructed for buried service.

603.7

VALVE BOXES

- A. All gate valves shall be provided with extension shafts (where the operating nut is greater than five (5) feet below grade), operating nuts and valve boxes as follows:
 - 1. Extension shafts shall be steel and the operating nut shall be two (2) inches square. Shafts shall be designed to provide a factor of safety of not less than four (4). Operating nuts shall be pinned to the shafts.
 - 2. Valve boxes shall be selected from the AML and suitable for installation on the buried valves. Covers shall be cast iron with integrally-cast direction-to-open arrow and "WATER" shall be cast in the cover when used on a water line or "SEWER" when used on a wastewater force main. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box. The valve box lid shall be furnished with a pentagon-head bolt for locking.
 - 3. The upper section of each box shall have a bottom flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
 - 4. An approved operating key or wrench shall be provided.
 - 5. All fasteners shall be Type 304 stainless steel.

603.8

RESILIENT SEATED GATE VALVES

- A. Valves shall be manufactured in accordance with AWWA C509.

Acceptable Gate Valves are listed in the AML.
- B. Valves shall be provided with a minimum of two (2) O-ring stem seals.
- C. Bonnet and gland bolts and nuts shall be either fabricated from a low alloy-steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.
- D. Wedges shall be totally encapsulated with rubber.
- E. Units shall be, in addition, UL and FM approved.
- F. Resilient wedge gate valves shall be furnished and installed in sizes and shall be manufactured in accordance with the latest AWWA C-509 and cast iron shall conform to the latest ASTM A-126 standards. Gate valves furnished under these specifications shall be of the solid wedge, resilient seat type with cast iron/ductile iron body and bronze stem designed for 250 pounds per square inch minimum working pressure. All gate valves shall be tested hydrostatically to 400 pounds per square inch. Gate valves shall meet the latest AWWA standard specifications (C-509).
- G. The seat shall be made of Styrene Butadiene rubber and provide a positive water tight seal. The seat shall be permanently bonded or mechanically attached to the wedge with stainless steel screws. If



bonded, ASTM P-429 requirements shall be followed. Non-rising stem gate valves shall be equipped with "O" ring type packing gland consisting of at least two (2) "O" rings. The thrust collar shall work in an "O" ring seal lubricant reservoir or against bearings or washers, above and below constructed of Delrin or approved equal material. Gate valve stems, shall be fabricated from solid bronze rod having a tensile strength of not less than 60,000 pounds per square inch, and a minimum yield strength of 30,000 pounds per square inch.

- H. Cast iron body shall be of iron with an even grain and shall possess a tensile strength of not less than 32,000 pounds per square inch. All bronze castings, except the stem, shall have a tensile strength of not less than 30,000 pounds per square inch. The entire internal valve body surfaces shall be coated with a factory applied two (2) component epoxy system or approved equal. The seating surface shall be machined or otherwise constructed to provide a smooth, even surface for the resilient seat. All valves shall open left (counter clockwise) and have a two (2) inch square wrench nut unless specified otherwise.

603.9

TAPPING SLEEVES AND TAPPING VALVES

- A. Tapping sleeves shall be stainless steel, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe, Mueller, Clow, or equal. Nuts and bolts shall be Type 304 stainless steel.
- B. Size-on-Size tapping sleeve shall be ductile iron or cast iron.
- C. Tapping valves shall conform to the requirements specified above for gate valves except that one (1) end shall be flanged and one (1) mechanical. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters. Tapping valves shall be Ford B81-777 or equal.

603.10

CHECK VALVES

- A. Controlled Closing Swing Check Valves (lever & weight)
 - 1. Check valves shall be of the controlled closing swing type. The controlled closing swing check valves shall be guaranteed to operate under severe conditions as check valves. The valve shall be designed to open smoothly, provide full pipe line flow, permit minimum head loss and close at a controlled rate of speed for the final predetermined portion of its stroke. All bolts and nuts used in the assembly shall be steel, commercial.
 - 2. The valve body shall be Cast Iron ASTM A126-B/ductile iron ASTM A536. The disc arm and chamber level shall be of heavy steel construction and keyed to the hinge shaft. The hinge shaft shall be of 18-8 stainless steel and of adequate diameter to withstand a complete hydraulic unbalance pressure of 125 psi on the valve disc. A single cushioning device mounted on the external side of the valve shall control the valve closure by way of the interchange of oil to and from an oil reservoir. The use of air or gas pressurized oil reservoir shall not be permitted. The oil plunger assembly shall be rigidly attached to the valve body by shoulder bolts or dowel pins to prevent fretting.
 - 3. The Manufacturer, if required by the Engineer or the City, shall submit design calculations of principle component stresses to substantiate the integrity of the valve for the working pressure involved.
 - 4. The valve when closed shall be tight seating by way of a resilient replaceable seat against a bronze seat ring in the body.
 - 5. Valves shall be as listed in the AML. The City reserves the right to inspect all valves before shipment is made. Any failure of valves to operate satisfactorily during the first year of installation due to faulty workmanship or defective material shall be replaced and made good by



the Manufacturer. Under these specifications, any valve stuffing box that leaks for any reason or because of excessive wear or deterioration of packing, shall be reason for classification as defective material.

B. Slanted / Tilted Check Valves

1. Slanted or tilted check valves shall be furnished and installed where shown on the Plans.
2. The body of the valve shall be ductile iron or cast iron with access ports to the disc. The disc shall be cast iron. The seat and disc rings shall be bronze. Pivot pins and bushings shall be bronze or stainless steel. The valve shall include a localized indicator of the position of the valve.
3. The valves shall include a top mounted oil dash pot to prevent slamming of the disc. The dash pot shall control the last 10% of closure of the disc. The speed of closure within this 10% shall be adjustable.
4. Valves shall be as listed in the AML.

603.11 FLANGES

- A. Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Dimensions and drilling of flanges shall be in accordance with the American Standard Association for a working pressure of 125 pounds per square inch. Special drilling shall be provided where necessary.

603.12 FIRE HYDRANTS

- A. Fire hydrants shall be dry-barrel type conforming to the requirements of the latest revision of AWWA C502. Hydrants shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.
- B. Hydrants shall have six (6)-inch mechanical joint inlet connections, two 2½-inch hose connections and one 5¼-inch pumper connection. Threads for the hose and pumper connections shall be in accordance with National Standard Thread. Hydrants shall be according to Manufacturer's standard pattern. Hydrants shall be equipped with "O" ring packing. Each nozzle cap shall be provided with a Buna-N rubber washer.
- C. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism or obstructing the discharge from any outlet. The body of the hydrant shall be equipped with a breakable flange, or breakable cast iron flange bolts, just above the grade line.
- D. A bronze or rustproof steel nut and check nut shall be provided to hold the main hydrant valve on its stem.
- E. Hydrant valve opening shall have an area at least equal to that area of a 5¼-inch minimum diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons per minute minimum through its two 2½-inch hose nozzles when opened together with a loss of not more than two (2) psi in the hydrant.
- F. Hydrants shall be designed for installation in a trench that will provide minimum cover as noted on Plans and for the flange to be 3 ½-inches above ground surface. Hydrant extensions shall be as manufactured by the company furnishing the hydrants and of a style appropriate for the hydrants as furnished.
- G. Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs or



gravity is not acceptable.

- H. Operating stems whose threads are located in the barrel or waterway shall be of manganese bronze, everdur, or other high-quality non-corrodible metal, and all working parts in the waterway shall be bronze to bronze.
- I. Hydrants shall open by turning operating nut to left (counter-clockwise) and shall be marked with a raised arrow and the word "open" to indicate the direction to turn stem to open hydrant.
- J. Hydrants shall be furnished with caps, double galvanized steel hose cap chain, galvanized steel pumper hose cap chain, a galvanized steel chain holder and any other hooks and/or appurtenances required for proper use.
- K. Hydrant operating nut shall be AWWA Standard pentagonal type measuring 1½-inch point to flat.
- L. Hydrants shall be hydrostatically tested as specified in AWWA C502.
- M. Hydrants shall beas listed in the AML.:

- N. All iron work to be set below ground, after being thoroughly cleaned, shall be painted with two (2) coats of asphalt varnish specified in AWWA C502. Iron work to be left above ground shall be factory primed and, with exception of the bonnet, painted flynt aluminum using a high grade enamel paint of quality and color to correspond to the present standard of the City. The bonnet shall be primed only.
- O. Fire hydrants shall be installed on the same side of the street or roadway as the water main and shall be installed plumb and true.
- P. Heel and thrust blocks shall be placed in undisturbed soil as shown in the details of the Plans.

603.13 CORPORATION STOPS

- A. Corporation stops shall be brass, not less than 3/4-inch in diameter and shall be installed where shown, specified or required.
- B. Provide corporation stops from manufacturers listed in the AML.

603.15 SURFACE PREPARATION AND SHOP COATINGS

- A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-6 and painted with two (2) coats of an approved two (2) component coal tar epoxy coating specifically formulated for potable water use. The coating used must appear on the current edition of the United States Environmental Protection Agency's list entitled "Accepted Categories and Subcategories of Coatings, Liners and Paints for Potable Water Usage."
- B. Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6 and given two (2) shop coats of a heavy coat tar enamel or an approved two (2) component coat tar epoxy paint.

603.16 INSPECTION AND PREPARATION

- A. During installation of all valves and appurtenances, the Contractor shall verify that all items are clean, free of defects in material and workmanship and function properly.



- B. All valves shall be closed and kept closed until otherwise directed by the Engineer or the City.

603.17

INSTALLATION OF BURIED VALVES AND VALVE BOXES

- A. Buried valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve.
- B. Before backfilling, all exposed portions of any bolts shall be coated with two (2) coats of bituminous paint.

603.18

INSTALLATION OF TAPPING SLEEVES AND VALVES

- A. The City shall be contacted and their permission granted prior to tapping a line. The required procedures and time table shall be followed exactly.
- B. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be a minimum of $\frac{1}{4}$ -inch less than the inside diameter of the branch line.
- C. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor.
- D. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three (3) feet from a pipe joint.
- E. A tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the Engineer and the City shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.
- F. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

603.19

INSTALLATION OF FIRE HYDRANTS

- A. Fire hydrants shall be set at the locations as shown on the Plans and bedded on a firm foundation. Hydrants and connecting pipe shall have at least the same depth of cover as the distributing pipe. A drainage pit as detailed on the Plans shall be filled with $\frac{3}{4}$ -inch washed rock gravel and compacted. The hydrants shall be set upon a slab of concrete not less than six (6)-inches thick and 24-inches square. During backfilling, additional screened gravel shall be brought up around and six (6) inches over the drain port. Each hydrant shall be set in true vertical alignment and properly braced.
- B. 2,500 psi concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Plans. Eight (8) mil. Polyethylene film shall be placed around the hydrant elbow before placing concrete. CARE SHALL BE TAKEN TO ENSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS.
- C. All connections from the main to the fire hydrants shall be anchoring mechanical joints designed to prevent movement due to thrust or pressure.



- D. The hydrant shall be tied to the pipe with suitable rods or clamps, and shall be coated with Koppers 300 or approved equal at a minimum of 8 mil. thick. Bolts shall have a zinc bolt cover per AWWA. Hydrant paint shall be touched up as required after installation.
- E. Fire hydrants shall be factory primed and, with exception of the bonnet, painted flynt aluminum using a high grade enamel. The bonnet shall be primed only.

603.20

FIELD TESTS AND ADJUSTMENTS

- A. Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of Engineer or the Representative of the City to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided by the Contractor at his/her sole expense.

603.21

PAYMENT

- A. Gate valves, tapping sleeves and tapping valves, and fire hydrants complete in place as shown on the Plans and as specified, will be paid for at the unit contract price per each as provided in the Proposal and Bid Schedule.
- B. The unit price per each installation shall be the total compensation for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work including excavation, base blocking, disposal of surplus materials and backfill in conformance with the Plans and these specifications. The six (6) inch connection pipe, six (6) inch gate valve, concrete collar, thrust block, drain pit, concrete pad, rods, bolts, paint, protective coatings, and fittings for fire hydrants shall not be paid for separately.
- C. Fire hydrants shall be furnished with the proper length of barrel to comply with these specifications. Barrel extensions will not be measured and paid for separately.
- D. No separate payment shall be made for work performed in accordance with this specification, other than that listed in Parts A-C of this subsection, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 600 – WATER SPECIFICATIONS

ITEM 604. ENCASEMENT PIPE

604.1 SCOPE OF WORK

- A. This specification covers the requirements for furnishing and installing encasement pipe complete in place including any required spacers and end plugs as shown on the plans and specified herein.

604.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, technical product literature including type and Manufacturer of pipe, spacers, and end plugs, and all other pertinent data to illustrate conformance to the specification found within.

604.3 GENERAL

- A. Where pipe is required to be installed under highways, streets, or other facilities, construction shall be made in such a manner that will not interfere with the operation of the street, highway, or other facility, and shall not weaken or damage any embankment or structure.
- B. All carrier pipe shall be laid to the required line and grade within the specified limits through the encasement pipe. Carrier pipe shall be handled and placed in the encasement pipe by use of proper skids, wedges, guide rails or other approved means. Care shall be taken that once the pipe is in place to line and grade, it shall not be disturbed or become displaced.

604.4 MATERIALS

- A. Encasement pipe shall be smooth steel 35,000 psi yield strength, ¼” minimum wall thickness; 3/8” minimum wall thickness when crossing TxDOT facility; ½” minimum wall thickness when crossing railroad and sizing according to the following table:

Carrier Size (Inner Diameter)	Minimum Encasement Steel Casing Size (Inner Diameter)
4"	10"
6"	12"
8"	16"
10"	18"
12"	20"
14"	24"
16"	24"
18"	28"
20"	36"
24"	36"
30"	42"



- B. Casing spacers shall be polyethylene (RACI or equivalent). Connecting flanges shall be ribbed for extra strength. Casing spacers shall have runners made of ultra high molecular weight polymer, with a minimum height of two (2) inches. Wedges shall not be used between the top of the carrier pipe and the inside of the easement pipe. Casings spacers shall have a minimum of one (1) inch clear distance between the runners on top of the casing spacers and the inside of the encasement pipe. Prior to inserting the carrier pipe, all water shall be pumped out of the encasement pipe to at least a point where no more than two (2) inches of water remains. Spacers shall be required within at least three (3) feet from both openings of the encasement pipe and spaced no greater than six (6) feet through out the encasement pipe. Casing spacers will not be paid for directly but shall be considered subsidiary to the bid item of encasement pipe. Casing spacers shall be made by Cascade Waterworks MFG Company or approve equal.
- C. End Plugs shall be provided as required and as specified by the pipe manufacturer.
- D. Spiral weld encasement pipe shall not be used.

604.5

PAYMENT

- A. Separate payment will be made for Steel Encasement Pipe per linear foot as called for on the Plans and set forth in the Proposal and Bid Schedule.
- B. All costs incurred for furnishing and installing encasement pipe shall include all labor, materials, tools, equipment and incidentals necessary to perform all work or whatever nature required to complete the specific operation.

END OF SECTION



SECTION 700 – WASTEWATER SPECIFICATIONS

ITEM 701. CONCRETE MANHOLES (WASTEWATER)

701.1 **SCOPE OF WORK**

- A. This specification covers the requirements to install precast concrete manholes, frames and covers, and appurtenances as shown on the Plans and as specified herein.

701.2 **SUBMITTALS**

- A. Within 30 days after the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, shop drawings, product data, materials of construction, and details of installation shall be submitted in accordance with Section 211- SUBMITTALS. Submittals shall include the following: base sections, riser sections, eccentric conical top sections, flat slab tops, grade rings with notarized certificate indicating compliance with ASTM C478, pipe connection to manhole, manhole frame and cover with notarized certificate indicating compliance with ASTM A48, Class 30, method of repair for minor damage to precast concrete sections, manhole lining system.

B. **Design Data**

1. **Precast concrete structures:**

- a. Six (6) copies of sectional plan(s) and elevations showing dimensions and reinforcing steel placement.
- b. Six (6) copies of concrete design mix.

C. **Test Reports**

1. **Precast concrete structures:**

- a. Six (6) copies of concrete test cylinder reports from an approved testing laboratory certifying conformance with specifications.

701.3 **REFERENCE STANDARDS**

A. **American Society for Testing and Materials (ASTM)**

1. ASTM A48 - Specification for Gray Iron Castings.
2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM C33 - Specification for Concrete Aggregates.
4. ASTM C150 - Standard Specification for Portland Cement.
5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
6. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.



- B. American Concrete Institute (ACI)
 - 1. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 2. ACI 350R - Concrete Sanitary Engineering Structures.
- C. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. Standard Specifications for Highway, Streets and Bridges.
- D. Occupational Safety and Health Administration (OSHA)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

701.4

QUALITY ASSURANCE

- A. All material shall be new and unused.
- B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by Engineer or other City representative. Inspection may be made at place of Manufacture, at work site following delivery, or both.
- C. Materials will be examined for compliance with ASTM specifications, these Specifications and approved Manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions(s), blisters, cracks and soundness.
- D. Materials shall be rejected for failure to meet any Specification requirement. Rejection may occur at place of manufacture, at work site, or following installation. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to City.
- E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by Engineer or the City.

701.5

PRODUCTS

- A. Reference to a Manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials/equipment shall be the end products of one Manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and Manufacturer's service.
- C. Provide lifting lugs or holes in each precast section for proper handling.

701.6

PRECAST CONCRETE MANHOLE SECTIONS

- A. Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall conform to ASTM C478 and meet the following requirements:
 - 1. Bottom slab thickness shall be 12-inches.
 - 2. Top section shall be flat slab with a minimum clear opening of 30-inches diameter.
 - 3. Base, riser and transition top sections shall have tongue and groove joints.
 - 4. Sections shall be cured by an approved method.



5. Precast concrete sections shall be shipped after concrete has attained 3,000 psi compressive strength.
 6. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum HS-20 loading plus earth load. Calculate earth load with a unit weight of 130 pounds per cubic foot.
 7. Mark date of manufacture, name and trademark of Manufacturer on the inside of each precast section.
 8. Construct and install precast concrete base as shown on the Plans.
- B. Manhole diameter shall be as shown on the Plans, but not less than required in the wastewater construction standards and details.
- C. Pipe Sections
- Pipe sections shall conform to current specifications for Precast Reinforced Manhole Sections, ASTM Designation C478, with the following additions:
1. Pipe shall be made by a process which will provide for uniform placement of concrete in the form and compaction which will assure a dense concrete in the finished product.
 2. Aggregates for the concrete shall consist of limestone aggregates in the proportion of at least 75% by weight of the total aggregates.
 3. Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM C76 for Class III pipe.
- D. Joints
1. Joints shall conform to the joint specifications in ASTM C478, C76, and ASTM C443. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with mortar or an approved non-shrink grout on the inside and a 6" joint wrap on the outside of the manhole after testing. Grade rings shall be sealed with adhesive to each other and on the inside and outside to provide a waterproof seal.

701.7

MANHOLE FRAME AND COVER

- A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.
- B. Manhole covers shall be per the wastewater construction standards and details and as listed on the AML.



701.8 JOINTING PRECAST MANHOLE SECTIONS

- A. Seal tongue and groove joints of precast manhole sections with rubber gasket. Gasket shall conform to ASTM C443.
- B. Completed joint shall withstand 13 psi internal water pressure without leakage or displacement of gasket or sealant.

701.9 PIPE CONNECTIONS TO MANHOLE

- A. Connect pipe to manhole in the following ways:
 - 1. Flexible sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PSX Press-Seal Gasket or equal.
 - 2. Compression gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok, or equal.

701.10 INSTALLATION

- A. Manhole Installation
 - 1. Manholes shall be constructed to the dimensions shown on the Plans and as specified herein. Protect all work against flooding and flotation.
 - 2. Place manhole base on a bed of gravel six (6) inches in depth as shown on the Plans. Set manhole base so that a maximum grade adjustment of one (1) foot is required to bring the manhole frame and cover to final grade. When located under pavement, a minimum grade adjustment of four (4) inches is required to bring the manhole frame and cover to final grade.

Use precast concrete grade rings with adhesive to adjust manhole frame and cover to final grade.
 - 3. Set precast concrete barrel sections plumb with a $\frac{1}{4}$ -inch maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber "O" ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with non-shrink grout to the satisfaction of the Engineer and the City.
 - 4. No thru lifting holes will be allowed.
 - 5. Core holes in precast sections to accommodate pipes prior to setting manhole sections in place to prevent jarring which may loosen the mortar joints.
 - 6. Backfill carefully and evenly around manhole sections.
- B. Manhole Pipe Connections
 - 1. Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.



C. Setting Manhole Frame and Cover

1. Set manhole covers and frames in an adhesive bed. Utilize precast concrete grade rings, a maximum of one (1) foot thick (a minimum of four (4) inches when under pavement), to assure frame and cover are set to the finished grade. Set manhole frame and cover to final grade prior to placement of permanent paving.

701.11 INTERIOR COATING

A. The interior of wastewater manholes accepting influent from force mains shall be coated with a minimum 100 mils of Raven 405 Lining System, or approved equivalent.

1. Interior surface of each manhole shall be prepared in accordance with applicable industry standards and specific product specification requirements. Sandblasting and/or hydro-demolition with high pressure water may be used to remove existing deterioration, chemical salts, dust, loose concrete, and other debris.
2. Application of bug-hole filler material with primer application prior to application of sprayed epoxy. Coating shall not be sprayed over surfaces with exposed aggregate or un-filled bug-holes.
3. All coating terminations shall be keyed in at the top and bottom of walls, gates, thimbles, pipes, etc.
4. All grease, oils and grime shall be removed by washing with an emulsifying alkaline water-base cleaner with no bio-stimulants, manufactured or approved by the coating manufacturer. Follow with a thorough rinsing.
5. Application of the coating shall be performed by a qualified work crew meeting the manufacturer's standards.
6. Application of the coating shall be in accordance with the manufacturer's standards and shall be a minimum of 100 mils.
7. A certified manufacturer's representative shall be present to observe application of coating and after completion to inspect and certify that product was properly applied.

701.12 TESTS

A. Test each manhole in accordance with Section 213- TESTING OF PIPELINES AND MANHOLES. Engineer or the City's representative shall observe each test (i.e. hydrostatic test, vacuum test).

701.13 CLEANING

A. Thoroughly clean all new manholes of all silt, debris and foreign matter of any kind, prior to final inspections.

701.14 PAYMENT

- A. Payment for furnished and installed manholes shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule.
- B. All work and materials to complete the reinforced concrete pipe including but not limited to excavation, bedding, backfill, connection to pipe, etc. shall be subsidiary to this item.

END OF SECTION



SECTION 700 - WASTEWATER SPECIFICATIONS

ITEM 702. POLYVINYL CHLORIDE (PVC) PIPE-WASTEWATER

702.1 SCOPE OF WORK

- A. This specification covers the requirements to install and test polyvinyl chloride (PVC) pipe and fittings, including excavation, sheeting, storing, dewatering, pipe laying, jointing, testing, backfilling, and any other work that is required or necessary to complete the installation as shown in the Plans as specified herein, complete as shown on the Plans and as specified herein.

702.2 SUBMITTALS

- A. Within 30 days of the Notice to Proceed, the Contractor shall provide a list of materials to be used from the Approved Materials List (AML) or submit to the Engineer or City Staff for approval, technical product literature including the names of the pipe and fittings suppliers, a list of materials to be furnished, shop drawings on required pipes and fittings, certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM Standards specified herein, and all other pertinent data to illustrate conformance to the specification found within.

702.3 QUALITY ASSURANCE

- A. All PVC pipe and fittings of a given size shall be from a single Manufacturer. The Supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of plant inspection of disapproved pipe, will be borne by the Contractor.
- B. Inspections of the pipe may also be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

702.4 POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

- A. Pipe and fittings shall be Type PSM, PVC SDR 26 (pipe) or SDR 35 (fittings) with full diameter dimensions and shall conform to ASTM D3034, or Type PS-46 PVC conforming to ASTM F789, for sizes 4 through 15-inch and shall conform to ASTM F679 for sizes 18 through 27-inch. Straight pipe shall be furnished in lengths of not more than 13-14 feet and wyes shall be furnished in lengths of not more than three (3) feet. Saddle wyes will not be allowed.
- B. PVC pipe and fittings shall have bell and spigot push-on joints. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM F477.
- C. All fittings and accessories shall have bell and/or spigot configurations compatible with the pipe.



HANDLING AND CUTTING PIPE

- A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction.
- B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
- C. All pipe ends shall be square after cutting.
- D. While stored, pipe shall be adequately supported from below at not more than three (3) foot intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

JOINTING POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

- A. PVC wastewater pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.
- B. All manhole connections shall be as shown on the Plans.

INSTALLING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than $\frac{1}{16}$ -inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.
- B. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.
- C. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.
- D. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means.
- E. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell. Blocking under the pipe will not be permitted. The bedding as shown in the details of the Plans, shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. The bedding shall then be placed to 12-inches above the top of the pipe. The initial three (3) feet of backfill above the bedding backfill shall be placed in twelve (12) inch layers and carefully compacted. Generally, the compaction shall be done



evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial three (3) feet of backfill shall be approved by the pipe Manufacturer's representative prior to use.

- F. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.
- G. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- H. Precautions shall be taken to prevent flotation of the pipe in the trench.
- I. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened material shall be placed to fill any voids created and the screened material and backfill shall be re-compacted to provide uniform side support for the pipe.
- J. Pipe stubs for manhole connections shall not exceed 1-joint in length unless directed otherwise by the Engineer or the City. Install caps where required. When connecting to an existing manhole, the opening for the connection of the wastewater pipe and the manhole shall be cored using an approved coring machine to the dimensions and size required to install the flexible "SEAL BOOT" resilient connector that meets the requirements of ASTM C-923. The connection shall be watertight when complete and meet the requirements of Section 704- CONCRETE MANHOLES.

702.8 TESTING

- A. Testing and cleaning of pipe shall be as specified in Section 213- TESTING OF PIPELINES AND MANHOLES.

702.9 PAYMENT

- A. The wastewater line, complete in place, will be measured for payment in linear feet along the centerline of the pipe actually installed. Measurement shall be through all manholes and no deduction in length will be made for such appurtenances. Installation of the wastewater line will be paid for at the unit contract price per linear foot as provided in the Proposal and Bid Schedule.
- B. Payment of the unit contract price for the items of work performed shall be the total compensation for furnishing all labor, materials, tools, testing equipment and incidentals and performing all work that is necessary for the installation of the pipe, fittings, embedment or encasement, and all other appurtenances in accordance with the Plans and the provisions of these specifications.

END OF SECTION



SECTION 700 - WASTEWATER SPECIFICATIONS

ITEM 703. CONNECTIONS TO AND WORK ON THE EXISTING WASTEWATER SYSTEM

703.1 SCOPE OF WORK

- A. This specification covers the requirements to maintain flow in existing sewers, handle existing wastewater flow, construct and maintain all temporary connections and diversions and construct the permanent connections to the new system as shown on the Plans and as directed by the Engineer.

703.2 SUBMITTALS

- A. None required unless specifically called for in the Plans, details, or requested by the Engineer.

703.3 GENERAL

- A. The Contractor shall supply all materials, equipment and labor required for plugging existing wastewater lines, all work on existing manholes (including all work and materials required to reshape existing manhole inverts with concrete and connecting new wastewater lines to existing manholes) and all additional work required.
- B. Should damage of any kind occur that compromises the integrity of the existing wastewater line, manhole, etc., the Contractor shall at his/her own expense, as part of the work under this Section, make repairs to the satisfaction of the Engineer.
- C. The Contractor shall notify the Engineer immediately of any discrepancies in elevations of existing wastewater lines and manholes between those shown on the Plans and those established during construction in order that the Engineer can make the necessary modifications.
- D. All new wastewater pipe for connection shall conform to the pipe specifications in Section 702- POLYVINYL CHLORIDE (PVC) PIPE - WASTEWATER.

703.4 HANDLING WASTEWATER FLOWS

- A. The Contractor shall provide all labor, equipment and materials necessary to maintain existing flows, including temporary diversions and all pumping of sewage that may be required to prevent backing up of wastewater lines and shall immediately remove all offensive matter at his/her own expense.
- B. The Contractor shall not be permitted to overflow, bypass, pump or by any other means convey sewage to any stream, or other water course.
- C. All procedures for maintaining flows must meet the approval of the Engineer and the Contractor shall be required to submit to the Engineer, for approval, a detailed written plan of all methods of flow maintenance 10 days in advance of flow interruption.

703.5 PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 700 - WASTEWATER SPECIFICATIONS

ITEM 704. ABANDONING EXISTING MANHOLES (WASTEWATER)

704.1 SCOPE OF WORK

- A. This specification covers the requirements to abandon existing manholes as shown on the Plans and as specified herein.

704.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including backfill material (source, gradation and type), select backfill material (source, gradation, plasticity index and type), flexible base (binding material, additives, source, gradation and type), equipment and all other pertinent data to illustrate conformance to the specification found within.

704.3 REMOVAL OF MANHOLES SHOWN ON THE PLANS WHICH ARE NOT LOCATED IN THE STREET

- A. Excavate and remove manhole cone, ring, and cover.
- B. Plug all lines entering manhole with concrete.
- C. Backfill with grout or flowable fill to a point 12” above the highest plugged line. Backfill to a point 12” below natural ground surface with compacted native material.
- D. Backfill remaining 12” with suitable topsoil.
- E. Offer manhole ring and cover to Owner for salvage. Remove and dispose of all debris.

704.4 REMOVAL OF MANHOLES SHOWN ON THE PLANS WHICH ARE LOCATED IN THE STREET

- A. Excavate and remove manhole cone, ring, and cover.
- B. Plug all lines entering manhole with concrete.
- C. Backfill with grout or flowable fill to a point 12” above the highest plugged line. Backfill to a point 12” below existing roadway surface with compacted flexible base.
- D. Backfill remaining 12” with flexible base in accordance with Section 504 – FLEXIBLE BASE.
- E. Offer manhole ring and cover to Owner for salvage. Remove and dispose of all debris.

704.5 PAYMENT

- A. Payment for abandoning existing manholes shall be paid according to the unit price per each in the proper item of the Proposal and Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 801. CONCRETE STRUCTURES

801.1 SCOPE OF WORK

- A. This specification covers the requirements for the construction of all types of structures involving the use of structural concrete, except where the requirements are waived or revised by other governing specifications.
- B. All concrete structures shall be constructed in accordance with the design requirements and details shown on the Plans; in conformity with the pertinent provisions of the items contracted for; the incidental items referred to; and in conformity with the requirements herein.

801.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the type of concrete, concrete mix design, concrete type and Manufacturer of precast structures, a description of curing methods used, and all other pertinent data to illustrate conformance to the specification found within.

801.3 MATERIALS

A. Concrete

- 1. All concrete shall conform to the provisions of Section 802, CONCRETE FOR STRUCTURES. The class of concrete for each type of structure or unit shall be as specified on the Plans, or by pertinent governing specifications.

B. Expansion Joint Material

- 1. Preformed Fiber Material - Preformed fiber expansion joint material shall be one-half (½) inch or as shown on the Plans. At the Contractor's option, the material shall be one of the following types, unless otherwise noted on the Plans:
 - a. "Preformed Bituminous Fiber Material" shall meet the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM Designation: D1751.
 - b. "Preformed Non-Bituminous Fiber Material": shall meet the requirements of the Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction ASTM Designation: D1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.
- 2. Joint Sealing Material - Unless otherwise noted on the Plans, the sealer shall be synthetic polymer Sikaflex – ICSL or equivalent.
- 3. Asphalt Board - Asphalt Board shall consist of two liners of 0.016 inches asphalt impregnated paper, filler with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and sufficiently rigid to permit installation. When tested in accordance with Test Method Tex-524-C, the asphalt board shall not deflect from the horizontal more than one (1) inch in three and one half (3 ½) inches.
- 4. Rebonded Neoprene Filler - Rebonded neoprene filler shall consist of ground closed-cell neoprene particles, rebonded and molded into sheets of uniform thickness of the dimensions



shown on Plans.

Filler material shall meet the requirements of ASTM Designations: D1752 Type 1 where applicable.

- C. Expansion Joints - Joints and devices to provide for expansion and contraction shall be constructed as indicated herein or on the Plans.
- D. Placing Reinforcements - Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in the Section 807 – REINFORCING STEEL.
- E. Placing Concrete-General - The minimum temperature of all concrete at the time of placement shall not be less than 50°F.
- F. The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by Fog Spray Only, and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.
- G. The maximum time interval between the addition of cement to the batch, and the placing of concrete in the forms shall not exceed the following:

Air or Concrete Temperature	Maximum Time (Without Retarding Agent)	Maximum Time (With Retarding Agent)
Non-Agitated Concrete		
Up to 80° F	30 Minutes	45 Minutes
Over 80° F	15 Minutes	30 Minutes
Agitated Concrete		
90° F or above	45 Minutes	75 Minutes
Above 75° F to 89° F	60 Minutes	90 Minutes
75° F and below	90 Minutes	120 Minutes

- H. Upon completion of the final finish, interim curing will be required for slab concrete in bridge decks and top slabs of direct traffic culverts as follows:
 - 1. Unless otherwise shown on the Plans, Type 1 membrane curing compound (Resin Base Only) shall be applied to the slab surface.
- I. Required water curing shall begin as soon as it can be done without damaging the concrete finish.
- J. The Contractor shall notify the City two (2) days in advance before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations. Concrete shall not be placed in any unit prior to the completion of form work and placement of reinforcement therein.
- K. Concrete mixing, placing and finishing shall be done in daylight, hours, unless adequate provisions are made to light the entire site of all operations.
- L. Concrete placement will not be permitted when impending weather conditions will impair the quality of the finished work. If rainfall should occur after placing operations are started, the Contractor shall provide ample coverage to protect the work. In case of drop in temperature, the provisions set forth in Section 801.4- PLACING CONCRETE IN COLD WEATHER shall apply.
- M. The sequence of placing concrete shall be as provided on the Plans or as required herein. The placing



shall be regulated so the pressures caused by the plastic concrete shall not exceed the loads used in the form design. Form design shall be the sole responsibility of the Contractor.

- N. The method of handling, placing, and consolidation of concrete shall minimize segregation and displacement of the reinforcement, and produce a uniformly dense and compact mass. Concrete shall not have a free fall of more than 5 feet, except in the case of thin walls such as in culverts. Any hardened concrete splatter ahead of the plastic concrete shall be removed.
- O. The method and equipment used to transport concrete to the forms shall be capable of maintaining the rate of placement approved by the City. Concrete may be transported by bucket, chutes, buggies, belt conveyors, pumps or other acceptable methods.
- P. Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point and running or working it along the forms will not be allowed.
- Q. Concrete shall be deposited in the forms in layers of suitable depth but not more than 36-inches in thickness, unless otherwise directed by the City.
- R. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than one hour shall elapse between adjacent or successive placements of concrete. Unauthorized construction joints shall be avoided by placing all concrete between the authorized joints in one continuous operation.
- S. An approved retarding agent shall be used to control stress cracks, and/or unauthorized cold joints in mass placements where differential settlement and/or setting time may induce stress cracking, such as on false work, in deep girder stems, etc.
- T. Openings in forms shall be provided, if needed, for the removal of laitance or foreign matter of any kind.
- U. All forms shall be wetted thoroughly before the concrete is placed therein.
- V. All concrete shall be well consolidated and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms.
- W. The concrete shall be vibrated immediately after deposit. Prior to the beginning of work, a systematic spacing of the points of vibrations shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30-inches apart, and slowly withdrawn. The vibrator may be inserted in a sloping or horizontal position in shallow slabs. The entire depth of each lift shall be vibrated, allowing the vibrator to penetrate several inches into the preceding lift. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation, and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

801.4

PLACING CONCRETE IN COLD WEATHER

- A. Cast-in-Place Concrete - Concrete may be placed when the atmospheric temperature is not less than 35° F. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32° F.
- B. Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the



minimum specified concrete temperature, the aggregate and/or the water shall be heated uniformly, in accordance with the following:

The water temperature shall not exceed 180° F nor shall the aggregate temperature exceed 150° F. The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 50° F and 85° F before introduction of the cement.

C. All concrete shall be effectively protected as follows:

1. The temperature of slab concrete of all unformed surfaces shall be maintained at 50° F or above for a period of 72 hours from time of placement and above 40° F for an additional 72 hours.
2. The temperature at the surface of all concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottom of slabs, and other similar formed concrete shall be maintained at 40° F or above for a period of 72 hours from time of placement.
3. The temperature of all concrete, including the bottom slabs of culverts placed on or in the ground, shall be maintained above 32° F for a period of 72 hours from time of placement.

D. Protection shall consist of providing additional covering, insulated forms or other means, and if necessary, supplementing such covering with artificial heating. Curing as specified under Section 801.10- CURING CONCRETE, shall be provided during this period until all requirements for curing have been satisfied.

E. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before permission is granted to begin placement.

801.5

PLACING CONCRETE IN HOT WEATHER

A. When the temperature of the air is above 85° F, an approved retarding agent will be required in all concrete used in superstructures, top slabs of direct traffic culverts, and will be required in all cased drilled shafts regardless of temperature. No concrete will be placed any time the temperature of the concrete at placement, exceeds 90° F. Ice will be used to decrease the temperature of concrete. The general formula will be, five (5) pounds of ice per yard of concrete per degree of temperature drop.

801.6

PLACING CONCRETE IN WATER

A. Concrete shall be deposited in water only when specified on the Plans or with written permission of the City. The forms, cofferdams or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted during concrete placing, nor until it has set for at least 36 hours.

B. The concrete shall be placed with a tremie, closed bottom-dump bucket, or other approved method, and shall not be permitted to fall freely through the water nor shall it be disturbed after it has been placed. Its surface shall be kept approximately level during placement

C. The tremie shall consist of a water-tight tube 14-inches or less in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

D. The placing operations shall be continuous until the work is complete.



801.7

PLACING CONCRETE IN BOX CULVERTS

- A. In general, construction joints will be permitted only where shown on the Plans.
- B. Where the top slab and walls are placed monolithically in culverts more than four (4) feet in clear height, an interval of not less than one (1) nor more than two (2) hours shall elapse before placing the top slab to allow for shrinkage in the wall concrete.
- C. The base slab shall be finished accurately at the proper time to provide a smooth uniform surface. Top slabs which carry direct traffic shall be finished as specified under Item 360 "Concrete Pavement" of the Standard Specifications for the Construction of Highways Streets and Bridges of Texas Department of Transportation, latest addition. Top slab of fill type culverts shall be given a reasonable smooth float finish.

801.8

PLACING CONCRETE IN FOUNDATIONS AND SUBSTRUCTURE

- A. Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the City and permission has been given to proceed.
- B. Placing of concrete footings upon seal courses will be permitted after the caissons of cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concrete operation shall be done from a suitable pump located outside the forms.
- C. All temporary walls or braces inside cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in footings or shafts.
- D. When footings can be placed in a dry excavation without the use of cofferdams or caissons, forms may be omitted, if desired by the Contractor and approved by the City, and the entire excavation filled with concrete to the elevation of the top of footing.

801.9

TREATMENT AND FINISHING OF HORIZONTAL SURFACES

- A. All unformed upper surfaces shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

801.10

CURING CONCRETE

- A. The Contractor shall inform the City fully of the methods and procedures proposed for curing; shall provide the proper equipment and material in adequate amounts, and shall have the proposed method, equipment and material approved prior to placing concrete.
- B. Inadequate curing and/or facilities therefore shall be cause for the City to stop all construction on the job until remedial action is taken.
- C. All concrete shall be cured for a period of four (4) curing days except as noted herein.

801.11

EXCEPTIONS TO 4-DAY CURING

- A. When the air temperature is expected to drop below 35° F, the water curing mats shall be covered with polyethylene sheeting, burlap-polyethylene blankets or other material to provide the protection required by Section 801.4- PLACING CONCRETE IN COLD WEATHER.
- B. A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above 50° F for at least 19 hours, (or colder days are satisfactory if provisions are made to maintain the temperature at all surfaces of the concrete above 40° F for the entire 24 hours). The required curing period shall begin when all concrete therein has attained its initial set.



C. The following methods are permitted for curing concrete subject to the restrictions and the following requirements for each method of curing.

1. Form Curing - When forms are left in contact with the concrete, other curing methods will not be required except for cold weather protection.

a. Wet Mat - Cotton mats shall be used for this curing method. They shall be placed as soon as possible after the surface has sufficiently hardened to prevent damage to the concrete. Damp burlap blankets made from nine (9) ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats which may be placed dry and wetted down after placement.

The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces which cannot be cured by contact shall be enclosed with mats, anchored positively to the forms, or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

b. Water Spray - This method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

c. Ponding - This method required the covering of the surfaces with a minimum of two (2) inches of clean granular material, kept wet at all times, or a minimum of one (1) inch depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated sand.

2. Membrane Curing - Unless otherwise provided herein or shown on the Plans, either Type 1-D or Type 2 membrane curing compound in accordance with TxDOT DMS-4650 may be used where permitted. Materials Safety Data Sheets (MSDS) shall be furnished and complied with for the handling and application of membrane curing compounds.

a. For substructure concrete, only one (1) type of curing compound will be permitted on any one (1) structure. (Material requirements and construction methods shall be as required by Section 806 – MEMBRANE CURING except as changed herein.) Membrane shall be applied in a single, uniform coating at the rate of coverage recommended by the Manufacturer and as approved by the City, but not less than one (1) gallon per 180 square feet of area. Tests for acceptance shall be at this specified rate.

b. Membrane curing shall not be applied to dry surfaces, but shall be applied just after free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of applications of the membrane. Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing.

c. When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane which is damaged shall be corrected immediately by reapplication of membrane. Unless otherwise noted herein or on the Plans, the choice of membrane type shall be at the option of the Contractor, except that the City may require the same curing method for like portions of a single structure.



801.12 REMOVAL OF FORMS AND FALSEWORK

- A. Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than one (1) day when Type I or Type II cement is used, and not less than one-half ($1/2$) day when Type III cement is used, provided it can be done without damage to the concrete.

801.13 DEFECTIVE WORK

- A. Any defective work discovered after the forms have been removed shall be repaired as soon as possible in accordance with Section 801.14- FINISHING EXPOSED SURFACES.
- B. If the surface of the concrete is bulged, uneven or shows excess honeycombing or form marks, which in the opinion of the City, cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the Contractor.

801.14 FINISHING EXPOSED SURFACES

- A. Ordinary Surface Finish - An Ordinary Surface Finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher grade or class of finish. Higher grades and classes of finish shall be in accordance with the Plans, Standards or Special Conditions. Where neither a grade nor class of finish is specified, and Ordinary Surface Finish, only, will be required.
- B. Ordinary Surface Finish shall be provided as follows:
 - 1. After form removal, all porous or honeycombed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete.
 - 2. Featheredges shall be eliminated by cutting a face perpendicular to the surface. Shallow cavities shall be repaired using adhesive grout or epoxy grout. If judged repairable by the Engineer or the City, large defective areas shall be corrected using concrete or other material approved by the City.
 - 3. Holes and spalls caused by removal of metal ties, etc., shall be cleaned and filled with adhesive grout or epoxy grout. Exposed parts of metal chairs on surfaces to be finished by rubbing, shall be chipped out to a depth of one-half ($1/2$) inch and the surface repaired.
 - 4. All fins, runs, dips or mortar shall be removed from surfaces which remain exposed. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing.

801.15 PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 802. CONCRETE FOR STRUCTURES

802.1 SCOPE OF WORK

- A. This specification covers the requirements for concrete related materials used for the storing and handling of concrete related materials; and for the proportioning and mixing of concrete for bridges, culverts, pre-stressed concrete, and incidental concrete construction.

802.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the type of concrete, concrete mix design, concrete type and Manufacturer of precast structures, a description of curing methods used, and all other pertinent data to illustrate conformance to the specification found within.

802.3 GENERAL

- A. The concrete shall be composed of Portland cement, aggregates (fine and coarse), admixtures if desired or required, and water, proportioned and mixed as hereinafter provided.
1. Cement - The cement shall be either Type, I, II, or III Portland Cement conforming to ASTM Designation : C150
 2. Mortar (Grout) - Mortar for repair of concrete, shall consist of 1 part cement, two (2) parts finely graded sand, and enough water to make the mixture plastic. When required to prevent color difference, white cement shall be added to produce the color required. When required by the City, latex adhesive shall be added to the mortar.
 3. Admixtures - Calcium Chloride will not be permitted. Unless otherwise noted, Air-entraining, retarding and water reducing admixtures may be used in all concrete and shall conform to the requirements of the Standard Specification for Construction of Highways, Streets, and Bridges of the Texas Department of Transportation, latest edition.

802.4 CLASSIFICATION AND MIX DESIGN

- A. It shall be the responsibility of the Contractor to furnish the mix design, using a Coarse Aggregate Factor acceptable to the City, for the class(es) of concrete specified. The mix shall be designed by a qualified concrete technician to conform with the requirements contained herein and in accordance with current Texas Department of Transportation standards. The Contractor shall perform, at his own expense, the work required to substantiate the design. Complete concrete design data shall be submitted to the City for approval.
- B. It shall also be the responsibility of the Contractor to determine and measure the batch quantity of each ingredient, including all water, so that the mix conforms to these specifications and any other requirements shown on the Plans.
- C. In lieu of the above mix design responsibility, the Contractor may accept a design furnished by the City, however, this will not relieve him of providing concrete meeting the requirements of these specifications.



QUALITY OF CONCRETE, GENERAL

- A. The concrete shall be uniform and workable. The cement content, maximum allowable water cement ratio, the desired and maximum slump and the strength requirements of the various classes of concrete shall conform to the requirements of Tables 1 - 4 and as required herein.

Table 1

Concrete Designation	Desired Slump	Max. Slump
Structural Concrete		
(1) All Drill Shaft	6	7
(2) Uncased Drilled Shafts, Thin-Walled Sections (9" or less), and Prestressed Concrete Members	4	5
(3) Slabs, Caps, Columns, Piers, Wall Sections Over 9", etc.	3	4
Underwater or Seal Concrete	6	7

Riprap, Curb, Gutter and Other Miscellaneous Concrete

As specified by City

NOTE: NO CONCRETE WILL BE PERMITTED WITH SLUMP IN EXCESS OF THE MAXIMUMS SHOWN.

B. Coarse Aggregate

Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof and shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. When white portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by weight of clay lumps, nor more than one (1) percent by weight of shale, nor more than five (5) percent by weight of laminated and/or friable particles when tested in accordance with Test Method Tex-413-A. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method Tex-410-A.

Unless otherwise shown on the Plans, coarse aggregate from each source will be subjected to five (5) cycles of both the sodium sulfate and the magnesium sulfate soundness test in accordance with Test Method

Tex-411-A. When the loss is greater than 12-percent with sodium sulfate and/or 18 percent with magnesium sulfate, further testing will be required prior to acceptance or rejection of the material. A satisfactory record under similar conditions of service and exposure will be considered in the evaluation of material failing to meet these requirements.

When tested in accordance with Test Method Tex-401-A, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements shown in Table 2.



Table 2
COARSE AGGREGATE GRADATION CHART

Percent Retained on Each Sieve										
Aggregate Grade No.	Nominal Size in.	2-1/2 in.	2 in.	1-1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8
1	2	0	0-20	15-50		60-80			95-100	
2 (467)*	1-1/2		0	0-5		30-65		70-90	95-100	
3	1-1/2		0	0-5		10-40	40-75		95-100	
4 (57)*	1			0	0-5		40-75		90-100	95-100
5 (67)*	1/4				0	0-10		45-80	90-100	95-100
6 (7)*	1/2					0	0-10	30-60	85-100	95-100
7	3/8						0	5-30	75-100	
8	3/8						0	0-5	35-80	90-100

* Numbers in parenthesis indicate that these gradations conform to corresponding ASTM gradation in ASTM C33.

C. Fine Aggregate

Fine Aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or Manufactured sand or a combination thereof, with or without a mineral filler. When white Portland cement is specified the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5-percent by weight of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method Tex-408-A, the test result shall not show a color darker than standard.

Unless otherwise shown on the Plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall be not less than 60 percent by weight when tested in accordance with Test Method Tex-612-J.

When tested in accordance with Test Method Tex-401-A, the fine aggregate or combinations of aggregates, including mineral filler shall conform to the gradation requirements shown in Table 3.

Table 3
FINE AGGREGATE GRADATION CHART

Percent Retained on Each Sieve								
Aggregate Grade No.	3/8 in.	No. 4	No. 8	No. 16	No. 30	No.50	No. 100	No. 200
1	0	0-5	0-20	15-50	35-75	65-90	90-100	97-100

1. Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.
2. Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 65 to 94 percent.
3. Fine aggregate will be subjected to the Sand Equivalent Test (Test Method Tex-203-F). The sand equivalent shall not be less than 80 unless otherwise shown on the Plans.
4. For all classes of concrete, except class K, the fineness modulus shall be between 2.30 and



3.10 as determined by Test Method Tex-402-A. The fineness modulus for class K shall be 2.6 to 2.8 unless otherwise shown on the Plans.

5. Air-entrain all concrete except for Class B in accordance with Table 5 unless otherwise shown on the plans. Use moderate exposure values unless otherwise specified. If the air content is more than 1½ 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 1½ but less than 3 percentage points above the required air, the concrete may be accepted based on strength tests.

Table 4
SLUMP REQUIREMENTS

Class of Conc.	Sacks of Cement per C. Y.	Min. Comp Strength 28 (f'c) 28 Day psi	Min Beam Strength 7 Day	Max. Water Cement Ratio gal/sack	Coarse Aggr. No.
A	5.0	3000	425 390 (3)	6.5	1-2-3-4-8 (1) (4)
B	4.5	2500	300	8.0	2-3-4-5-6-7
C	6.0	3600	510	6.0	1-2-3-4-5-
D	3.0	1500	215	11.0	2-3-4-5-6-7
E	6.0	3000	425	6.0	2-3-4-5
S	6.5	4000	570 525 (3)	5.0	2-3-4-5
P	5.0	NA	555 (2)	6.25	2-3
DC	8.75	5500	720	3.6	6
CO	7.0	4600	640	4.5	6
SS	7.0	3600	510	5.5	3-4-5

Table 5
AIR ENTRAINMENT

Nominal Maximum Aggregate Size, in.	% Air ¹	
	Moderate Exposure	Severe Exposure
3/8 (Grades 7 & 8)	6.0	7.5
1/2 (Grade 6)	5.5	7.0
3/4 (Grade 5)	5.0	6.0
1 (Grade 4)	4.5	6.0
1 1/2 (Grades 2 & 3)	4.5	5.5
2 (Grade 1)	4.0	5.0

¹ For specified concrete strengths above 5,000 psi, a reduction of 1 percentage point is permitted.

1. Grade 8 aggregate for use in extended course, unless a larger size is approved by the Engineer or City.
2. Minimum running average of concrete pavement.



3. When Type II or Type I / II is cement is used.
4. Unless otherwise permitted by the Engineer, Grade I coarse aggregate may only be used in massive foundations with four (4) inch minimum clear spacing between reinforcing steel bars. Grade I aggregate may not be used in Drill Shafts.

CLASS OF CONCRETE	TYPICAL USAGE
A	Drill Shafts, Culverts, (except top of slab of Direct Traffic Culverts), Inlets, Manholes, Headwalls, Approach Slabs, Curb, Gutter, Curb and Gutter, Concrete Retards, Sidewalks, Driveways, Concrete Pavement, Back-up Walls and Anchors.
B	Rip Rap, Small Roadside Signs, and Anchors
C	Drilled Shafts, Bridge Substructures, Bridge Railing, Culverts (except top of slab of Direct Traffic Culverts), Wing Walls, Approach Slabs, Concrete Traffic Barriers
D	Rip Rap
E	Seal Concrete
S	Bridge Slab, Top Slab of Direct Traffic Culvert, Bridge Sub-structure
P	Concrete Pavement
DC	Dense Concrete Overlay
CO	Concrete Overlay
SS	Slurry Displacement Shafts, Underwater Drill Shafts

802.6 MIXING CONDITIONS

- A. The concrete shall be mixed in quantities required for immediate use. Retempering of concrete will not be permitted.
- B. In threatening weather, which may result in conditions that will adversely affect quality of the concrete to be placed, the City may order postponement of the work. Where work has been started and changes in weather conditions require protective measures, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, or freezing temperatures. If necessary to continue operations during rainfall, the Contractor shall also provide protective coverings for the material stock piles. Aggregate stock piles need to be covered only to the extent necessary to control the moisture conditions in the aggregates to adequately control the consistency of the concrete.

802.7 PLACING, CURING AND FINISHING

- A. The placing of concrete, including construction of forms and falsework, curing and finishing, shall be in accordance with Section 801- CONCRETE STRUCTURES, and Section 801.14- FINISHING EXPOSED SURFACES.

802.8 TESTING

- A. Fresh Concrete.
 1. Air Content. TEX-414-A or TEX-416-A
 2. Slump. TEX-415-A
 3. Temperature. TEX-422-A



4. Making and Curing Strength Specimens. TEX-447-A
- B. Hardened Concrete. Only compressive strength testing will be used unless otherwise specified or shown on the plans.
1. Compressive Strength. TEX-418-A
 2. Flexural Strength. TEX-448-A
 3. Maturity. TEX-426-A

802.9

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 803. CONCRETE RIPRAP

803.1 SCOPE OF WORK

- A. This specification covers the requirements for the furnishing and placing of riprap concrete of the type indicated on the Plans.
 - 1. Bar reinforcement shall conform to the requirements of Section 807- REINFORCING STEEL. Wire reinforcement shall consist of welded fabric meeting the requirements of the Section 807- REINFORCING STEEL.
- B. Pre-molded expansion joint material shall conform to the requirements of Section 801- CONCRETE STRUCTURES.

803.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including concrete mix design, expansion joint material, curing method, and all other pertinent data to illustrate conformance to the specification found within.

803.3 CONSTRUCTION METHODS

- A. The slopes and other areas to be protected shall be dressed to the line and grade shown on the Plans prior to the placing of riprap.

803.4 CONCRETE RIPRAP

- A. Concrete for riprap shall be placed in accordance with the details and to the dimensions shown on the Plans or as established by the City. Unless otherwise shown by a note on the Plans, concrete riprap shall be reinforced using wire or bar reinforcement.
- B. The class of concrete shall be “Class B”, and shall be in accordance with Section 802- CONCRETE FOR STRUCTURES.
- C. If wire reinforcement is used, it shall be a six-inch by six-inch (6” x 6”) No. 6 plain electric welded reinforcing fabric or its equal. A minimum lap of six (6) inches shall be used at all splices. At the edge of the riprap, the wire fabric shall not be less than one (1) inch or more than three (3) inches from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.
- D. If bar reinforcement is used, the sectional area of steel in each direction shall not be less than the sectional area of the wire fabric described above. The spacing of bar reinforcement shall not exceed 18-inches in each direction and the distance from the edge of concrete to the first parallel bar shall not exceed six (6) inches.
- E. Reinforcement shall be supported properly throughout the placement to maintain in position approximately equidistant from the top and bottom surface of the slab.
- F. If the slopes and/or bottom of the trench for tow walls are dry and not consolidated properly, the City may require the entire area to be sprinkled, or sprinkled and consolidated before the concrete is placed. All surfaces shall be moist when concrete is placed.



- G. After the concrete has been placed, compacted and shaped to conform to the dimensions shown on the Plans, and after it has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface. The concrete shall require a broomed finish in areas of pedestrian traffic.
- H. Immediately following the finishing operation the riprap shall be cured in accordance with Section 801- CONCRETE STRUCTURES.

803.5

PAYMENT

- A. Payment for concrete riprap shall be according to the square yard unit price of concrete placed as shown in the Plans or details. All work and materials involved in preparing forming reinforcing, finishing, etc. shall be subsidiary to the bid item.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 804. CONCRETE CURB AND GUTTER

804.1 **SCOPE OF WORK**

- A. This specification covers the requirements for constructing concrete curb and gutter as shown on the Plans and specified herein.

804.2 **SUBMITTALS**

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including concrete mix design, expansion joint material, curing method, and all other pertinent data to illustrate conformance to the specification found within.

804.3 **GENERAL**

- A. “Concrete Curb and Gutter” shall consist of Portland cement combined concrete curb and gutter or separate concrete approved subgrade or foundation material in accordance with these specifications, in conformity with the lines and grades and details shown on the Plans.

804.4 **MATERIALS**

- A. Unless otherwise specified on the Plans, materials and proportions for concrete used in construction under this item shall conform to the requirements as specified for Class “A” concrete under Section 802- CONCRETE FOR STRUCTURES. Reinforcing steel shall conform to the requirements as specified in Section 807- REINFORCING STEEL. Expansion joint filler shall be pre-molded material meeting the requirements specified in Section 801- CONCRETE STRUCTURES.

804.5 **EQUIPMENT**

- A. If either, required by the Plans or Details, requested by the City or chosen by the Contractor, the curb and gutter shall be machine laid by an extrusion machine approved by the City. When machine laid curb and gutter is used for a project, the line for the top of curb shall be maintained from a guideline set by the Contractor from survey points as established by the Plans, details or contract. The forming tube of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine, to provide the required variable height of the curb and gutter necessary to conform to the established gradeline. In order to provide a continual monitor to the proposed grade of the curb and gutter, a pointer or gauge shall be attached to the machine in such a manner that a comparison can be made between the curb and the guideline. Other methods may be used if prior approval is granted by the City.

804.6 **CONSTRUCTION METHODS**

- A. The subgrade or foundation shall be excavated and shaped to line, grade and cross section, and, if considered necessary in the opinion of the City, hand tamped and sprinkled. If dry, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon.
- B. Outside forms shall be of wood or metal, of a section satisfactory to the City, straight, free of warp and of a depth equal to the depth of the curb and gutter. They shall be securely staked to line and grade, and maintained in a true position during the depositing of concrete. Inside forms for the curb shall be of approved material, shall be of such design as to provide the curb required and shall be rigidly attached to the outside forms. Where specifically permitted by the City in writing, the Contractor may place concrete curb and gutter with an extrusion machine.
- C. The reinforcing steel shall be placed in position as shown on the typical sections. Care shall be



exercised to keep all steel in its proper locations. New curb and gutter shall be doveled into existing curb and gutter, where applicable.

- D. Concrete for curb and gutter shall be mixed in a manner satisfactory to the City. The curb and gutter shall be poured in sections of the length indicated on the Plans, and each section shall be separated by a pre-molded or board joint of cross section specified of the curb and gutter and of the thickness indicated on the Plans. In the event the curb and gutter is placed by an extrusion machine the approved mix shall be fed into the machine in such a manner and consistency that the finished curb and gutter will present a well compacted mass with a surface free from voids and honeycombs. It shall be true to the established shape, line and grade. Any additional surface finishing specified and/or required shall be performed immediately after extrusion.
- E. After the concrete has been struck off and after it has become sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden float. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on Plans. Unless specified otherwise on the Plans, when the concrete in the curb and gutter has become sufficiently set, the inside form shall be carefully removed and the surface shall be plastered with a mortar consisting of one part of Portland cement and two (2) parts fine aggregate. The mortar shall be applied with a template or "mule" made to conform to curb and gutter dimensions as shown on the Plans. All exposed surfaces of curb and gutter, or gutter, shall be brushed to a smooth and uniform surface.
- F. The completed curb and gutter shall be cured in accordance with the requirements of Section 806-MEMBRANE CURING, Type 2, white pigmented, unless shown otherwise on the Plans. Other methods of curing as outlined in Section 801- CONCRETE STRUCTURES will be acceptable with a required curing period of 72 hours.
- G. The curb and gutter shall be backfilled, to the full height of the concrete, tamped and sloped as directed. The curb shall not be backfilled until proper curing time has elapsed to prevent structural damage to the curb.
- H. Any damage to the curb or gutter shall be replaced or repaired at the option of the Engineer or the City at the sole expense of the Contractor.

804.7

PAYMENT

- A. Payment for furnished and installed concrete curb and gutter shall be paid according to the unit price per linear foot in the proper item of the Proposal and Bid Schedule. All work and materials to complete the concrete curb and gutter shall be subsidiary to this bid item.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 805. CONCRETE SIDEWALKS, DRIVEWAYS AND FLATWORK

805.1 **SCOPE OF WORK**

- A. This specification covers the requirements for the construction of sidewalks and driveways on an approved subgrade with or without reinforcing steel, composed of Portland cement concrete, in conformity with the lines and grades established by the Engineer, and the details shown on the Plans.

805.2 **SUBMITTALS**

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer for approval, technical product literature including concrete mix design, expansion joint material, curing method, and all other pertinent data to illustrate conformance to the specification found within. TDLR approvals shall be submitted by the Engineer of Record.

805.3 **MATERIALS**

- A. Materials and proportions used in construction under this item shall conform to the requirements as specified for Class “A” Concrete under Section 802- CONCRETE FOR STRUCTURES unless otherwise shown on the Plans. Reinforcing steel, if required, shall conform to the requirements as specified in Section 807- REINFORCING STEEL. Expansion joint filler shall be pre-molded material meeting the requirements specified in Section 801- CONCRETE STRUCTURES.

805.4 **CONSTRUCTION METHODS**

- A. The subgrade shall be excavated and shaped to line, grade and cross section and if considered necessary in the opinion of the City hand tamped and sprinkled. The subgrade shall be moist at the time the concrete is placed.
- B. Forms shall be of wood or metal, of a section satisfactory to the City, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.
- C. The reinforcing steel, if required, shall be placed in position as shown on the Plans. Care shall be exercised to keep all steel in its proper locations.
- D. Sidewalks shall be constructed in sections of the lengths shown on the Plans. The different sections shall be separated by a pre-molded or board joint of the thickness shown on the Plans, placed vertically and at right angles to the longitudinal axis of the sidewalk. Where the sidewalk or driveways abut a curb or retaining wall, approved expansion material shall be placed along their entire length. Similar expansion material shall be placed around all blockouts and obstructions protruding through sidewalks or driveways.
- E. Concrete shall be mixed in a manner satisfactory to the City, placed in the forms to the depth specified and shaped and tamped until thoroughly compacted and mortar entirely covers the surface. The top surface shall be finished with a wooden float to a rough texture. The outer edges and joints shall then be finished with approved tools to the radii shown on the Plans.
- F. Sidewalks shall be marked into separate sections, each four (4) feet in length, by the use of approved jointing tools.
- G. Sidewalks may be placed with Fibrous Concrete in lieu of reinforced concrete. All concrete for Fibrous Concrete shall conform to the requirements of Section 802- CONCRETE FOR



STRUCTURES. Unless otherwise shown on the Plans the concrete shall be Class "A" as shown in Table 3 in Section 802- CONCRETE FOR STRUCTURES. Reinforcing shall be 100% virgin polypropylene fibrillated fibers specially manufactured for use as concrete reinforcement and meeting the requirements of ASTM C-1116. The fibrous material shall not contain reprocessed olefia. Each container of fibrous material shall bear the Manufacturer's name and its trademark and the net weight of fibrous material in the package. The specific gravity of the fibrous material shall be 0.91 plus or minus 0.05. The lengths of fibrous material shall be ½, ¼, 1 ½, and 2 inches in length. Each cubic yard of concrete shall contain no less than 1.5 pounds of fibrous material unless otherwise shown on the Plans. The fibrous material shall be added to the concrete mix at the time the mix is batched.

805.5

PAYMENT

- A. Payment for work performed in accordance with this section of the specifications shall be made at the unit bid price per square yard under the proper items of the Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 806. MEMBRANE CURING

806.1 **SCOPE OF WORK**

- A. This specification covers the requirements for curing concrete pavement, concrete pavement (base), curbs, curb and gutters, retards, sidewalks, driveways, medians, islands, concrete riprap, cement stabilized riprap, concrete structures and other concrete as indicated on the plans by impervious membrane method.

806.2 **SUBMITTALS**

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the type of membrane curing, the Manufacturer of the method used, a description of the water retention test to be used, and all other pertinent data to illustrate conformance to the specification found within.

806.3 **MATERIALS**

- A. The membrane curing compound shall comply with the “Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete”, ASTM Designation: C 309, Type 1-D clear or translucent, or Type 2 white pigmented in accordance with TxDOT DMS-4650. The material shall have a minimum flash point of 80° F when tested by the “Pensky-Martin Closed Cup Method”.
- B. It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40° F.
- C. It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1-D compound shall contain a fugitive dye that will be distinctly visible for not less than four (4) hours or more than seven (7) days after application.
- D. The compound shall produce a firm, continuous, uniform moisture impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete surface at the rate of coverage specified herein, dry to touch in not more than four (4) hours and shall adhere in a tenacious film without running off or appreciably sagging. It shall not disintegrate, check, peel or crack during the required curing period.
- E. The compound shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.
- F. The compound shall be delivered to the job only in the Manufacturer’s original containers, 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.
- G. The water retention test shall be in accordance with Test Method Tex-219-F. Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percentage moisture loss (at the rate of coverage specified herein) shall not exceed the following:

24 hours after application.....	2 percent
72 hours after application.....	4 percent



CONSTRUCTION METHODS

- A. The membrane curing compound shall be applied after the surface finishing has been completed, and immediately after the free surface moisture has disappeared. The surface shall be sealed with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the Manufacturer and directed by the City, but not less than one (1) gallon per 180 square feet of area. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of applications of the compound.
- B. The compound shall be thoroughly agitated during its use and shall be applied by means of approved mechanical power pressure sprayers. The sprayers used to apply the membrane to concrete pavement or concrete pavement (base) shall travel at uniform speed along the forms and be mechanically driven. The equipment shall be of such design that it will insure uniform and even application of the membrane material. The sprayers shall be equipped with satisfactory atomizing nozzles. Only on small miscellaneous items will the Contractor be permitted to use hand powered spray equipment. For all spraying equipment, the Contractor shall provide facilities to prevent the loss of the compound between the nozzle and the concrete surface during the spraying operations.
- C. The compounds shall not be applied to a dry surface and if the surface of the concrete has become dry, it shall be thoroughly moistened prior to application of membrane by fogging or mist application. Sprinkling or coarse spraying will not be allowed.
- D. At locations where the coating shows discontinuities, pinholes, or other defects; or if rain falls on the newly-coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.
- E. To insure proper coverage, the City shall inspect all treated areas after application of the compound for the period of time designated in the governing specification for curing, either of membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in rounded beads or small pools which can be blown along the surface of the concrete without wetting the surface, the water-impervious film is present. If the water wets the surface of the concrete as determined by obvious darkening of the surface, or by visible soaking into the surface, no water-impervious film is present. Should the foregoing test indicate that any area during the curing period is not protected by the required water-impervious film, additional coat or coats of the compound shall be applied immediately, and the rate of application of the membrane compound shall be increased until all areas are uniformly covered by the required water-impervious film.
- F. When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.
- G. If at any time there is reason to believe that this method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one (1) of the other methods specified under this contract.

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 807. REINFORCING STEEL

807.1 SCOPE OF WORK

- A. This specification covers the requirements for the furnishing and placing of reinforcing steel, deformed and smooth, of the size and quantity designated on the Plans and in accordance with these specifications.

807.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including the type of steel, mill test results, cut list as required by Contract, Plans or Details, type and Manufacturer of spacers and/or chairs, and all other pertinent data to illustrate conformance to the specification found within.

807.3 MATERIALS

- A. Unless otherwise designated on the Plans, all bar reinforcement shall be deformed, and shall conform to one of the following:

1. ASTM A 615, Grades 40 or 60 open hearth, basic oxygen, or electric furnace new billet steel.
2. ASTM A617, Grades 40 or 60, axle steel.
3. ASTM A616, Grade 60, rail steel will be permitted in concrete pavement only. ASTM A616 bars shall be furnished as straight bars only and bending is prohibited. Bend tests will not be required.
4. ASTM A706, Grade 60, weldable reinforcing steel.
5. Smooth Bars for concrete pavement shall have a minimum yield strength of 60 ksi.

All other smooth bars, larger than No. 4, may be steel conforming to the above or may be furnished in any steel that meets the physical requirements of ASTM A36.

6. Spiral reinforcement shall be in accordance with TxDOT Item 440 of the Standards Specifications for Construction of Highways, Streets and Bridges and be either smooth or deformed bars, or wire, of the minimum size or gage shown on the plans, or as specified herein.

Bars for spiral reinforcement shall comply with ASTM A675, Grade 80 (reference to ASTM A29 is voided) A615 or A617, Grade 40, unless otherwise shown on the plans. Smooth wire shall comply with ASTM A82 and deformed wire shall comply with ASTM A496.

7. Wire for fabric reinforcement shall be in accordance with TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges and conform to ASTM A82 or A496. Wire fabric shall conform to ASTM A185 or A497.
8. Epoxy coating material and the material used for the repair of the coating shall be in accordance with TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges.



807.4 BENDING

- A. The reinforcement shall be bent cold, true to the shapes shown on the plans. Fabrication shall preferably be done in the shop. Field fabrication, if permitted, shall be done with equipment approved by the Engineer. Misfabricated, damaged or broken bars shall be rejected and replaced at the Contractor's expense. Damaged or broken bars imbedded in a previous concrete placement may be repaired with the approval of the Engineer. The inside diameter, unless otherwise shown on the plans, shall be in accordance with TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges.

807.5 TOLERANCES

- A. Fabricating tolerances for bars, from plan dimensions, shall not be greater than shown in Figure 1 of TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges.

807.6 STORING

- A. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practical from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross-sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

807.7 SPLICES

- A. The splicing of bars, except when provided on the Plans, or specified herein, will not be permitted without written approval of the City.
- B. Splices not provided for on the plans will be permitted in slabs 15 inches or less in thickness, columns, walls and parapets, but will not be included for measurement, and subject to the following:
- C. Unless otherwise approved by the City, splices will not be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plans length, the distance center to center of splices shall not be less than 30 feet minus one splice length, with no more than one individual bar length less than 10 feet. Lap splices not shown on the plans, but permitted herein, shall be made in accordance with Table 1. The specified concrete cover and proper spacing shall be maintained at such splices and the lap spliced bars placed in contact and securely tied together.

Table 1 – Minimum Lap Requirements for Bar Sizes Through No. 11

SIZE	LAP LENGTH	
	UNCOATED	COATED
No. 3	1'-0"	1'-6"
No. 4	1'-6"	2'-3"
No. 5	1'-10"	2'-9"
No. 6	2'-3"	3'-4"
No. 7	3'-0"	4'-6"
No. 8	3'-9"	5'-7"
No. 9	4'-8"	7'-0"
No. 10	5'-7"	8'-4"
No. 11	6'-7"	9'-10"

Spiral steel shall be lapped a minimum of one turn. Bar sizes No. 14 and No. 18 may not be lapped.



- D. Welded splices shall conform to the requirements of the plans and TxDOT Item 448, “Structural Field Welding”, of the Standard Specifications for Construction of Highways, Streets and Bridges. End preparation for butt welding reinforcing bars shall be done in the field. Delivered bars shall be of sufficient length to permit weld preparation.
- E. Welded wire fabric shall be spliced using a lap length that will include the overlap of a minimum of two (2) cross wires plus two (2) inches on each sheet or roll. Splices using bars which develop equivalent strength and lapped in accordance with Table 1 will be permitted.
- F. For box culvert extensions with less than one (1) foot of fill, the existing longitudinal bars shall have a lap with the new bars as shown in Table 1. For extensions with more than one (1) foot of fill, a minimum of six (6) inch lap will be required.

807.8

MECHANICAL COUPLERS

- A. When shown on the plans, or approved by the City, mechanical splices may be made in the reinforcing steel bars in accordance with TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges.

807.9

PLACING

- A. Reinforcement shall be placed as near as possible in the position shown on the Plans. Unless otherwise shown on the Plans, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than one-twelfth ($1/12$) of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than one-quarter inch. Cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than one and a half ($1 \frac{1}{2}$) inches.
- B. Vertical stirrups shall always pass around the main tension members and be attached securely thereto. The reinforcing steel shall be spaced its required distance from the form surface by means of approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers, or approved pre-cast mortar or concrete blocks. For approval of plastic spacers on a project, representative samples of the plastic shall show no visible indications of deterioration after immersion in a five (5) percent solution of sodium hydroxide for 120 hours.
- C. All reinforcing steel shall be tied at all intersections, except that where spacing is less than one (1) foot in each direction in which case reinforcing site shall be tied at alternate intersections. For reinforcing steel cages for other structural members, the steel shall be tied at a sufficient number of intersections to provide a rigid cage of steel.
- D. Before any concrete is placed, all mortar, mud, dirt, etc. shall be cleaned from the reinforcement. Precast mortar or concrete blocks to be used for holding steel in position adjacent to formed surfaces shall be cast in molds meeting the approval of the City and shall be cured by covering with wet burlap or cotton mats for a period of 72 hours. Mortar for blocks shall contain approximately one (1) part portland cement to three (3) parts sand. Concrete for blocks shall contain nine (9) sacks of portland cement per cubic yard of concrete.
- E. The blocks shall be cast in the form of a frustum of a cone or pyramid with the smaller face placed against the forms.
- F. A suitable tie wire shall be provided in each block, to be used for anchoring to the steel. Except in unusual cases, and when specifically otherwise authorized by the City, the size of the surface to be placed adjacent to the forms shall not exceed two and one-half ($2\frac{1}{2}$) inches square or the equivalent thereof in cases where circular or rectangular areas are provided. Blocks shall be cast accurately to the



thickness required, and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.

- G. Reinforcement shall be supported and tied in such manner that a sufficiently rigid cage of steel is provided. If the cage is not adequately supported to resist settlement or floating upward of the steel, overturning of truss bars, or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to insure compliance with the first paragraph of the Article.
- H. Mats of wire fabric shall overlap each other sufficiently to maintain a uniform strength and shall be fastened securely at the ends and edges.
- I. No concrete shall be deposited until the City has inspected the placement of the reinforcing steel and given permission to proceed. If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, concrete placement will be halted until corrective measures are taken.

807.10

EPOXY COATING OF REINFORCING STEEL

- A. When shown on the plans, coating with epoxy of reinforcing bars, plain wire, deformed wire or welded wire fabric to be used as reinforcement of concrete shall conform to the requirements of TxDOT Item 440 of the Standard Specifications for Construction of Highways, Streets and Bridges.

807.11

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 808. FLOWABLE BACKFILL

808.1 SCOPE OF WORK

- A. This specification covers the requirements for the furnishing and placing of flowable backfill as indicated on the Plans.

808.2 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including flowable backfill mix design, curing method, and all other pertinent data to illustrate conformance to the specification found within.

808.3 CONSTRUCTION METHODS

- A. All trenches to be backfilled shall be properly prepared according to the Plans and Specifications prior to placement of flowable backfill.

808.4 FLOWABLE BACKFILL

- A. Flowable backfill shall be placed in accordance with the details and to the dimensions shown on the Plans or as established by the City.
- B. The mixture shall consist of 188 pounds of Type III Portland cement, 94 pounds of fly ash and 3,000 pounds of sand per cubic yard of flowable backfill.
- C. The minimum allowable slump for flowable backfill is 6-inches.
- D. Immediately following the placement of flowable backfill, it shall be cured in accordance with Section 801- CONCRETE STRUCTURES.
- E. When the temperature of the air is above 85° F, an approved retarding agent will be required in all flowable backfill regardless of temperature. No flowable backfill will be placed any time the temperature of the flowable backfill at placement, exceeds 90° F. Ice will be used to decrease the temperature of flowable backfill. The general formula will be, five (5) pounds of ice per yard of flowable backfill per degree of temperature drop.
- F. 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.

808.5 PAYMENT

- A. Payment for flowable backfill shall be subsidiary to the appropriate bid items of the Proposal and Bid Schedule.

END OF SECTION



SECTION 800 - CONCRETE SPECIFICATIONS

ITEM 809. CONCRETE PAVEMENT

809.1 SCOPE OF WORK

- A. This item shall consist of a pavement and/or base of Portland Cement concrete, with or without reinforcement as indicated on the Drawings, with or without monolithic curbs, constructed as herein specified, on prepared subgrade or base course in conformity with the thickness and typical cross sections indicated on the Drawings. Concrete to be considered of satisfactory quality provided it is made (a) of materials accepted for job, (b) in the proportions established by the Contractor and (c) mixed, placed, finished and cured in accordance with the requirements of this specification.
- B. This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

809.2 SUBMITTALS

The submittal requirements of this specification item may include:

- A. Mix design option(s) of the class of concrete required on the project,
- B. The supplier of the concrete mix design(s) and type of mixing equipment, and
- C. Type of admixtures to be used with the concrete mixes.

809.3 MATERIALS

- A. Cementitious Materials
 - 1. Portland cement shall conform to ASTM C 150, Type I (General Purpose) and Type III (High Early Strength). Type III cement shall be used when high early strength concrete is indicated on the Drawings. If the use of high early cement is not specified and the Contractor desires to use it, he shall obtain written permission from the Engineer or designated representative prior to its use and shall assume all additional costs incurred by the use of such cement. All cement shall be of the same type and from the same source for a project unless written permission is first received from the Engineer or designated representative.
 - 2. Portland cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Commission on Environmental Quality (TCEQ) and the United States Environmental Protection Agency (USEPA). Supplier shall provide current TCEQ and EPA authorizations to operate the facility.
 - 3. Bulk or sacked cement may be used and a bag shall contain 94 pounds (42.6 KG) net. All bags shall be in good condition at the time of inspection. Bulk cement shall be weighed on approved scales as herein prescribed.
 - 4. All cement shall be stored in a suitable weather tight building or bin, which will protect the cement from dampness. The cement shall be so stored as to provide easy access for proper inspection. Any cement, which has become partially set or which contains hard lumps or cakes or cement salvaged from discarded or used bags, shall not be used.



5. Fly ash (denoted by Texas DOT designations Type A and Type B) may replace 20 to 35 percent of a mix design's Portland cement content by absolute volume. Fly ash shall not be used in mix designs with less than 5 sacks of Portland cement per cubic yard [six and a half (6.5) sacks of Portland cement per cubic meter] unless specifically permitted by the Contract plans of project manual. Fly ash shall conform to the requirements of TxDOT Department Material Specification DMS-4610, "Fly Ash".

B. Admixtures

1. Concrete admixtures conforming to TxDOT DMS-4640, "Chemical Admixtures for Concrete" may be used when approved by the Engineer or designated representative to minimize segregation, improve workability, reduce the amount of mixing water and to provide normal hot weather concreting provisions. The use of admixtures shall not alter the approved mix designs, except for water content.

C. Coarse Aggregate

1. Coarse aggregate shall consist of durable particles of gravel, crushed blast furnace slag and/or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or other objectionable material, either free or as an adherent coating on the aggregate. It shall not contain more than 0.25 percent by weight of clay lumps nor more than 1.0 percent by weight of shale nor more than 5.0 percent by weight of laminated and/or friable particles when tested in accordance with TxDOT Test Method Tex-413-A.
2. Coarse aggregate shall have a wear of not more than 45 percent when tested according to TxDOT Test Method Tex-410-A and when tested by standard laboratory methods shall meet the following grading requirements:

Retained on 1 3/4 inch (43.75 mm) sieve	0%
Retained on 1 1/2 inch (37.5 mm) sieve	0 to 5%
Retained on 3/4 inch (19.0 mm) sieve	30 to 65%
Retained on 3/8 inch (9.5 mm) sieve	70 to 90%
Retained on No. 4 (4.75 mm) sieve	95 to 100%

Loss by Decantation TxDOT Test Method *Tex-406-A. 1.0% Maximum

* In the case of aggregate made primarily from crushing of stone. If the material finer than the 200 sieve is definitely established to be the dust of fracture essentially free from clay or shale as established by Part III of TxDOT Test Method Tex-406-A, the percent may be increased to 1.5.

3. When the plans do not require a monolithic pour of curb or curb and gutter, the Contractor may elect to use the following gradation of coarse aggregate for curb or curb and gutter:

Retained on 1 1/2 inch (37.5 mm) sieve	0%
Retained on 3/8 inch (9.5 mm) sieve	5 to 30%
Retained on No. 4 (4.75 mm) sieve	75 to 100%



4. Where the coarse aggregate is delivered on the job in 2 or more sizes or types, each type and/or size shall be batched and weighed separately.
5. All aggregates shall be handled and stored in such a manner as to prevent size segregation and contamination by foreign substances and maintain as nearly as possible in a uniform condition of moisture. When segregation is apparent, the aggregate shall be remixed with suitable equipment as required. At time of its use, the aggregate shall be free from frozen material and aggregate containing foreign materials will be rejected. Coarse aggregate that contains more than 0.5 percent free moisture by weight shall be stockpiled for at least 24 hours prior to use.
6. Adequate storage facilities shall be provided for approved materials. The intermixing of non-approved materials with approved materials either in stockpiles or in bins will not be permitted. Aggregates from different sources shall be stored in different stockpiles unless otherwise approved by the Engineer or designated representative.

D. Fine Aggregate

1. Fine aggregate shall be free from injurious materials of salt, alkali or vegetable matter. It shall not contain more than 0.5 percent by weight of clay lumps. When subjected to the color test for organic impurities, TxDOT Test Method Tex-408-A, the fine aggregate shall not show a color darker than standard.
2. Unless shown otherwise on the drawings, fine aggregate shall have an acid insoluble residue of at least 60% by weight when tested in accordance with Tex 612-J.
3. Unless specified otherwise, fine aggregate shall meet the following grading requirements:

Retained on 3/8 inch (9.5 mm) sieve	0%
Retained on No. 4 (4.75 mm) sieve	0 to 5%
Retained on No. 8 (2.36 mm) sieve	0 to 20%
Retained on No. 16 (1.185 mm) sieve	15 to 30%
Retained on No. 30 (0.600 mm) sieve	35 to 75%
Retained on No. 50 (0.300 mm) sieve	70 to 90%
Retained on No. 100 (0.150 mm) sieve	90 to 100%
Retained on No. 200 (0.075 mm) sieve	97 to 100%

4. Fine aggregate will be subjected to the Sand Equivalent Test, TxDOT Test Method Tex-203-F. The sand equivalent value shall not be less than 80.

E. Mineral Filler

1. Mineral filler shall consist of clean stone dust, crushed sand, crushed shell or other approved inert material. It shall meet the following requirements when tested in accordance with TxDOT Test Method Tex-401-A:

Retained on No. 30 (0.600 mm) sieve	0%
Retained on No. 200 (0.075 mm) sieve	0 to 35%



2. Where fine aggregate is delivered to the job in 2 or more sizes or types, each type and/or size of material shall be batched and weighed separately. Where mineral filler is used, it shall be batched and weighed separately. At the time of its use the fine aggregate shall be free from frozen material and aggregate containing foreign material will be rejected.
3. All fine aggregate shall be stockpiled for at least 24 hours prior to use.

F. Mixing Water

1. Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as Cl nor more than 1,000 parts per million of sulfates as SO₄.
2. Water from municipal supplies approved by the State Health Department will not require testing. Contractor shall sample and test water from other sources and submit test results to the Engineer or designated representative for approval 10 days prior to proposed use.
3. Tests shall be made in accordance with "Standard Method of Test for Quality of Water to be used in Concrete," AASHTO Method T-26.

G. Transit-mixed Concrete

1. The use of transit-mixed (ready-mixed) concrete will be permitted by the Engineer or designated representative provided the batching plant and mixer trucks meet requirements of quality specified herein.
2. When ready-mixed concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the drum of the mixer or agitator truck. Delivery of concrete to the site of the work and its discharge from the truck mixer, agitator or non-agitating equipment shall be in accordance with the requirements of Item TxDOT Item 421, "Hydraulic Cement Concrete."
3. Ready-mixed concrete, batching plant and mixer truck operation shall include the following:
 - a. A ticket system will be used that includes a copy for the construction inspector. The ticket will have machine stamped time/date of the concrete batch, weight of cement, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on the ticket may be cause for rejection of the concrete.
 - b. Sufficient trucks will be available to support continuous slab placements. The Contractor will satisfy the Engineer or designated representative that adequate standby trucks are available to support monolithic placement requirements.
 - c. A portion of the mixing water, required by the batch design to produce the specified slump, may be withheld and added at the job site but only with the permission of the Engineer or designated representative and under the Inspector's observation. When water is added under these conditions, it will be thoroughly mixed before any slump or strength samples are taken.



H. Joint Sealer

1. Unless otherwise shown on the plans, joint sealant for concrete pavement used on airport runways and/or taxiways shall be TxDOT Class 5. All other joint sealant shall be TxDOT Class 2.
2. Joint sealant shall be placed in accordance with the manufacturer's recommended procedures. Apply the primer, when required, at the specified rate.

The sealant material shall have the following properties:

Color	Gray
Flow, MIL-2-8802D, Sec 4.8.4, max	0.2
Working time, minutes	10
Tack-free time at 77°F +/- 2°F (25°C +/- 1.1°C), MIL-2-8802D	
Sec 4.8.7, minutes	60
Cure time at 77°F (25°C), days	7-14
Full Adhesion, days	14-21

As Cured - after 7 days at 77°F (25°C) and 40% Relative Humidity

Elongation, minimum percent	1200
Durometer Hardness, Shore A, ASTM D 2240, min	15
Joint movement capability, percent	+100/-50
Tensile Strength, maximum elongation, percent	100
Peal strength, psi	25 (172 kPa)

- I. Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement.
- J. Joint Filler. Boards for expansion joint filler and for contraction and longitudinal joints shall be of the size, shape and type indicated.
 1. Board shall be obtained from Redwood, Cypress, Gum, Southern Yellow Pine or Douglas Fir timber. They shall be solid heartwood and shall be free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler. With the exception of Redwood and Cypress, all boards shall have a creosote or pentachlorophenol treatment of 6 pounds per cubic foot (96 kg/m³). When oven dried at 230°F (110°C) to a constant weight, the weight of the board per cubic foot (minus treatment), shall not be less than 20 pounds nor more than 35 pounds (not less than 320 nor more than 561 kgs per cubic meter).

K. Asphalt Board

1. Asphalt board when used as indicated shall be of required size, full depth of concrete placement and uniform thickness. When used in transverse joints, it shall conform approximately to shape of the pavement crown as indicated. Asphalt board shall consist



of 2 liners of 0.016-inch (0.4 mm) asphalt impregnated paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout and shall be sufficiently rigid to permit easy installation. Boards that crack or shatter during installing and finishing operations will not be acceptable. Board shall be furnished in lengths equal to 1/2 the pavement width or in lengths equal to the width between longitudinal joints and may be furnished in strips or scored sheets of the required shape. When tested in accordance with TxDOT Test Method Tex-524-C the asphalt boards shall not deflect from the horizontal more than 3/4 inch in 3 1/2 inches (19.3 cm in 90 cm). The asphalt board shall be placed such that they will not interfere with the bonding of the joint sealer.

L. Load Transmission Devices for Expansion and Contraction Joints

1. Approved load transmission devices, when indicated, shall meet the requirements specified herein:
2. Smooth steel bar dowels, used when indicated, shall be of the size and type indicated and shall be open-hearth, basic oxygen or electric-furnace steel conforming to the properties specified for grade 60 in ASTM A 615. The free end of dowel bars shall be smooth and free of shearing burrs.
3. When indicated, one end of each dowel bar shall be encased in an approved cap having an inside diameter of 1/16 inch (16 mm) greater than the diameter of the dowel bar. The cap shall be of such strength, durability and design as to provide free movement of the dowel bar and shall be approved by the Engineer or designated representative prior to use. One end of the cap shall be filled with a soft felt plug or shall be void in order to permit free movement of the dowel bar for a distance equivalent to 150 percent of the width of the expansion joint used. The dowel caps and dowel bars shall be held securely in place by bar ties as indicated on the drawings. Mechanical methods of implanting dowel bars in the plastic concrete may be used when approved by the Engineer or designated representative.
4. Where required, dowel bars shall be coated with a plastic material meeting the requirements indicated.
5. Where red lead and oil bar coating is indicated, the red lead may be of any standard commercial grade and the oil shall be clean and no lighter than Standard No. 30 SAE grade. Approved thinner and dryer may be added to the red lead, but the material upon application shall be of such consistency that will provide a uniform and heavy coating on the bar. Where asphalt bar coating is indicated, the material may be any standard grade of oil asphalt and shall be applied hot. Cutback asphalt will not be permitted for bar coating.

M. Metal Installing Devices for Joint Assembly

1. Metal installing devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes and marker channels, channel caps, etc.) shall be as indicated or may be similar devices of equivalent or greater strength, approved by the Engineer or designated representative, that will secure joint assembly in correct position during the placing and finishing of concrete. Load transmission devices used in joint assemblies shall be secured in position by a transverse metal brace of the type and design indicated or may be secured in position by other approved devices of equivalent or greater strength that will provide positive mechanical connection between the brace and each unit (or than by wire tie) and prevent transverse movement of each load transmission device.



N. Steel Reinforcement

1. Steel reinforcing bars as required including tie bars shall be open-hearth, basic oxygen or electric-furnace new billet steel of Grade 60 or Grade 40 for concrete reinforcement as indicated. Bars that require bending shall be Grade 40 conforming to the requirements of ASTM A 615.
2. High yield reinforcing steel shall be either (a) open-hearth, basic oxygen or electric-furnace new billet steel conforming to ASTM A 615 Grade 60 or (b) rail steel bars for concrete reinforcement, conforming to ASTM A 616 Grade 60. Bars produced by piling method will not be accepted. High yield reinforcing steel bars shall be further identified by a special marking rolled into each bar. All reinforcing steel shall be deformed bars conforming to the requirements of pertinent ASTM Specifications.
3. Where prefabricated deformed wire mats are indicated or permitted, the wire shall be cold worked deformed steel wire conforming to the requirements of ASTM A 496, except that steel shall be made by open-hearth, electric-furnace or basic oxygen processes. The prefabricated deformed wire mats shall conform to the requirements of ASTM A 497, except that wires used shall be deformed and transverse wires shall project beyond the centerline of each edge longitudinal wire as indicated. Mats that have been bent or wires dislocated or parted during shipping or project handling shall be realigned to within 1/2 inch (13 mm) of original horizontal plane of the mat. Mats with any portion of the wires out of vertical alignment more than 1/2 inch (13 mm) after realignment and/or wires dislocated or mutilated so that, in the opinion of the Engineer, they do not represent the original mat, shall be rejected. The reinforcement may be clamped or wired so that the reinforcement will retain the horizontal and vertical alignment as indicated or as approved by the Engineer or designated representative. Deformed wire may be used for tie bars and load transfer bars that require bending. The nominal size, area and theoretical weight of reinforcing steel wires covered by this provision are as listed in Table II. When fabricated steel bars or rod mats are indicated, the mats shall meet requirements of ASTM A 184.
4. Steel wire fabric reinforcement shall be of the gage and spacing indicated and shall conform to the requirements of ASTM A 82. Longitudinal and transverse wires shall be electrically welded together at all points of intersection and the welds shall be of sufficient strength that they will not be broken during handling or placing. All welding and fabrication of fabric sheets shall conform to the requirements of ASTM A 185. Welded steel wire fabric shall be furnished in sheets as indicated and steel having been previously bundled into rolls will not be accepted. An approved hinge will be permitted in each sheet to provide for each sheet longitudinally. When wire fabric is used, it will replace only the longitudinal and transverse bars. The tie bars and load transmission units at joints will not be affected.



Table II: DIMENSIONAL REQUIREMENTS FOR DEFORMED STEEL WIRE FOR CONCRETE REINFORCEMENT

Deformed Wire Size No.	Unit Weight Pounds Per Ft. (Kgs per Meter)	Diameter Inches (Centimeters)	Cross-Sectional Area, Sq. Inches (Sq. Centimeters)	Perimeter Inches (Centimeters)
Column 1	Column 2	Column 3	Column 4	Column 5
D-1	0.034 (.051)	0.113 (.287)	0.01 (.06)	0.355 (.902)
D-2	0.068 (.101)	0.159 (.404)	0.02 (.13)	0.499 (1.267)
D-3	0.102 (.152)	0.195 (.495)	0.03 (.19)	0.612 (1.554)
D-4	0.136 (.202)	0.225 (.572)	0.04 (.26)	0.706 (1.793)
D-5	0.170 (.253)	0.252 (.640)	0.05 (.32)	0.791 (2.009)
D-6	0.204 (.304)	0.276 (.701)	0.06 (.39)	0.867 (2.202)
D-7	0.238 (.354)	0.296 (.752)	0.07 (.45)	0.936 (2.377)
D-8	0.272 (.405)	0.319 (.810)	0.08 (.52)	1.002 (2.545)
D-9	0.306 (.455)	0.338 (.859)	0.09 (.58)	1.061 (2.695)
D-10	0.340 (.506)	0.356 (.904)	0.10 (.65)	1.118 (2.840)
D-11	0.374 (.557)	0.374 (.950)	0.11 (.71)	1.174 (2.982)
D-12	0.408 (.607)	0.390 (.991)	0.12 (.77)	1.225 (3.112)
D-13	0.442 (.658)	0.406 (1.031)	0.13 (.84)	1.275 (3.239)
D-14	0.476 (.708)	0.422 (1.072)	0.14 (.90)	1.325 (3.366)
D-15	0.510 (.759)	0.437 (1.110)	0.15 (.97)	1.372 (3.485)
D-16	0.544 (.810)	0.451 (1.146)	0.16 (1.03)	1.416 (3.600)
D-17	0.578 (.860)	0.465 (1.181)	0.17 (1.10)	1.460 (3.708)
D-18	0.612 (.911)	0.478 (1.214)	0.18 (1.16)	1.501 (3.813)
D-19	0.646 (.961)	0.491 (1.247)	0.19 (1.23)	1.542 (3.917)
D-20	0.680 (1.012)	0.504 (1.280)	0.20 (1.29)	1.583 (4.021)
D-21	0.714 (1.063)	0.517 (1.313)	0.21 (1.35)	1.624 (4.125)
D-22	0.748 (1.113)	0.529 (1.344)	0.22 (1.42)	1.662 (4.221)
D-23	0.782 (1.164)	0.541 (1.375)	0.23 (1.48)	1.700 (4.318)
D-24	0.816 (1.214)	0.553 (1.405)	0.24 (1.55)	1.737 (4.412)
D-25	0.850 (1.265)	0.564 (1.433)	0.25 (1.61)	1.772 (4.500)
D-26	0.884 (1.316)	0.575 (1.461)	0.26 (1.68)	1.806 (4.587)
D-27	0.918 (1.366)	0.586 (1.488)	0.27 (1.74)	1.841 (4.676)
D-28	0.952 (1.417)	0.597 (1.516)	0.28 (1.81)	1.876 (4.765)
D-29	0.986 (1.467)	0.608 (1.544)	0.29 (1.87)	1.910 (4.851)
D-30	1.020 (1.518)	0.618 (1.570)	0.30 (1.94)	1.942 (4.933)
D-31	1.054 (1.569)	0.628 (1.595)	0.31 (2.00)	1.973 (5.011)



- O. Polyethylene Film
1. Polyethylene film shall be opaque pigmented white in color and shall be manufactured from virgin resin without additives or scrap. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period. The film shall have a minimum thickness of 4 mils (0.004 inch), shall have a minimum tensile strength of 1,700 psi at 77°F (11,720 kPa at 25°C) in the longitudinal direction and 1,200 psi at 77°F (8,275 kPa at 25°C) in the transverse direction and shall have a minimum elongation of 200 percent at 77°F (25°C) in the longitudinal direction and 150 percent at 77°F (25°C) in the transverse direction. The permissible percent moisture loss shall not exceed 2 percent after 24 hours and 4 percent after 72 hours. Tests for tensile strength and elongation will be conducted in accordance with ASTM Designation: D 882, Method A. Tests for moisture retention will be conducted in accordance with ASTM Designation: C 156.
- P. Membrane Curing Compound
1. The membrane curing compound shall comply with the “Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete”, ASTM Designation: C 309, Type 1 clear or translucent, or Type 2 white pigmented. The material shall have a minimum flash point of 80° F when tested by the “Pensky-Martin Closed Cup Method”.
- Q. Asphalt Curing
1. 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 emissions. Maintain the emulsion in a mixed condition during application.

809.4

EQUIPMENT

- A. General. All equipment necessary for construction of this item shall be on the Project and shall be approved by Engineer or designated representative as to conditions before the Contractor will be permitted to begin construction operations on which the equipment is to be used. When approved by the Engineer or designated representative in writing, a commercial or independently operated batching plant for measuring materials outside limits of the project may be used.
- B. Mixer. The mixer furnished may be either a paving mixer (operated at site of construction or centrally located), a stationary mixer (central mixer) or a paving mixer (truck mounted) that will produce adequately mixed concrete meeting the specified requirements. The mixer, or mixers, shall conform to the following requirements:
1. Each mixer shall have attached in a prominent place a manufacturer's plate showing rated capacity of the drum in terms of volume of mixed concrete and the recommended speed of rotation of the mixing drum or blades.
 2. The stationary mixer (central mixer) or truck mounted paving mixer shall be operated at the manufacturer's recommended speed.
 3. The size of the paving mixer shall not be less than that of a 27-E paver, as established by the Mixer Manufacturer's Bureau of Associated General Contractors. The paving mixer shall be operated at a drum speed of not less than 16 revolutions per minute and not more than 22 revolutions per minute. Pickup and throw over blades in the drum of the mixer shall be replaced when worn down 3/4 inch (19 mm) or more.



4. Each truck mounted paving mixer shall be approved by the Engineer or designated representative prior to use on the project. It shall be classified as a "paving mixer" by the manufacturer and shall be so designed that a uniform and low slump concrete (approximately 1 1/2 inch [38 mm] slump) can be mixed without aggregate size segregation. The mixer shall be capable of discharging the low slump concrete at a speed of 10 seconds per cubic yard (13 seconds per cubic meter) or faster.
5. Each mixer shall be equipped with an approved automatic device for satisfactorily timing the mix and locking the discharging device in order to prevent the discharging of the mixer before the end of the required mixing period. This timing device shall operate a sounding device to signal plainly the completion of the mixing time. When permitted by the Engineer a light signal device may be used.
6. Multiple drum mixers will be permitted provided their operation is properly synchronized. The mixing time shall be determined exclusive of the time required to transfer concrete from one drum to the next drum.
7. Each mixer shall be equipped with a water-measuring device so constructed that it will measure the water within 1 percent of the total amount required for each batch. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank with a capacity greater than that of the measuring tank and from which the measuring tank will be filled by gravity flow. The measuring tank shall be open to the atmosphere and shall be so placed and constructed that the water for a batch can be discharged into a calibrated tank or weighing device for checking the accuracy of water measurement without seriously delaying the paving operations. The Contractor shall have a calibrated tank or weighing device available at all times at a location satisfactory to the Engineer or designated representative.
8. If a paving mixer is furnished and operated at the site of construction, it shall be equipped with a power controlled boom and bucket, so designed as to permit uniform distribution of the concrete for the full width between pavement forms. Alternate equipment for distributing concrete may be substituted when approved by the Engineer in writing, provided uniform distribution is obtained without segregation.
9. If central mixed concrete is used on the project, the Contractor shall provide equipment designed to provide uniform distribution for the concrete for the full width between pavement forms without segregation.

C. Transit-mix Trucks

When transit-mix (ready-mix) concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to the batch to coat the drum of the mixer or agitator truck. This shall be required for every load of concrete. The mixing speed shall be attained as soon as all ingredients are in the mixer. Each complete batch (containing all the required ingredients) shall be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed.

A portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with permission of the Engineer and under his supervision. When water is added at the job site, 25 revolutions (minimum) at mixing speed, will be required to flush down the blades after charging shall be accurately measured and included in the quantity of mixing water. The introduction of the initial mixing water, except blade wash down water and that permitted in this Article shall be prior to or simultaneous with the charging of the aggregates and cementitious material.



Mixing and agitating speed shall be as designated by the mixer manufacturer. All revolutions after prescribed mixing shall be at agitating speed. Except for short periods of time during discharge, the drum shall be kept in continuous motion from the time the mixing is started until the discharge is completed.

Additional mortar, consisting of 1 sack cement, 3 parts sand and sufficient water, shall be added to the batch to coat the drum of the transit mixer or agitator truck. This shall be required for every load of concrete.

The loading of transit-mixers shall not exceed 63 percent of the drum volume. When used as an agitator only, the loading of truck mixers shall not exceed 80 percent of the drum volume.

The batching plant and transit-mix trucks shall operate under the following system:

1. A ticket system will be used that includes a copy for the construction inspector. The ticket will have machine stamped time/date of water/cement batch; weight of cement, fly ash (if applicable), water, sand and aggregates; exact nomenclature and quantities of admixture. Any item missing or incomplete on the ticket will be cause for rejection. Coded readouts may be used if approved in advance by the Engineer.
2. Sufficient trucks will be available to support continuous placements. The Contractor will satisfy the Engineer that adequate standby trucks are available to support monolithic placement when required.
3. A portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with the permission of the Engineer and under the Inspector's observation. When water is added under these conditions, it will be thoroughly mixed before any slump or strength samples are taken.

D. Hauling Equipment

1. Batch hauling equipment for the transportation of measured materials from the batching plant to the mixer shall be equipped with tight covers, which shall be used to prevent excessive evaporation of moisture or any loss of material.
2. If a central mixer is used, concrete may be transported to the point of delivery in truck agitators or non-agitating trucks.
3. If a truck mounted paving mixer is used, it may be used to transport the concrete after mixing is complete.
4. If non-agitator trucks are used they shall conform to the following requirements:
5. The bed of non-agitating hauling equipment shall be a smooth, mortar-tight, metal container. The hauling equipment shall be capable of delivering the concrete to the work site in a thoroughly mixed and uniform mass and capable of discharging the concrete at a satisfactory controlled rate without segregation. If in the opinion of the Engineer any appreciable segregation or accumulation of excess water and/or mortar occurs on the surface of the concrete, this may be cause for rejection and this method of transporting the concrete to the point of delivery shall be suspended as directed by the Engineer.

E. Subgrade or Subbase Planer and Templates

1. Unless a stabilized subbase is provided, an approved subbase planer shall be provided, mounted on visible rollers riding on the forms and having adjustable cutting blades which



shall trim the subgrade to the exact section as indicated. The planer frame shall be heavy enough to remain on the forms at all times and shall be of such strength and rigidity that, under a test made by changing the support from the wheels to the center, it shall not develop a deflection for more than 1/8 inch (3 mm). Tractive power equipment used to pull the planer shall not be such as to produce ruts or indentations in the subgrade.

2. When the slip form method of paving is to be used, the subgrade planer will be operated on a prepared track grade or controlled by an electronic sensor system operated from a string line that establishes the horizontal alignment and the elevation of the subbase.
3. A template for checking the contour of the subbase shall be provided and operated by the Contractor. The template shall rest upon the side forms and shall be of such strength and rigidity that, under a test made by changing the support to the center, it shall not show a deflection of more than 1/8 inch (3 mm). It shall be provided with accurately adjustable rods projecting downward to the subgrade at 1-foot (30 cm) intervals and these rods shall be adjusted to the required cross section of the bottom of the slab when the template is resting upon the side forms. Where stabilized subbase is provided, use of a scratch template will be required.

F. Forms

1. Side forms shall be of metal of approved cross section. The preferred depth of the form shall be equal to the required edge thickness of the pavement. Forms with depth greater than the required edge thickness of the pavement will be permitted.
2. The length of form sections shall not be less than 10 feet (0.3 meters) and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200-foot (61 meter) radius or less. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible springing or settlement, the impact and vibration of the spreading and finishing machinery. In no case shall the base be less than 6 inches (15.2 cm) for a form 6 inches (15.2 cm) or more in height. The forms shall be free from warps, bends or kinks and shall be sufficiently true to provide a reasonably straight edge on the concrete. The top of each form section, when tested with a straightedge shall conform to the requirements specified for the surface of the completed pavement. Sufficient forms shall be provided for satisfactory prosecution of the work.
3. Outside curb forms shall be of wood or metal of a section satisfactory to the Engineer or designated representative, straight, free of warp and shall be in a depth at least equal to the depth of the curb. They shall be mounted on the paving forms and securely attached thereto and maintained in true position during the placing of the concrete. Inside curb forms, if required, shall be of approved material and of such design as to provide the curb required and shall be rigidly attached to the outside forms.

G. Concrete Spreader

1. Use of concrete spreader shall be required and it shall be a self-propelled machine having sufficient power and traction to spread and strike off concrete without slippage on the forms. It shall be equipped with a power driven device for spreading the concrete uniformly between the forms. The spreading device may be either a reciprocating blade, a screw conveyer or a belt conveyer. The spreader shall be capable of striking off the surface of the concrete between the forms in the longitudinal direction of the slab at any required elevation.



2. Mechanically operated concrete spreaders of other designs, which uniformly distribute the concrete with a minimum of segregation, may be used when approved by the Engineer.

H. Slipform Paver

1. With prior approval, the Contractor may place concrete with slip form paver. This paver shall be equipped with a longitudinal transangular finishing float adjustable to crown and grade and be satisfactory to the Engineer or designated representative. The float shall extend across the pavement practically to the side forms and/or the edge of slab. A “string line” shall be used to provide grade control for the paver.

I. Mechanical Vibratory Equipment

1. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the transverse finishing machine and designed to vibrate the concrete internally and/or from the surface. Vibratory members shall extend across the pavement practically to, but shall not come in contact with the side forms. Mechanically operated vibrators shall be mounted in such manner as not to interfere with transverse or longitudinal joints. The internal-type vibrators shall be spaced at not more than 24 inches (61 cm) and shall be equipped with synchronized vibratory units. Separate vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire width of the pavement. The frequency in air of the interval spud type vibratory units shall be not less than 8,000 cycles per minute and not less than 5,000 cycles per minute for tube types and the method of operation shall be as directed by the Engineer or designated representative. The Contractor shall have a satisfactory tachometer available for checking vibratory the elements.
2. The pavement vibrators shall not be used to level or spread the concrete but shall be used only for purposes of consolidation. The vibrators will not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement, except for the first lift of concrete where double strike off method of placement is employed and the vibrators shall not be operated for more than 15 seconds while the machine upon which they are installed is standing still.
3. The pan type vibratory units shall apply the vibrating impulses directly to the surface of the concrete. The operating frequency shall be not less than 3,500 cycles nor more than 4,200 cycles per minute in air. The Contractor shall have a satisfactory tachometer available for checking the speed of the vibratory elements.
4. Approved hand manipulated mechanical vibrators shall be furnished in the number required for provision of proper consolidation of the concrete along forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.
5. Complete and satisfactory consolidation of the concrete pavement is a most important requirement of this specification. Cores taken shall be carefully examined for voids, honeycombing or other evidence of incomplete consolidation. If such evidence is present, changes in the consolidation procedures and/or equipment will be made to insure satisfactory consolidation.

J. Finishing Equipment

1. Transverse Finishing Machine

The Transverse finishing machine shall be provided with 2 screeds accurately adjusted to the crown of the pavement, shall be self-propelled and mounted in a substantial frame



equipped to ride on the forms, or may be slip form finished, and shall be so designed and operated as to strike off and consolidate the concrete.

2. Longitudinal Finishing

- a. A transverse drag float may be used in lieu of the longitudinal finishing machine with the Engineer's approval. Finishing machines shall be maintained in a tight and good operating condition, accurately adjusted to the required crown or profile and free from deflection, wobble or vibration tending to affect the precision of finish. Machines failing to meet these requirements will be rejected by the Engineer or designated representative and the Contractor shall provide approved equipment.
- b. Where hand finishing is permitted under this specification, the Contractor shall provide a strike template and a tamping template both of 4 by 10 inch (10 by 25 cm) lumber or equivalent metal section and at least 2 feet longer than the width of the pavement. Both templates to conform to the crown section of the pavement and the tamp, if of wood, shall have a steel face not less than 3/8 inch (9.5 mm) in thickness. The Contractor shall also provide a longitudinal float of approved design and not less than 14 feet (4.25 meters) in length.
- c. The Contractor shall furnish and maintain at least two standard 10-foot (3.05 meter) steel straightedges on the work site at all times during the paving operations. The Contractor shall operate same in the presence of the Engineer or designated representative.
- d. The Contractor shall furnish a sufficient number of bridges to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. All necessary finishing and edging tools shall be furnished as may be required to complete the pavement as indicated.

809.5

PROPORTIONING OF CONCRETE

A. Proportions

Concrete shall be composed of Cementitious Materials, fine aggregate, coarse aggregate, mineral filler and/or admixture if used and water, mixed in the proportions designated by the approved Mix Design and in the manner set forth in this specification. On the basis of job and laboratory investigations of the proposed materials, the Contractor will fix proportions by weight of water, coarse aggregate, fine aggregate, cementitious materials, admixture and mineral filler where required, in order to produce concrete of the specified strength and workability for the actual delivery time and site conditions to be encountered. Where curbs are placed separately, the Engineer or designated representative may allow aggregate gradation conforming to Class A Concrete, Section 801, "CONCRETE FOR STRUCTURES."



B. Concrete Strength

The concrete mix to be designed to produce a concrete with the following requirements:

Table 1: CONCRETE PAVEMENT		
Item	Test	Value
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio gal. (liter)/sack, Maximum		6.25 (23.66)
Sacks Cement, Minimum, 94 pounds (42.6 KG) ea		6 per cubic yard (7.85 per cubic meter)
Coarse Aggregate Factor		0.65 min - 0.85 max.
Compressive Strength after 7 Days, psi (kPa)	Tex-418-A	4000 (27,600)
Compressive Strength after 28 Days, psi (kPa)	Tex-418-A	4500 (31,000)
Maximum Concrete Mix Temperature °F (°C)		95 (35)
Retarder: Regular Concrete increase in time over 360S.7(3), minutes, Maximum		60
Table 2: HIGH EARLY STRENGTH CONCRETE		
Item	Test	Value
Cement Type		III
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio gal. (liter)/sack, Maximum		6.25 (23.66)
Sacks Cement, Minimum, 94 pounds (42.6 KG) ea		7 per cubic yard (9.16 per cubic meter)
Coarse Aggregate Factor		0.65 min-0.85 max
Slump, inches (Centimeters)	Tex-415-A	1/2 to 2 (1.25 to 5.0)
Compressive Strength, after 24 hours, psi (kPa)	Tex-418-A	2,100 (14,500)
Compressive Strength, after 3 Days, psi (kPa)	Tex-418-A	2,750 (19,000)
Compressive Strength, after 7 Days, psi (kPa)	Tex-418-A	4,500 (31,000)
Compressive Strength, after 28 Days, psi (kPa)	Tex-418-A	4,925 (34,000)
Maximum Concrete Mix, Temperature °F (°C)		95 (35)



The Contractor may submit a mix design using high range water reducing admixtures conforming to TxDOT Item 421, “Hydraulic Cement Concrete” in lieu of the concrete pavement mix specified and shall meet the following requirements:

Table 3: HIGH RANGE WATER REDUCING ADMIXTURES: SUPERPLASTERSIZER CONFORMING TO SPECIFICATION ITEM NO. 405S, “CONCRETE ADMIXTURES”

Item	Test	Value
Entrained Air	Tex-416-A	3 to 6 percent
Water-Cement Ratio, gal. (liter)/sack, Maximum		6.25
Sacks Cement, Minimum, 94 pounds (42.6 KG) ea		6 per cubic yard (7.85 per cubic meter)
Coarse Aggregate Factor		0.65 min. - 0.85 max.
Slump, inches (cms) before Admixture	Tex-415-A	1/2 to 2 (1.25 to 5)
Slump, Inches (cms) after Admixture	Tex-415-A	4 to 10 (2.5 to 25)
Compressive Strength, after 3 Days, psi (kPa)	Tex-418-A	3,125 (21,500)
Compressive Strength, after 7 Days, psi (kPa)	Tex-418-A	4,500 (31,000)
Compressive Strength, after 28 Days, psi (kPa)	Tex-418-A	4,925 (34,000)
Maximum Concrete Mix, Temperature, °F (°C)		100 (37.8)
Retarder, Regular Concrete Over 360S.7C, Minutes, Maximum		120

Table 4: Over Design Required to Meet Compressive Strength Requirements ¹					
Number of Tests ^{2,3}	Standard Deviation, psi (mPa)				
	300 (20.6)	400 (2.75)	500 (3.44)	600 (4.13)	700 (4.82)
15	470 (3.24)	620 (4.27)	850 (5.85)	1,120 (7.71)	1,390 (9.57)
20	430 (2.96)	580 (3.99)	760 (5.23)	1,010 (6.95)	1,260 (8.67)
30 or more	400 (2.75)	530 (3.65)	670 (4.61)	900 (6.20)	1,130 (7.78)

Notes:

1. When designing the mix, add the tabulated amounts to the minimum design strength in Tables 1, 2 or 3. Maximum water-cement or water-cementitious ratio by weight
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 (6.88 MPa) of the specified strength may be used.
3. If less than 15 prior tests are available, the overdesign should be 1,200 psi (8.26 MPa) for specified strengths from 3,000 to 5,000 psi (20.65 to 34.42 MPa) and 1,400 psi (9.64 MPa) for specified strengths greater than 5,000 psi (34.42 MPa).

High range water reducing admixtures shall be capable of maintaining the original slump until placement and screeding, which may be 2 hours, without the addition of water, additional admixture or other retempering or remixing techniques.



C. Workability of Concrete

Concrete shall be uniformly plastic, cohesive and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface of the pavement after the specified finishing machine has been over a given area twice. Workability shall be obtained without producing a condition such that free water appears on the surface of the slab when being finished as specified. Where water appears on the surface of the concrete after finishing and this condition cannot be corrected by reasonable adjustment in the batch design, the bleeding to be immediately corrected by one of the following measures or a combination of two or more of the following listed measures:

1. Redesign of the batch;
2. Addition of mineral filler to fine aggregates;
3. Increase of cement content; or
4. Use of an approved air entraining agent or approved admixture.

In the event that the measures taken do not eliminate the bleeding immediately, concrete placement operations will be suspended, as directed by the Engineer or designated representative, by placing a bulkhead or "header" as indicated and according to applicable requirements for intentional stoppage of placement of concrete under TxDOT Item 360, "Concrete Pavement" and will remain suspended until such time as additional trial mixes demonstrate that a non-bleeding batch design has been achieved. Failing to achieve a satisfactory laboratory batch design the Contractor will be required to use different materials and to submit samples thereof for additional trial mixes and pilot cylinders.

The mix will be designed with the intention of producing concrete, which will have a slump of 1 1/2 inches (3.8 cms). The slump shall not be less than 1/2 inch (1.25 cms) nor more than 2 inches (5 cms).

D. Mix Design

1. The Contractor shall perform at his own expense and be responsible for the design of the concrete mix. The mix design shall be prepared and sealed by a person qualified and experienced in such work. Establish proportions on the basis either of laboratory trial batches or of field experience with the materials to be employed.
2. When ice is used to lower the concrete temperature during hot weather, concrete placement (Section 801, "CONCRETE STRUCTURES"), the Contractor shall furnish a mix design (Section 800, "CONCRETE FOR STRUCTURES") acceptable to the Engineer or designated representative for class of concrete specified. The addition of ice shall not exceed 50 percent of the total mix water weight.
3. Complete concrete mix design data shall be submitted to the Engineer or designated representative for approval at least 10 days before concrete placement begins. Submittal of the mix shall be accompanied by such test data and certifications as may be necessary to demonstrate compliance with specification requirements. Approval of this mix design shall in no way relieve the Contractor of responsibility for the quality of the concrete.
4. It shall also be the responsibility of the Contractor to determine and measure batch quantity of each ingredient, including water, not only for batch designs but for all concrete produced for the project, so that the mix conforms to these specifications.



5. Trial batches shall be made and tested using all the proposed ingredients prior to the placing of concrete and also when the aggregate and/or type, brand or source of cement or admixture is changed. When the brand and/or source of cement only is changed, the Engineer or designated representative may waive trial batches only if a prior record of satisfactory performance of the cement has been established.
6. Mix designs used successfully on previous or concurrent jobs may be approved by the Engineer or designated representative without trial batches if it is shown that there is no substantial change in any of the proposed ingredients.
7. The Contractor shall prepare a minimum of four concrete test cylinders of each mix design, cure and test two each at the age of 7 and 28 days. From these preliminary tests the water-cement ratio required to produce concrete of the specified strength will be selected by the Contractor for approval by the Engineer or designated representative. The Contractor may at any time present in writing a suggested mix design and if the Engineer or designated representative concurs with the suggested design, the Contractor shall conduct trial batches necessary to determine its acceptability under these specification requirements.
8. The Contractor shall furnish and operate the mixer approved for use on this project unless the concrete is to be furnished from a transit mix (ready-mix) plant. For mixing the concrete to be used in making the preliminary test specimens, a minimum 1 cubic yard (1 cubic meter) batch shall be mixed or a batch of sufficient size to afford proper mixing, whichever is the greater. In lieu of the above mixer and procedure, the Contractor may furnish a portable mixer of sufficient rated capacity to mix a minimum 3-sack batch; in which case, the batch mixed for the preliminary test not to be less than the rated capacity of the mixer furnished. A coating batch will be mixed prior to mixing for test cylinders.
9. No additional compensation to be allowed for equipment, materials or labor involved in making job mix design test specimens.
10. After the mix proportions and water-cement ratio required to produce concrete of the specified strength have been determined, placing of the concrete may be started. The strength of the concrete in the completed pavement will be determined by a minimum of four compressive strength test specimens made, cured with a minimum of two each tested at 7 and 28 days as provided in TxDOT Bulletin C-11. Modifications of the mix design may be requested by the Contractor on basis of conformity of the strength of these test specimens with the requirements and intent of this specification.
11. Changes in the water-cement ratio and the mix design, including an increase in cement factor if necessary, will be made when the average 7 day and/or 28 day compressive strength of the concrete, as indicated by the last 10 compressive strength values obtained from tests of cylinders made from concrete of the same water-cement ratio, departs from the desired minimum average strength by more than 4 percent.

E. Construction Testing

1. Straightedge surface testing to be carried out as prescribed above.
2. The Engineer shall take test cylinders for compressive strength values on a random basis. The comparative results shall consist of the average of 2 cylinders each at 7 and 28 days for regular concrete, high early strength concrete and high range water reducing admixture concrete. Tests shall be made for each 500 square yards constructed, in accordance with TxDOT Bulletin C-11. Additional tests may be taken as determined by



the concrete placement conditions or for adequately determining the strength of concrete where the early opening of the pavement to traffic is dependent upon concrete strength tests. No extra compensation will be allowed for materials and work involved in fulfilling these requirements.

809.6

CONSTRUCTION METHODS

A. Preparation of Subgrade

1. Where stabilized subbase is not provided, the subgrade shall be excavated as required, all unstable or otherwise objectionable material removed and all holes, ruts and depressions filled with approved material and compacted. Rolling and sprinkling shall be performed when and to the extent required and the roadbed shall be completed to or above the plane of the typical sections, lines and grades indicated or as established by the Engineer or designated representative. The subgrade shall be proof rolled and any soft areas shall be repaired before the forms are placed. In the event that the proof rolled subgrade is exposed to rainfall or other conditions, which may soften the subgrade, corrective measures shall be taken and the subgrade shall be proof rolled again.
2. The subgrade planer shall be operated from approved forms immediately ahead of paving operations and the subgrade shall be finished to the exact section of the bottom of the pavement as indicated. Where traveling form pavers are used, the subgrade planer shall operate on a prepared track grade or be controlled by electronic sensors operating from a stringline that establishes line and grade. It shall be tested with the approved template, operated and maintained by the Contractor. The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the pavement is placed and shall be kept thoroughly wetted down sufficiently in advance of placing any pavement to insure its being in a firm and moist condition for at least 2 inches (5 cms) below the prepared surface. Sufficient subgrade shall always be prepared in advance to insure satisfactory prosecution of the work.
3. No equipment or hauling shall be permitted on the prepared subgrade, except by special permission of the Engineer or designated representative, which will be granted only in exceptional cases and only where suitable protection in the form of 2-ply timber mats or other approved material is provided.

B. Placing and Removing Forms

1. The subgrade under the forms shall be firm and cut true to grade so that each form section when placed will be firmly in contact for its whole length and base width and exactly at the established grade. Any subgrade under the forms below established grade shall be corrected, using suitable material, placed, sprinkled and rolled as directed. Forms shall be staked with at least 3 pins for each 10-foot (3-meter) section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement. Forms shall be cleaned and oiled each time they are used.
2. Forms shall be set for a sufficient distance in advance of the point where concrete is being placed to permit a finished and approved subgrade length of not less than 300 feet (90 meters) ahead of the mixer. Conformity of the grade and alignment of forms shall be checked immediately prior to placing concrete and necessary corrections made by the Contractor. Where any form has been disturbed or any subgrade becomes unstable, the form shall be reset and rechecked. In exceptional cases, the Engineer or designated representative may require suitable stakes driven to the grade of the bottom of the forms to afford additional support. Sufficient stability of forms to support the equipment operated and to withstand its vibration without springing or settlement shall be required.



If forms settle and/or deflect over 1/8 inch (3 mm) under finishing operations, paving operations shall be stopped and the forms shall be reset to line and grade.

3. Forms shall be leveled using cement-stabilized material containing not less than 1 1/2 sacks of cement per ton (1 2/3 sacks of cement per MG) of mix as placed. The aggregate gradation and water content shall be determined by the Contractor. The cement-stabilized material shall be sufficiently plastic to insure filling voids underneath the paving forms. Paving equipment will not to be permitted on the forms until the cement-stabilized material has cured for at least 12 hours.
4. Forms shall remain in place for not less than 8 hours after the concrete has been placed. Forms shall be carefully removed in such a manner that little or no damage will be done to the edge of the pavement. Any damage resulting from this operation shall be immediately repaired. After the forms have been removed, the ends of all joints shall be cleaned and any honeycombed areas pointed up with approved mortar and the surfaces protected with curing material conforming to Section 806, "MEMBRANE CURING."
5. Immediately after pointing is complete, the form trench, if used, shall be filled with granular material or earth from the shoulders in such manner as to shed water from rainfall and prevent curing material from washing away from the edge of pavement. On completion of the required curing, the subgrade or shoulders adjacent to the pavement shall be placed and compacted in condition to maintain drainage.

809.7

CONCRETE MIXING AND PLACING

- A. Mixing Methods. The concrete shall be mixed in a mixer conforming to the requirements of this item.
- B. Mixing.
 1. The aggregates, mineral filler if required, cementitious materials and water shall be measured separately, introduced into the mixer and mixed for a period of not less than 50 seconds nor more than 90 seconds, measured from the time the last aggregate enters the drum to the time discharge of the concrete begins. The required water shall be introduced into the mixing drum during the first 15 seconds of mixing. The entire contents of the drum shall be discharged before any materials of the succeeding batch are introduced.
 2. The Engineer or designated representative may increase the minimum mixing time to that necessary to produce thoroughly mixed concrete based on inspection or appropriate uniformity tests. The mixing time may be varied at any time as necessary to produce acceptable concrete.
 3. If a central mixer is used, the concrete shall be discharged into the specified hauling equipment and delivered to the road site. If truck agitators are used, the concrete shall be continuously agitated at not less than 1 nor more than 6 rpm as directed by the Engineer or designated representative.
 4. The maximum size of the concrete batch, absolute volume, shall not exceed 120 percent of the rated size of the mixer (40.8 cubic feet maximum batch for 34 cubic foot paver – 1.2 cubic meter maximum batch for 1 cubic meter paver). Spilling of material from the mixer drum shall be corrected by reducing the size of the batch. Retempering or remixing of concrete will not be permitted.



5. The initial batch of concrete mixed after each time the mixer is washed out shall be enriched by additional mortar. The additional mortar shall be 1 sack of cement and 3 parts of sand.
6. When transit-mix (ready-mix) concrete is permitted, the batching plant shall meet the requirements of TxDOT Item 421 "Hydraulic Cement Concrete."

C. Placement

1. Unless otherwise indicated, the concrete may be placed by using forms or by use of a slipform paver. Any concrete not placed as herein prescribed within 30 minutes after mixing shall be rejected and disposed of as directed except as provided otherwise herein. If in the opinion of the Engineer or designated representative, the temperature, wind and/or humidity conditions are such that the quality of concrete will not be adversely affected, the specified placing time may be extended by a maximum of 45 minutes. Concrete with high range water reducing admixture shall not be placed after the slump has dropped by 3 inches (7.5 cms) or more. Except by specific written authorization of the Engineer or designated representative, concrete shall not be placed when the temperature is below 40°F (4.5°C) and falling but may be placed when the temperature is above 35°F (1.7°C) and rising, the temperature being taken in the shade and away from artificial heat.
2. When the temperature of the air is above 85°F (29.4°C), an approved retarding agent will be required in concrete. The maximum temperature of all regular concrete placed shall not exceed 95°F (35.0°C), unless otherwise specified.
3. When concrete is being placed in cold weather, the Contractor shall have available a sufficient supply of an approved covering material to immediately protect concrete if the air temperature falls to 32°F (0°C) or below, before concrete has been placed 4 hours. Such protection shall remain in place during the period the temperature continues below 32°F (0°C) or for a period of not more than 5 days. Neither salt nor other chemical admixtures shall be added to the concrete to prevent freezing. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at his expense. Concrete shall not be placed before sunrise and shall not be placed later than will permit finishing of the pavement during sufficient natural light.
4. Concrete shall be placed only on approved subgrade or subbase and unless otherwise indicated on the drawings, the full width of the pavement shall be constructed monolithically. The concrete shall be deposited on the subgrade or subbase in such manner as to require as little rehandling as possible. Where hand spreading is necessary, concrete shall be distributed to the required depth by use of shovels. The use of rakes will not be permitted. Workmen will not be permitted to walk in the concrete with any earth or foreign material on their boots or shoes. The placing of concrete shall be rapid and continuous.
5. When the concrete is to be placed in separate lanes, the junction line shall not deviate from the true line more than 1/2 inch (1.25 cm) at any point and shall be finished as indicated on the drawings.
6. The mixer shall not be located on completed pavement, except as herein provided, but may be located on the subgrade of that lane of the pavement being constructed, as provided under "Preparation of Subgrade." When limited space, in the opinion of the Engineer or designated representative, requires operation of the mixer on completed pavement, the mixer may be so operated provided the concrete has attained the minimum



average compressive strength required and provided suitable protection to the pavement in the form of 2 ply timber mats or otherwise approved material is provided.

7. Concrete shall be distributed to such depth that when consolidated and finished, the slab thickness indicated will be obtained at all points and the surface shall not, at any point, be below established grade. Special care shall be exercised in placing and spading concrete against forms and at all joints to prevent the forming of honeycombs and voids.
8. Concrete for the monolithic curbs 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. It may be placed from the separate mixer, if desired, but in any case must be placed while the pavement concrete is still plastic. When sawed joints are used, curbs shall be doweled as indicated and poured after sawing. Curbs doweled on and placed separately may be placed with an extrusion machine.
9. If a central mixer or batcher is used, the Contractor shall provide a system satisfactory to the Engineer or designated representative for determining that concrete delivered to the road meets the specified requirements for mixing and time of placing.
10. Unless otherwise indicated, 2 mixers or transit mixers will be required where the double strike off method is employed.

D. Reinforcing Steel and Joint Assemblies

1. All reinforcing steel, including steel, welded wire fabric reinforcement, tie bars, dowel bars and load transmission devices used in accordance with plan provisions shall be accurately placed and secured in position in accordance with details indicated on the drawings. Reinforcing bars shall be securely wired together at alternate intersections, following a pattern approved by the Engineer or designated representative and at all splices and shall be securely wired to each dowel intersected. When wire fabric is used, it shall replace only the longitudinal and transverse bars and shall be securely wired together at all splices and to each dowel intersected. When welded wire fabric is selected, the Contractor shall pour the lower half of the slab, place the welded wire fabric and place the remaining concrete. Tie bars shall be installed in the required position by the method and device indicated. Bar coating indicated and of material specified, shall be completed and the bars and coating shall be free of dirt or other foreign matter at the time of installation in the concrete.
2. Tightly adhered scale or rust which resists removal by vigorous wire brushing need not be removed except that excessive loss of section to the reinforcement due to rust shall be cause for rejection. Excessive loss of section shall be defined as loss of section to the extent that the reinforcement will no longer meet the physical requirements for the size and grade of steel specified.
3. Where indicated on the drawings, an assembly of parts at pavement joints, the assembly shall be completed, placed at required location and elevated and all parts rigidly secured in required position by the method and devices indicated on the drawings. Dowel bars shall be accurately installed in joint assemblies as indicated on the drawings, each parallel to the pavement surface and to the center line of the pavement and shall be rigidly secured in the required position by such means as indicated that will prevent their displacement during placing and finishing of the concrete. Unless specifically authorized by the Engineer or designated representative in writing, the load transmission devices shall be accurately installed in joint assemblies indicated, each unit vertical with its length parallel to the center line of the pavement and all units shall be rigidly secured in required position by such means as indicated that will prevent their displacement during placing and finishing of the concrete. Header boards, joint filler and other material used



for forming joints shall be accurately notched to receive each load transmission device. All load transmission devices shall be free of rust and clean when installed in the concrete.

4. The Contractor has the option of substituting welded wire fabric in place of reinforcement bars. The welded wire fabric selected shall have an area and distribution of steel at least equal to the plan requirements. The Contractor shall submit their proposed design to the Engineer for approval before any material is ordered.
5. If welded wire fabric is used, the entire width of the bottom layer of concrete shall be struck off to conform to the cross section and elevation indicated on the drawings. The reinforcement shall then be placed immediately upon the concrete, after which the top layer of concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 15 minutes without being covered with the top layer of concrete shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

E. Joints

1. General

- a. All transverse and longitudinal joints when required in the pavement shall be of the types indicated and shall be at required location, on required alignment, in required relationship to tie bars and joint assemblies and in accordance with details indicated. When no transverse joints are indicated, joints shall not exceed 40 feet (13.1 meters). Such stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Where concrete base is overlaid by asphaltic concrete, the joints to be prepared as specified herein, but joint sealing will not be required unless indicated.
- b. If necessary for proper installation of the sealer, excessive spalling of the joint groove shall be repaired to the satisfaction of the Engineer.
- c. Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the outline indicated on the drawings. The Contractor shall install joint materials, which will function as a compatible system. Joint sealer shall not be placed where a bond breaker is present.
- d. Green concrete or wet sawed joints are permitted provided the Contractor cleans the joint within 5 minutes after cutting with a 3,000 psi (20.7 mPa) water blast followed by a minimum of 7 day cure and sand blast the saw cut immediately prior to placing joint sealer.
- e. Dry sawed joints are permitted provided the Contractor sand blasts the saw cut immediately prior to placing joint sealer.

2. Expansion Joints

- a. Transverse expansion joints shall be formed perpendicular to the centerline and surface of pavement and shall be constructed in accordance with the sequence of operations indicated on the drawings. After the transverse finishing machine and before the longitudinal finishing machine have passed over the joint, the Contractor shall test the joint filler for correctness of position and make any



required adjustment in the position of the filler and shall install the joint seal space form as indicated on the drawings. After removal of the joint seal form as indicated on the drawings, the joint seal space above the joint filler shall be thoroughly sandblasted or machine routed to remove all projecting concrete, laitance, dirt or foreign matter. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint. On completion of curing of the pavement, the joint sealing filler of the type specified shall be placed as indicated. The faces of the joint seal space shall be clean and surface dry at the time joint sealing filler is placed. On completion of the joint seal, the pavement adjacent to the joint shall be left free of joint sealing material. The joint seal space shall be exactly above and not narrower than the joint filler with no concrete overhangings.

3. Weakened Plane Joints

- a. Weakened plane joints shall consist of transverse contraction joints and longitudinal joints and shall be formed or sawed as indicated on the drawings. When the joints are sawed, the saw shall be power driven, shall be manufactured especially for the purpose of sawing concrete and shall be capable of performing the work. Saw blades shall be as indicated. Tracks adequately anchored, the chalk, string line or other approved methods shall be used to provide true alignment of the joints. The concrete saw shall be maintained in good operating condition and the Contractor shall keep a standby power saw on the project at all times when concrete operations are under way.
- b. If membrane curing is used, the portion of the seal, which has been disturbed by sawing operations, shall be restored by the Contractor by spraying the areas with additional curing seal.
- c. Forming, finishing and sealing of the joint seal space shall conform to this item, described above and details indicated on the drawings.

4. Contraction Joints

- a. Transverse contraction joints shall be formed or sawed joints perpendicular to the centerline and surface of the pavement and shall be constructed by the method and in the sequence of operations as indicated. Where sawed joints are used, contraction joints at intervals indicated shall be sawed as soon as sawing can be accomplished without damage to the pavement and before 24 hours after the concrete has been placed, the exact time to be approved by the Engineer or designated representative. The remaining contraction joints shall be sawed in a uniform pattern as directed by the Engineer or designated representative and they shall be completed before uncontrolled cracking of the pavement takes place. All joints shall be completed before placing concrete in succeeding lanes and before permitting traffic to use the pavement.

5. Longitudinal Joints

- a. Longitudinal joints shall be of the type or alternate types indicated and shall be constructed of specified materials in accordance with provisions indicated on the drawings. Longitudinal joints shall be constructed accurately to required lines, shall be perpendicular to the pavement surface at the joint and the pavement surface over and adjacent to the joint shall be finished as specified on the drawings.



- b. Longitudinal joints shall be sawed as soon as sawing can be accomplished without damage to the pavement. Sawing shall not cause damage to the pavement and the groove shall be cut with a minimum of spalling. No traffic (including construction traffic) shall be permitted on pavement until the longitudinal joint is cut.
6. Construction Joints. Intentional stoppage of the placing of the concrete shall be at either an expansion joint or at a weakened plane joint. The following provisions shall govern for each type of joint at which the placing of concrete is stopped:
- a. When the placing of concrete is stopped at an expansion joint, the complete joint assembly shall be installed and rigidly secured in required position as indicated. A bulkhead of sufficient cross sectional area to prevent deflection, accurately notched to receive the load transmission devices or dowels, as the case may be, and shaped accurately to the cross section of the pavement shall be provided and installed as a back-up for the joint filler and rigidly secured in required position to permit accurate finishing of the concrete up to the joint. After the concrete has been finished to the joint, formation of the joint seal space and finishing of the joint shall be executed as specified herein and as indicated. The backup bulkhead shall remain in place until immediately prior to the time when concrete placement is resumed, then it shall be carefully removed in such manner that no element of the joint assembly will be disturbed. The exposed portion of the joint assembly shall be free of adherent concrete, dirt or other material at the time placing of concrete is resumed.
 - b. When placing of concrete is stopped at a weakened plane joint, all applicable provisions of paragraph (a) above shall apply in addition to the following requirement:

The face of the bulkhead adjoining the slab end shall be notched and grooved to fit the exposed half section of the joint assembly and shall be shaped to form the slab end at the center of the joint as indicated on the drawings. The 1/2 width of joint seal space may be formed by a strip of required section placed and removed as indicated for construction of transverse contraction joints. The Contractor shall have available a bulkhead shaped to section of the pavement. This bulkhead must be drilled to permit the continuation of all longitudinal reinforcing steel through the construction joint and shall be of sufficient section and strength to prevent deflection.

- c. When load transmission devices are not provided in the design, intentional stopping of placement of concrete shall occur in the middle of a slab. Provisions shall be made to provide a bulkhead, which will accommodate tie bars of the same length, size and spacing as tie bars used for the longitudinal joints. When the concrete placement is resumed, the bulkhead shall be removed without bending tie bars or damaging the concrete. The joint seal space and sealer shall be the same as for longitudinal joints.

Immediately upon the unintended stoppage of the placing of concrete, the Contractor shall place the available concrete to a line and install the above-described bulkhead at right angles to the centerline of the pavement, perpendicular to the surface and at the required elevation. Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed by the Engineer or designated representative. When placing of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be rodded with the first. An edge created by a construction joint of this type shall have a joint seal space and shall be sealed as required for contraction joints.



F. Joint Sealers

1. Class 2 Material. This material shall conform to TxDOT DMS-6310, "Joint Sealants and Fillers".

For placement in vertical joints (curb faces, etc.) either of the following procedures may be used.

- a. An amount of the mixed material may be set aside until partial curing has taken place and carefully trowelled into the joint with a suitable tool.
 - b. The portion of the joint in the roadway shall be poured and cured. The vertical curb faces shall then be taped or formed and the material poured into the vertical joint from the top.
2. Class 5 Material. This material together with backer rods shall be applied as indicated in accordance with manufacturer's recommendations.

G. Asphalt Board

1. Premolded materials, wherever used, shall be anchored to the concrete on one side of the joint by means of copper wire or nails not lighter than No. 12 B and S gage. Such anchorage shall be sufficient to overcome the tendency of the material to fall out of the joint. The Contractor shall not contaminate joints to receive Class 5 Joint Material with asphalt from the asphalt board.

H. Curbs

1. The curb shall be constructed in lengths equal to the adjoining pavement slab lengths and expansion joints shall be provided in the curb opposite each transverse expansion joint in the pavement. Expansion joint material shall be of the same thickness, type and quality as indicated for the pavement and shall be of the section as indicated for the curb. All expansion joints shall be carried through the curb, sidewalk and retaining walls when these items are indicated.
2. When sawed joints are provided for the pavement, the curb placement shall be delayed until all transverse joints have been sawed. To provide bond for the curb, dowel bars shall be placed as indicated on the drawings, while the pavement concrete is still plastic.
3. Weakened plane joints shall be formed in monolithic curbs at a spacing to coincide with the joints in the concrete pavement. The joints shall be formed by inserting in the curb an asphaltic board strip cut to conform to the shape of the curb. When the concrete is sufficiently set, the joint on the top and face of curb shall be grooved with an approved type of grooving tool.
4. A finish coat of mortar shall be applied on the exposed surfaces of the monolithic curbs. The mortar shall be composed of 1 part of Portland Cement and 2 parts of fine aggregate. A mortar coat will not be required for extruded curbs.
5. The curb face, lower radius and top of curb shall be plastered with the sand-cement mortar. The mortar shall be applied with a template or "mule" made to conform to the curb dimensions as indicated. All exposed surfaces of the curb shall be finished with a steel trowel and brushed to a smooth and uniform surface. The mortar finish as required shall be included in the unit price bid for this item.



I. Machine Finishing

1. All concrete pavement shall be finished mechanically with approved self-propelled machines, except as herein provided. Hand finishing will be permitted on the transition from a crowned section to a superelevated section without crown on curves, on straight line superelevation sections less than 300 feet (91.4 meters) in length, on that portion of a widened pavement outside normal pavement width and on sections where the pavement width is not uniform, isolated, narrow in width or required monolithic widths are greater than that of available finishing machines.
2. Machine finishing of pavement shall include the use of power-driven vibrators, power-driven transverse strike off and screed or such alternate equipment as may be substituted and approved under this item.
3. All concrete pavement shall be consolidated by a mechanical vibrator. As soon as concrete has been spread between the forms, the approved mechanical vibrator shall be operated to consolidate the concrete and remove all voids. Hand manipulated vibrators shall be used for areas not covered by the mechanical vibratory unit.
4. The transverse finishing machine shall first be operated to compact and finish pavement to the required section and grade, without surface voids. The machine shall be operated over each area as many times and at such intervals as directed. At least 2 trips will be required and the last trip over a given area shall be a continuous run of not less than 40 feet (12.2 meters). After completion of finishing with the transverse finishing machine, a transverse drag float may be used.
5. The consistency of the concrete as placed should allow completion of finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum.
6. After finishing is complete and the concrete still workable, the surface shall be tested by the Contractor for trueness with an approved 10 foot (3.05 meter) straightedge. The straightedge shall be operated from the side of the pavement, placed parallel to the pavement centerline and passed across the slab to reveal any high spots or depressions. The straightedge shall be advanced along the pavement in successive stages of not more than 1/2 its length. Practically perfect contact of the straightedge with the surface will be required and the pavement shall be leveled to this condition, in order to insure conformity with the surface test required below after the pavement has fully hardened. Any correction of the surface required shall be accomplished by adding concrete if required and by operating the longitudinal float over the area. The surface test with the straightedge shall then be repeated.
7. For one lane pavement placement and uniform widening, the equipment for machine finishing of concrete pavement shall be as directed by the Engineer or designated representative but shall not exceed requirements of these specifications.
8. After completion of the straightedge operation, as soon as construction operations permit, texture shall be applied with 1/8 inch (3 mm) wide metal tines with clear spacing between the tines being not less than 1/4 inch (6.3 mm) nor more than 1/2 inch (12.7 mm).
9. If approved by the Engineer or designated representative, other equipment and methods may be used, provided that a surface texture meeting the specified requirements is obtained. The texture shall be applied transversely. It is the intent that the average depth



resulting from the number of tests directed by the Engineer or designated representative be not less than 0.060 inch (1.52 mm) with a minimum texture depth of 0.050 inch (1.27 mm) for any one test when tested in accordance with TxDOT Test Method Tex-436-A. Should the texture depth fall below that intended, the finishing procedures shall be revised to produce the desired texture.

- a. Emergency Procedures
- b. The Contractor shall have available at all times hand rakes with tines for the purpose of providing textures in the event of equipment breakdown.
- c. The Contractor also shall have available a conventional garden spray type can containing a commercially available monomolecular film compound. This shall be applied in the case of equipment breakdown or other emergencies to prevent the pavement from drying too rapidly. The use of this product will give the Contractor additional time to provide adequate texturing.
- d. After completion of texturing and about the time the concrete becomes hard, the edge of the slab and joints shall be carefully finished with an edger in a workmanlike manner and the pavement shall be left smooth and true to line.

J. Hand Finishing

1. Hand finishing shall be resorted to only in those conditions provided for above and upon specific authorization by the Engineer or designated representative. When hand finishing is permitted, concrete shall be struck off with an approved strike off screed to such elevation that when consolidated and finished the surface of the pavement to conform to the required section and grade. The strike template shall be moved forward with a combined transverse and longitudinal motion in the direction work is progressing, maintaining the template in contact with the forms and maintaining a slight excess of material in front of the cutting edge. The Concrete shall then be tamped with an approved tamping template to compact the concrete thoroughly and eliminate surface voids and the surface screed to required section.
2. After completion of a strike off, consolidation and transverse screeding, a hand-operated longitudinal float shall be operated to test and level the surface to the required grade.
3. Workmen shall operate the float from approved bridges riding on the forms and spanning the pavement. The longitudinal float shall be held in contact with the surface and parallel to the centerline and operated with short longitudinal strokes while being passed from one side of the pavement to the other. If contact with the pavement is not made at all points, additional concrete shall be placed, if required and screed and the float shall be used to produce a satisfactory surface. Care shall be exercised to keep the ends of the float from digging into the surface of the pavement. After a section has been smoothed so that the float maintains contact with the surface at all points in being passed from one side to the other, the bridges may be moved forward half the length of the float and the operations repeated.
4. Other operations and surface tests shall be as required for machine finishing.

K. Surface Testing

After the concrete has been placed 12 hours or more, the Engineer or designated representative will test the surface of the pavement with a 10-foot (3.05 meter) straightedge placed parallel to the centerline. Unless specified otherwise, the surface shall not vary from the straightedge by more than 1/16 inch per foot (5 mm per meter) from the nearest point of contact and in no case



shall the maximum ordinate from a straightedge to the pavement be greater than 1/8 inch (3 mm). Any high spots causing a departure from the straightedge in excess of that specified shall be ground down by the Contractor to meet the surface test requirements. Where the texture of the pavement is removed by extensive grinding, the texture shall be restored by grooving the concrete to meet the surface finishing specifications.

L. Curing

All concrete pavement shall be cured by protecting it against loss of moisture for a period of not less than 72 hours from the beginning of the curing operations. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered and cured in accordance with the requirements specified for whichever of the following methods the Contractor may elect. Newly laid concrete base to be overlaid by asphaltic concrete shall not be cured by "Membrane Curing" and surfaces not to be overlaid by asphaltic concrete shall not be cured by "Asphalt Curing." In all cases in which curing requires the use of water, the curing shall have prior right to water supply or supplies. Failure to provide sufficient cover material of the type the Contractor elects to use, failure to maintain saturation in wet curing methods, lack of water to adequately take care of both curing and other requirements or other failures to comply with curing requirements shall be cause for immediate suspension of concreting operations. The covering material used in curing shall be removed as necessary to saw joints or to comply with the requirements for "Surface Test." The concrete surface shall be maintained wet with a water spray if indicated and the covering material replaced immediately on completion of sawing and testing and any required surface correction.

1. Waterproofed Paper Curing

- a. Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it shall be wetted with water applied in the form of a fine spray and covered with waterproofed paper so placed and weighted as to cause it to remain in intimate contact with the surface. Waterproofed paper used for the curing of concrete pavement shall be of a type and quality approved by the Engineer. It shall be sufficiently strong and tough to permit its use under the conditions existing on street paving work without being torn or otherwise rendered unfit for the purpose during the curing period. The paper covering shall be maintained in place continuously for not less than the specified curing period.
- b. The waterproofed paper shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab and such blankets shall not be more than 60 feet in length. All joints in the blankets occasioned by joining paper sheets shall lap not less than 5 inches (12.7 cms) and shall be securely sealed with asphalt cement having a melting point of approximately 180°F (82.2°C). Blankets shall be placed to secure an overlap of at least 12 inches (30.5 cms) and this lap securely weighted to form a closed joint.
- c. The waterproofed paper blankets shall be adequately weighted to prevent displacement or billowing due to wind and the paper folded down over the side of the pavement shall be secured by a continuous bank of earth. Plowing of this windrow into place will not be permitted.
- d. All tears or holes appearing in the paper during the curing period shall be immediately repaired by cementing patches over such defects. It shall be the Contractor's responsibility to prevent damage to paper blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer or designated representative at any time when, in his opinion, they do not provide an airtight covering.



- e. Paper blankets rejected on account of pinholes or minor tears may be continued in service by folding the blanket over lengthwise, first thoroughly spraying 1/2 the blanket with the asphalt cement used for seams. The 2 thicknesses shall be firmly pressed together and well cemented. Blankets shall be of a width sufficient to cover the pavement surface and both edges. Doubled blankets may be rejected for the same cause as provided for single blankets. All paper blankets rejected by the Engineer shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.
- f. No walking on paper shall be permitted at any time and, in locations where pedestrian traffic cannot be entirely controlled, the Contractor shall provide walkways and barricades or shall substitute other permissible curing methods on such sections of pavement.

2. Polyethylene Film Curing

- a. Immediately after the finishing of the surface has been completed and the concrete has taken its initial set, it shall be wetted with water applied in the form of a fine spray and covered with the polyethylene film so placed and weighted as to cause it to remain in intimate contact with the surface. The polyethylene film covering shall be maintained in place continuously for not less than the specified curing period.
- b. The film shall be prepared to form blankets of sufficient width to cover the entire surface and both edges of the pavement slab. All joints in the blankets occasioned by joining film sheets shall lap not less than 12 inches (30.5 cms). All joints shall be sealed in a manner acceptable to the Engineer or designated representative to provide a moisture-proof lap.
- c. The polyethylene film blankets shall be adequately weighted to prevent displacement or billowing due to wind and the film folded down over the side of the pavement shall be secured by a continuous bank of earth. Plowing of this windrow into place not to be permitted.
- d. All tears or holes appearing in the polyethylene film during the curing period shall be immediately repaired by placing acceptable moisture proof patches over such defects or by replacing the blankets. It shall be the Contractor's responsibility to prevent damage to the film blankets, which would affect their serviceability and effectiveness as a concrete curing method. Blankets may be rejected by the Engineer at any time when, in his opinion, they do not provide an airtight covering.
- e. Polyethylene film blankets rejected on account of pinholes or minor tears may be continued in service when repaired to an airtight condition. All polyethylene film blankets rejected by the Engineer or designated representative shall be immediately marked by the Contractor for identification and then destroyed or stored entirely separate from approved blankets.
- f. Should the film blanket be damaged or torn for any cause during the first 72 hours of the curing period such damage shall be repaired immediately.



3. Membrane Curing

Immediately after the finishing of pavement has been completed and after the free surface moisture has disappeared, the pavement shall be sprayed uniformly with a curing compound. Membrane curing shall conform to Section 806, "Membrane Curing," Type 2 white pigmented. Should the film of compound be damaged from any cause before the expiration of 72 hours after original application, the damaged portions shall be repaired with additional compound. Unless otherwise indicated on the drawings, membrane curing shall be used when the concrete (except that concrete to be used as a base) is placed with a slip form paver.

4. Asphalt Curing

Where emulsified asphalt is used for curing concrete base, the material shall conform to TxDOT Item 300, "Asphalts, Oils and Emulsions," for the type and grade shown on the drawings. The rate of application may vary between the limits of 1 gallon per 180 square feet and 1 gallon per 90 square feet (1 liter per 4.4 square meters and 1 liter per 2.2 square meters). The rate of application will be determined by the Engineer or designated representative, after observation of sections where amounts varying between the above limits have been applied. If it is found necessary to add water to the emulsion for the proper distribution through the spray, this may be done upon approval of the Engineer or designated representative. When the emulsion is diluted with water the amount of the applied mixture shall be increased to give a coverage of the original emulsion between the limits as set out herein. Care shall be taken to properly mix the emulsion and water and to keep the mixture well agitated during application.

M. Protection of Pavement

1. The Contractor shall erect and maintain the barricades indicated on the drawings and such other standard and approved devices as will exclude public traffic and traffic of the Contractor's employees and agents from the newly placed pavement for a minimum of 14 days. Portions of the roadway or crossings of the roadbed required to be maintained open for use by traffic shall not be obstructed by above required barricades. Crossings of the pavement indicated on the drawings or by construction sequence, during the period prior to opening to traffic as herein indicated, shall be provided with an adequate and substantial bridge approved by the Engineer or designated representative.
2. Curb shall be backfilled to the full height of the concrete, tamped and sloped as indicated on the drawings or as directed by the Engineer. The top 4 inches (10 cms) of backfill shall be of clean, friable soil capable of supporting plant life. This material shall also be free of stones and all other debris.

N. Opening Pavement to Traffic

1. The pavement shall be closed to traffic, including vehicles of the Contractor, until the concrete is at least 14 days old and has attained an average compressive strength acceptable to the Engineer or designated representative. This period of closure to traffic may be extended if, in the opinion of the Engineer or designated representative, weather or other conditions make it advisable to provide an extension of the time of protection.
2. At the end of the 14 day period and as long thereafter as ordered by the Engineer or designated representative and if so desired by the Contractor, the pavement may be opened for use by vehicles of the Contractor provided the gross weight (vehicle plus load) of such vehicles does not exceed 14,000 pounds (6,350 KGs). Such opening, however, shall in no manner relieve the Contractor from his responsibility for the work. On those sections of the pavement thus opened to traffic, all joints shall first be sealed,



the pavement cleaned and topsoil placed against the pavement edges or behind the curb where turf or vegetation is to be established before permitting vehicles thereon.

3. After the concrete in any section is 14 days old or as long thereafter as ordered by the Engineer, such section of pavement may be opened to all traffic indicated on the drawings or when so directed by the Engineer or designated representative. On those sections of the pavement thus opened to traffic, all joints shall first be sealed, the pavement cleaned and 4 inches (10 cms) of top soil placed against the pavement edges and all other work performed as required for the safety of traffic. Such opening, however, shall in no manner relieve the Contractor from his responsibility for the work.
4. When High Early Strength Concrete, resulting from the use of Type III cement as indicated on the drawings is used, the pavement may be opened to all traffic after the concrete is 7 days old or as long thereafter as ordered by the Engineer or designated representative, subject to the same provisions governing the opening after 14 days as above indicated.
5. Where the Contractor desires to move any equipment not licensed for operation on public streets, on or across any pavement opened to traffic, he shall protect the pavement from damage by means of 2 ply timber mats of 2 inch (5 cm) stock or runways of heavier material laid on a layer of earth, all as approved by the Engineer or designated representative.
 - a. Emergency Opening to Traffic

The Engineer or designated representative may require the opening of pavement to traffic prior to the minimum time specified above under conditions of emergency, which in his opinion require such action in the interest of the public. In no case will the Engineer or designated representative order opening of the pavement to traffic within less than 72 hours after the last concrete in the section is placed. The Contractor shall remove all obstructing materials, place earth against pavement edges and perform other work involved in providing for the safety of traffic as required by the Engineer or designated representative in ordering emergency opening. Orders for emergency opening of the pavement to traffic will be issued by the Engineer or designated representative in writing.

809.6

PENALTY FOR DEFICIENT PAVEMENT THICKNESS OR STRENGTH

The adjustment in unit prices provided for in this item will apply only when measurement for payment is by the square yard.

It is the intent of this specification that the pavement be constructed in strict conformity with the thickness, strength and typical sections indicated on the drawings. Where any pavement is found not so constructed, the following rules relative to adjustment of payment for acceptable pavement and to replacement of faulty pavement shall govern.

A. Pavement

1. The pavement will be core drilled after any grinding operations have been completed for surface corrections prior to final acceptance. Locations of core tests may be selected by the Engineer or designated representative; however, spacing interval for core tests, as specified herein, shall be maintained. The thickness of the pavement will be determined by measurement of the cores in accordance with TxDOT Test Method Tex-424-A.



2. For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 1,000 linear feet of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 1,000 feet plus the fractional part of 1,000 feet remaining. Traffic lane width will be as shown on typical sections and pavement design standards.
3. For the purpose of establishing an adjusted unit price for ramps, widening, acceleration and deceleration lanes that are machine placed, isolated pavements of traffic lane width but less than 1,000 feet in length and other areas designated by the Engineer or designated representative, units will be considered separately and are defined as 1,000 square yards of pavement or fraction thereof.
4. One core will be taken at the location selected by the Engineer or designated representative or at random in each unit. When the measurement of the core from any unit is not deficient more than 0.2 inches from the plan thickness, full payment will be made. When the measurement of the core from any unit is deficient more than 0.2 inch but not more than 0.75 inch from the plan thickness, 2 additional cores will be taken from the unit and the average of the 3 cores determined. The 2 additional cores from any 1,000-foot unit will be taken at intervals of not less than 300 feet. The 2 additional cores from any 1,000 square yard unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these 3 cores is not deficient more than 0.2 inches from the plan thickness, full payment will be made. If the average thickness of the 3 cores is deficient by more than 0.2 inch but not more than 0.75 inch from the indicated thickness, an adjusted unit price as provided below will be paid for the areas represented by these cores.
5. In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch and measurements which are less than the specified thickness by more than 0.75 inch will be considered as the specified thickness less 0.75 inch.
6. When the measurement of any core is less than the specified thickness by more than 0.75 inch, the actual thickness of pavement in this area will be determined by taking additional cores at 10 foot intervals parallel to the center line in each direction from the deficient core until, in each direction, a core is taken which is not deficient by more than 0.75 inch. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine the length of pavement in a unit that is to be left in place without pay and/or removed and replaced as provided herein.
7. For new Concrete Pavement roadways, and for Concrete Pavement rehabilitation and overlay projects, if cracks develop in the pavement surface within the one year warranty period, the Contractor shall seal the cracks in accordance with TxDOT Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)", or perform other corrective measures as directed by the Engineer. Payment for this work will be considered subsidiary to Concrete Pavement, unless included as a separate pay item in the Contract.
8. Irrespective of an acceptable overall project average for any or all of the Pay-Adjustment Acceptance Factors, limited substandard portions of the work, as determined by the Engineer or designated representative, shall be remedied or removed and replaced to the satisfaction thereof.



B. Price Adjustments

1. After any grinding or milling operations have been completed to meet the surface-testing requirement of this specification, if average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.75 inch, payment will be made at an adjusted price as specified in the following table:

Concrete Pavement Deficiency	
Deficiency in Thickness Determined by Cores, Inches	Proportional Part of Contract Price Allowed
0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent

1. Any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch or 1/8 of the indicated thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, 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 indicated on the drawings.
2. Any area of pavement found deficient in thickness by more than 1 inch or more than 1/8 of the indicated thickness, whichever is greater, shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness indicated on the drawings.
3. No additional payment over the Contract unit price will be made for any pavement of a thickness exceeding that indicated on the drawings.
4. If the average compressive strength based on concrete test cylinders at 28 days is less than the specified minimum strength of the concrete, then payment will be made at an adjusted price as specified in the following table.

Pay Adjustment Factor for Deficient Compressive Strength	
Ratio of Average Strength from Test Cylinders to Specified Minimum Compressive Strength both at 28 Days	Proportional Part of Contract Price Allowed
More than 0.95	100 percent
0.90 to 0.95	85 percent
0.85 to 0.90	70 percent
0.80 to 0.85	60 percent
Less than 0.80	0 percent (Remove & Replace)

5. When, in the opinion of the Engineer or designated representative, the compressive strength test results appear unrepresentative, additional testing of field cores may be



authorized. To be considered acceptable for consideration the field cores shall be acquired, properly handled and tested in accordance with ASTM C 42/C 42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" within 45 days of the original concrete placement date. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous in the opinion of the Engineer or designated representative, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the City of Killeen.

6. When, in the opinion of the Engineer or designated representative, the concrete compressive strength is deemed unacceptable for the intended use of the pavement, the concrete shall be removed and replaced to the limits indicated by test results.

809.9

MEASUREMENT

- A. When indicated, concrete pavement will be measured by the square yard of surface area of completed and accepted work. The surface area shall be so measured to also include that portion of pavement slab extending beneath the curb. When concrete pavement is to be measured by the square yard and monolithic curb is required, measurements for "Monolithic Curb" will be by the linear foot complete in place.
- B. When indicated on the drawings, concrete pavement, including monolithic curb when required, will be measured by the cubic yard of absolute volume of materials entering the mixture.

809.10

PAYMENT

- A. The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Pavement," of the depth indicated on the drawings, "Concrete Pavement (High Early Strength)" of the depth indicated on the drawings and "Monolithic Curb" of the type indicated on the drawings (when pavement is measured by the square yard), as required or adjusted unit price for pavement of deficient thickness as provided under "Deficient Pavement Thickness", which price shall be full compensation for shaping and fine grading the roadbed, including furnishing and applying all water required; for furnishing, loading and unloading, storing, hauling and handling all concrete ingredients, including all freight and royalty involved; for placing and adjusting forms, including supporting material or preparing track grade; for mixing, placing, finishing, sawing, cleaning and sealing joints and curing all concrete; for furnishing and installing all reinforcing steel; for furnishing all materials for sealing joints and placing longitudinal, expansion and weakened plane joints, including all steel dowel caps and load transmission devices required and wire and devices for placing, holding and supporting steel bars, load transmission devices and joint filler material in proper position, for coating steel bars where complete the work.
- B. Excavation required by this item in the preparation of the subgrade and for completion of the parkway will be measured and paid for in accordance with provisions governing the Items of "Street Excavation" and "Borrow," respectively, with provision that yardage to be measured and paid for once only, regardless of manipulations involved. Measurement of subgrade excavation for payment shall be limited to a total width of that of pavement plus 1 foot on each side.
- C. Sprinkling and rolling required for the compaction of the rough subgrade in advance of fine grading will be measured and paid for as indicated in the governing items of excavation. Maintenance of a moist condition of the subgrade in advance of fine grading and concrete placing will not be paid for directly but shall be included in the unit price bid, as provided above.

END OF SECTION



SECTION 800 – CONCRETE SPECIFICATIONS

ITEM 810. SHOTCRETE

810.1 SCOPE OF WORK

The work shall consist of furnishing, mixing, applying and curing shotcrete. Except as otherwise specified, either a dry mix or wet mix process may be used.

810.2 MATERIALS

- A. Portland cement shall conform to the requirements TxDOT DMS-4600, “Hydraulic Cement” for the specified type.
- B. Aggregates shall conform to the requirements of ASTM C33 normal weight aggregate with combined gradation of coarse and fine aggregates conforming to ACI 506.2, Gradation No. 1 or Gradation No. 2 as applicable to the work.
- C. Admixtures, if specified, shall meet the requirements indicated. Non-chloride chemical admixtures shall conform to ASTM C 494. Air-entraining admixtures shall conform to ASTM C 260. Fly ash or pozzolanic materials shall conform to ASTM C 618. Calcium chloride shall conform to ASTM D 98 and shall be in flake or pellet form.
- D. Water used in mixing or curing shotcrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.
- E. Curing compound shall conform to the requirements of Section 806, MEMBRANE CURING.

810.3 STRENGTH AND QUALITY

- A. The compressive strength of shotcrete at the age of 28 days shall be not less than 4,000 psi.
- B. Shotcrete shall be uniform and dense, free from "drummy" areas that indicate laminations, voids, sand pockets, or disbanded material.

810.4 CONSISTENCY

- A. The proportion of water added to the mixture shall be accurately controlled to produce thorough and uniform hydration of the shotcrete. The consistency of the shotcrete shall be such that the surface of the shotcrete in place shall have a rich, glossy appearance and that the shotcrete shall adhere to the supporting surface without flowing, slumping or sloughing. For application to vertical or overhanging surfaces the mix proportions shall be adjusted so that the placed shotcrete will adhere to a minimum thickness of 3/4-inch without sagging or sloughing. For adjustment of consistency the addition of fly ash or pozzolanic material to the mixture in amounts not greater than 20-percent (by weight) of cement in the mixture will be permitted.

810.5 INSPECTION AND TESTING

- A. Procedures for preparing shotcrete test panels and the testing specimens sawed or cored from panels will be performed in accordance with ASTM Method C 1140. The compression test specimens will be cores taken from the test panels or from the structure.
- B. Similar panels not less than 18 inches square and not less than six (6) inches thick shall be made periodically as directed by the Engineer during the progress of the work.



- C. Cores, taken from the test panels, shall receive standard curing in lime-saturated water at 73.4° +/- 3.0° F within 24 hours after removal. Cores shall continue to receive the prescribed initial cure treatment until standard curing is commenced.
- D. For each strength test, three (3) cores will be tested in compression. The test result will be the average of the strengths of the three (3) specimens, except that if one specimen shows manifest evidence of improper sampling, coring, or testing, it will be discarded and the strengths of the remaining two (2) specimens will be averaged. If more than one (1) specimen representing a test shows such defects, the entire test will be discarded.
- E. The Contractor shall furnish the forms and make the required test panels and shall provide such facilities, materials and assistance as may be necessary for curing, handling, and protecting the panels. Test panels shall be cast only when the Engineer is present.

810.6

NOZZLE OPERATOR QUALIFICATIONS

- A. The nozzle operator shall be able to document a minimum of 3000 hours of experience as a nozzle operator and shall have completed at least one (1) similar application as a nozzle operator, unless otherwise specified.
- B. The nozzle operator and application crew members shall be required to meet pre-construction testing requirements administered by the Engineer on a test panel or an area as follows:
- C. The Engineer will carefully observe shooting of the test panel or area and note if the nozzle operator examinee:
 - 1. Cleans the shooting surface with air and water prior to shooting.
 - 2. Applies a bonding coat on the shooting surface ahead of the heavier shotcrete applications.
 - 3. Directs shotcrete application around reinforcement in a manner which prevents buildup on the face of the reinforcement and allows the shotcrete to flow and compact tightly around the back of the reinforcement.
 - 4. If applicable, directs the finisher or nozzle helper to cutout any sags, sand or rebound pockets.
 - 5. If applicable, and where necessary, directs the finisher or nozzle helper to broom the shotcrete surface prior to application of additional layers.

810.7

MEASURING MATERIALS

- A. The proportions of the shotcrete mix shall be controlled on the basis of the weight of each component material, except that water may be measured by volume. Materials shall have the following batch tolerances of their mix proportion weights: Cement, plus or minus two (2) percent; Aggregate, plus or minus four (4) percent; Admixtures, plus or minus six (6) percent. Weighing equipment used shall be accurate to within 0.4 percent of scale capacity.

810.8

EQUIPMENT

- A. The Contractor shall furnish all equipment necessary for batching, mixing and placing the shotcrete. The equipment shall meet the following requirements.



- B. The placing equipment for dry mix shotcrete shall be designed and equipped to receive the dry mix, introduce the mix into a stream of compressed oil free dry air, convey the mix pneumatically through a delivery hose to a nozzle at the point of discharge, inject water under pressure into the suspended stream of dry sand and cement within the nozzle, and spray the resulting shotcrete mix onto the surface of the work at a uniform rate and at a controlled velocity. The placing equipment shall be equipped with accurate gauges to indicate the air pressure and water pressure and with devices capable of accurately controlling the air pressure at any level between 50-psi and 80-psi, the water pressure at any level between 50-psi and 100-psi, and the rate of application of water at the nozzle.
- C. The placing equipment for wet mix shotcrete shall be designed and equipped to receive the shotcrete from the mixer, convey it through a delivery hose to a nozzle at the point of discharge, accelerate it in the nozzle by means of compressed oil free dry air, and spray it onto the surface of the work. It shall be capable of delivering shotcrete to the nozzle uniformly and continuously and discharging it from the nozzle at a uniform rate and at a controlled velocity sufficient for all parts of the work.
- D. Batch and continuous mixing equipment shall include: a power-driven mixer capable of thoroughly mixing the materials at a rate adequate to insure uniform feeding of the mixture to the placing equipment; and a feeding apparatus capable of supplying the mixture to the placing equipment at an adequate and uniform rate.

810.9

MIXING

- A. Dry Mix Shotcrete The cement and admixtures and other additives (except accelerator) shall be mixed into a predampened homogeneous mass that thoroughly coats the aggregate before being fed through a vibratory screen into the placing equipment. Proper pre-dampening shall be indicated by the "ball-in-hand" test as follows: When a small amount of mix is tightly squeezed the resulting ball will hold together or crack slightly but essentially remain whole. The mix has too little pre-dampening moisture if the ball crumbles into discrete particles when the hand is opened and/or color is light gray. If moisture comes off on the hand, too much pre-dampening moisture is in the mix. The properly pre-dampened dry mix shall be used within 45 minutes after mixing (15 minutes in hot weather conditions with temperatures over 85° F) and any material that becomes dried out or caked after mixing shall be wasted. Rebound material shall not be remixed or reused.
- B. Wet Mix Shotcrete Air-entrainment and chemical admixtures may only be used in wet mix concrete. The cement, sand, admixtures (except accelerator) and water shall be thoroughly mixed in the mixer drum sufficiently to produce shotcrete of the required consistency that is uniform within each batch and uniform from batch to batch when discharged into the placing equipment.
- C. Accelerators, if specified, shall be mixed at the nozzle. Ready-mix concrete shall conform to the requirements of ASTM C 94 unless otherwise specified.
- D. The entire contents of the mixer shall be discharged from the drum before materials for a succeeding batch are placed therein. A mix that becomes difficult to pump shall be discarded; otherwise, a batch shall be gunned within 1 1/2 hours of batching in normal weather and within 45 minutes during hot weather conditions (temperatures over 85° F). Rebound material shall not be remixed or reused.

810.10

FORMS

- A. Forms shall be structurally adequate and of such design that rebound or accumulated loose sand can freely escape or be readily removed. Shooting strips shall be used at corners, edges, and on surfaces where necessary to obtain true lines and proper thickness. Where practicable, ground wires shall be installed as guides to accurately establish the specified contour of the finished



surface of shotcrete. Ground wires shall be set and used as guides for templates in forming curved and molded surfaces. When shotcrete is to be placed on horizontal or sloping surfaces, headers and ground wires shall be provided to the extent necessary to insure control of slab thickness. Ground wires shall be tightened and kept taut, secure, and true to line and plane during placement of shotcrete and shall be removed when placement is completed.

- B. Header boards will be required where the drawings indicate a square edge and at required joints. Form surfaces shall be thoroughly cleaned and a form release agent applied before shotcrete is placed.

810.11

PREPARATION OF SURFACES TO RECEIVE SHOTCRETE

- A. All surfaces to receive or support shotcrete shall be carefully prepared and conditioned. All such prepared surfaces shall be inspected and approved by the Engineer prior to the application of shotcrete.
- B. Earth surfaces to which shotcrete is to be applied shall be firmly compacted and neatly trimmed to line and grade.
- C. Asphaltic concrete surfaces shall be thoroughly cleaned of any growths, earth, or any other material that would affect bond, or be detrimental to the shotcrete.
- D. Concrete, mortar, or rock surfaces shall be thoroughly cleaned by water blasting or sand blasting to remove all dirt, laitance, weak or unbonded mortar, loose material, grease or other deleterious substances.
- E. Surfaces on which the shotcrete is to be placed shall be sufficiently rough to insure the adherence of the shotcrete. Offsets which would cause an abrupt and substantial change in thickness of the shotcrete shall be removed or tapered.
- F. All surfaces shall be maintained in a moistened condition for three (3) hours before application of shotcrete. Shotcrete shall not be applied to mud, dried earth, uncompacted fill, rebound material, or surfaces on which free water exists. All ice, snow and frost shall be removed and the temperature of all surfaces, to be in contact with the new shotcrete shall be no colder than 40° F.

810.12

PLACING

- A. The Contractor shall have all equipment and materials required for curing available at the site and ready for use before placement of shotcrete begins. No shotcrete shall be placed except in the presence of the Engineer or authorized representative. The Contractor shall give reasonable notice to the Engineer each time shotcrete placement is scheduled. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the surfaces to which the shotcrete is to be applied, the forms, steel reinforcement, and other preparations for compliance with the specifications prior to the start of placement operations.
- B. During placement of shotcrete the air pressure shall be adjusted as required to control rebound and density of shotcrete. For a given application, once the optimum operating pressures have been established they shall be maintained constant throughout the application. For dry mix shotcrete, the air pressure at the material outlet or air-inlet on the gun shall be not less than 40 psi plus 5 psi for each 50 feet of length of the discharge hose greater than 100 feet and 5 psi for each 25 feet the nozzle is above the gun (shotcrete delivery equipment). The water pressure at the nozzle shall be not less than 15 psi greater than the air pressure at the material outlet or air-inlet on the gun.
- C. For most applications the placing nozzle shall be held between two (2) and six (6) feet from and approximately normal to the surface of the work. At longer distances it may be necessary to



increase the nozzle velocity so that the impact velocity will suit the requirements of the application. Corners shall be filled first.

- D. Shotcrete shall be applied in a single thickness or to a layer thickness no greater than that which will cause sagging, sloughing, or dropout. Sags and sloughs shall be cut out and regunned. Replacement shall be accomplished before the previously placed shotcrete has completely set. When shotcrete is placed on a vertical surface, application shall be started at the bottom and be completed at the top.
- E. In any case when the placing of shotcrete is interrupted for more than one (1) hour, the edge of the layer shall be sloped off at an angle of approximately 45 degrees to the surface being shot, and the sloped portion shall be covered with a double layer of six (6) ounce burlap and kept continuously moist until the application of shotcrete is resumed. Before applying new material, the sloped portion shall be thoroughly cleaned and wetted by means of an air and water blast or an equally effective method approved by the Engineer.
- F. Material that rebounds and accumulates on forms, subgrade surfaces or reinforcing steel ahead of the shotcrete being placed shall be removed and discarded.

810.13

FINISHING

- A. Rebound material shall be carefully swept off the finished shotcrete surface and discarded before it becomes too hard for removal. After the shotcrete has been placed to the depth required, the surface shall be checked with a straightedge or template and any low spots shall be brought up to grade by placing additional shotcrete. The finished surface of the shotcrete shall be left as a natural gun finish unless screeding and or further finishing are specified.
- B. When specified screeding shall be accomplished as follows: Place shotcrete a fraction beyond the guide strips, ground wires or forms. Allow the surface of the shotcrete to stiffen to the point it will not pull or crack under screeding or troweling. Trim, slice, or scrape excess material to true line and grade and remove the placing guides.
- C. A natural rod finish shall consist of the removal, by floating, of the impressions left after the guide strips or ground wires have been removed.
- D. A natural broom finish shall be that finish resulting from brooming the natural rod finish.
- E. A float finish shall be that finish resulting from floating the natural rod finish with a wood or rubber float.

810.14

CURING

- A. Shotcrete shall be prevented from drying for a curing period of at least seven (7) days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying, or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water, or covering, shall be applied in such a way that the shotcrete surface is not eroded or otherwise damaged.
- B. Water for curing shall be clean and free from any substances that will cause discoloration of the shotcrete where finished surfaces will be exposed to view.
- C. Except for surfaces to which additional shotcrete is to be applied, shotcrete may be coated with curing compound as an alternative to the continued application of moisture.



- D. The compound shall be sprayed on the moist shotcrete surfaces as soon as rebound has been removed and any required repairs are completed, or as soon as water curing is discontinued.
- E. The curing compound shall be thoroughly mixed immediately before applied and continuously agitated during application. It shall be applied at a uniform rate of not less than one (1) gallon per 100 square feet of surface for natural gun finishes. Curing compound shall be applied in two (2) applications, one (1) in each direction. If a natural rod, broom, or float finish is specified, the curing compound application rate shall be at least one (1) gallon per 150 square feet. Curing compound shall not check, crack or peel, and shall be free from pinholes or other imperfections.
- F. Curing compound shall not be applied to subgrade surfaces or other surfaces requiring bond with subsequently placed shotcrete, such as construction joints, reinforcing steel and other embedded items.
- G. Surfaces subjected to heavy rainfall or running water within three (3) hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original applications.
- H. Surfaces covered by the membrane shall not be trafficked unless protected from damage and/or wear.

810.15

REPLACEMENT OR REPAIR

- A. When shotcrete lacks uniformity, exhibits segregation, honeycombing, or laminations, or contains dry patches, slugs, voids or sand pockets the Contractor shall remove and replace the defective shotcrete. The Engineer's concurrence in the extent of removal and replacement is required.
- B. Prior to starting significant removal and replacement work the Contractor shall obtain the Engineer's approval of their plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's or owner's right to require complete removal of defective work if the completed repair does not produce shotcrete of the required quality and appearance.
- C. Repair work shall be performed only when the Engineer is present.
- D. Repair shall be made with shotcrete conforming to this specification. When removal of defective shotcrete is required, reinforcement damaged or destroyed shall be replaced prior to replacement of the shotcrete. At the edges of removed sections the sound shotcrete shall be carefully trimmed to the extent required to expose sufficient reinforcement for effecting competent splices. The sound shotcrete at the edges of removed sections shall be trimmed to a slope of approximately 45 degrees with the surface of the work and shall be thoroughly moistened prior to placement of the new shotcrete.
- E. Any portions of the work having thickness less than those specified may be repaired by the placement of additional layers of shotcrete, provided that such repair is expressly approved by the Engineer.
- F. Surfaces of the work to which additional shotcrete is to be applied shall be prepared as required by Section 810.11 of this specification.
- G. Curing as specified in Section 810.14 of this specification shall be applied to repaired areas immediately after the repairs are completed.



PLACING IN COLD WEATHER

- A. When the atmospheric temperature may be expected to drop below 40° F at the time shotcrete is placed, or at any time during the curing period, the following provisions shall also apply:
1. Shotcrete placement shall be permitted when the air temperature is at least 40° F and rising. Placement shall be discontinued if the temperature falls to 40° F and is expected to continue to fall.
 2. The temperature of the shotcrete at time of placing shall not be less than 50° F nor more than 90° F. The temperature of neither aggregates nor mixing water shall be more than 100° F just prior to mixing with the cement.
 3. When the daily minimum temperature is less than 40° F, shotcrete shall be insulated or housed and heated after placement. The temperature of the shotcrete and air adjacent to the shotcrete shall be maintained at not less than 50° F nor more than 90° F for the duration of the curing period.
 4. Methods of insulating, housing and heating the structure shall be in accordance with "Standard Specification for Cold Weather Concreting," ACI Standard 306.1.
 5. The use of accelerators or antifreeze compounds will not be allowed unless otherwise specified.
 6. When dry heat is used to protect shotcrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the shotcrete has been coated with curing compound as specified in this section or is covered tightly with an approved impervious material.

PLACING IN HOT WEATHER

- A. When climatic factors such as high air temperature, reduced relative humidity and increased wind velocities are present, or conditions are such that the temperature of placed shotcrete exceeds 90° F at, or during the first 24 hours after placement, the following provisions shall also apply:
1. The Contractor shall maintain the temperature of the shotcrete below 90° F during mixing, conveying, and placing using the methods given in items a, b, and c below.
 - a. Exposed shotcrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected from drying immediately after placement.
 - b. Shotcrete surfaces exposed to the air shall be covered as soon as the shotcrete has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period, and for the entire curing period unless curing compound is applied as specified in Section 810.14 of this specification.
 - c. If moist curing is discontinued before the end of the curing period, white pigmented curing compound shall be applied immediately, following the procedures specified in Section 810.14 of this specification.



MEASUREMENT AND PAYMENT

- A. Payment will be made at the contract unit price per square foot for shotcrete. Such payment will constitute full compensation for completion of the work, including making and handling test panels but not including reinforcing steel or other items listed for payment elsewhere in the contract.
- B. Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Section 807, REINFORCING STEEL.

END OF SECTION

