Prepared by:

The City of San Angelo, Texas
Department of Public Works
Engineering Services

MLK and 3rd St. Valve Replacement
Project No.: WU-06-19

Technical Specifications

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Date: May 7, 2019

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4.1 - General Notes

4.1.1 Utility trenches extending into paved streets shall be completely repaired (including asphalt) as soon as possible after utility line installations are complete.

4.1.2 Implementation and maintenance of trench protection according to OSHA regulations is the CONTRACTOR's responsibility.

4.1.3 It shall be the CONTRACTOR's responsibility to familiarize themselves with the location of controlling water valves in an area prior to commencing construction in that area.

4.1.4 Where unpaved driveways are disturbed by construction operations, CONTRACTOR shall back-slope, grade and surface with a minimum of six inches (6") (unless existing base material is thicker) of base material to the right-of-way line as necessary to restore to original or better condition. Pay is subsidiary to other bid items.

4.1.5 Where paved driveways are disturbed by construction operations, CONTRACTOR shall repair in accordance with the City of San Angelo specifications.

4.1.6 The CONTRACTOR shall minimize any dust problems by sprinkling and/or sweeping as directed by the OWNER. Pay is subsidiary to the various bid items. After completing installation and pavement repair of each portion of the project, CONTRACTOR shall thoroughly sweep and clean up all dirt, material and debris from the street.

4.1.7 Wet connections, including new main tie-ins, occurring during utility line installation will not be paid for but are considered subsidiary to the item being constructed.

4.1.8 Wet taps of existing water lines will be by the CONTRACTOR. The CONTRACTOR shall perform all excavation and supply and install all tapping saddles, valves and other materials. Wet taps will be paid at the quote provided by the CONTRACTOR in the bid form. Connections to existing lines not itemized on the bid form will be subsidiary to line installation.

4.1.9 The CONTRACTOR will restore all disturbed areas, fences, drives, yards, etc. to original or better condition as approved by the OWNER.

4.1.10 Bacteriological testing will be completed in coordination with the City of San Angelo Water Quality Lab. The CONTRACTOR will have one of the certified Lab techs from the Water Quality Lab collect the field samples, and have analytical results emailed documented for the project.

4.1.11 Flushing of Mains/Test Water: All water flushed from a main shall be contained and not allowed to discharge onto the ground unless specifically authorized by the OWNER. The CONTRACTOR may discharge water into a City of San Angelo owned sewer manhole with the OWNER's approval and only at such flow rates as allowed by the OWNER. Any discharge or disposal of water shall be in compliance with all State and Federal regulations.

4.1.12 For all valves installed under this contract, the CONTRACTOR shall etch valve locations (direction and distance) into curb and gutter. All lettering and numbering shall be a minimum of three inches (3") in height. Valves shall also be constructed at each junction such that no connecting leg is unvalved. At street intersections, valves shall be located outside of pavement. At alley intersections with thoroughfare streets, valves shall be located at the projected right-of-way line of the street. Where possible, valves in streets should be designed to fall outside of wheel paths.

4.1.13 All process control operations including but not limited to operating isolation valves, disinfecting mains, turning on/off customer service valves, and taking chlorine residuals and microbiological samples must be under the direct supervision of a person with a Class D water license or higher. The CONTRACTOR is responsible for providing individuals with these classifications for supervision of the work. The CONTRACTOR must submit a list of licensed individuals to the OWNER for approval before any work may be performed on the OWNER's distribution system.

4.1.14 On-Site Storage of Materials: The CONTRACTOR must have the OWNER's approval for on-site storage of materials. Stored materials shall not obstruct the flow of stormwater, vision of vehicle operations, or cause damage to personal or public property. Storage areas shall be kept neat and clean.

4.1.15 City of San Angelo Owned Materials: The CONTRACTOR shall provide all materials to complete the project. The OWNER will not provide materials to the CONTRACTOR unless otherwise specified.

4.1.16 Pavement Cuts in High Traffic Areas: Pavement cuts in high traffic areas shall be backfilled and a temporary asphalt patch placed to stabilize the cut within forty-eight (48) hours of start of construction.

4.1.17 All Concrete shall be 3,000 psi minimum at twenty-eight (28) days unless otherwise specified. Concrete in Rigid Pavement shall be Class P 3,500 psi.

4.1.18 Sequencing and completion dates, if applicable, for the project shall be as follows:

4.1.19 For each section within the project, once construction begins, the CONTRACTOR shall designate a crew to remain on site during standard working hours, until all work has been completed. A section shall be each area noted in the "Approximate Breakdown of Quantities" below. This note shall also apply to work being conducted at each individual Fire Hydrant Replacement, Water Quality Sampling Station and water meter change-out, if applicable.

4.1.20 Some or all water meters may contain Automatic Meter Readers (AMR). An AMR consists of a meter body, register, M.I.U. box, antenna, and associated wiring. CONTRACTOR shall be trained by the OWNER (City of San Angelo Staff) prior to working on or around any meter boxes. Antenna wiring may be disconnected from M.I.U. boxes but must be reconnected according to the manufactures requirements. OWNER will provide wire connectors. The CONTRACTOR is responsible for any damages to an AMR. If an AMR is damaged, the

CONTRACTOR shall pay $220.00 per each unit damaged to cover replacement and labor. All damaged AMRs shall be reported immediately to the OWNER.

4.1.21 Backfilled trenches shall be finish paved within two weeks of backfilling or the CONTRACTOR shall place and maintain temporary cold mix paving until final paving is accomplished.

4.1.22 Connections to existing mains; position valves near the end of curb return on the intersecting street and away from the intersection. From the valve, transition the connection with approximately thirty feet of pipe and within 75% of the manufacturers recommended radius in order to accomplish a straight connection with lateral water main.

4.1.23 Where a new potable water line parallels an existing, non-pressure rated or pressure rated wastewater main or lateral and the existing wastewater main is determined not to be leaking, the new potable water line shall be located at least two feet above the existing wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the existing wastewater main or lateral. Every effort shall be exerted not to disturb the bedding and backfill of the existing wastewater main or lateral. As in accordance with TCEQ's Chapter 290.44(e)(4)(A)(i)

4.1.24 Where a new potable waterline crosses an existing, non-pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral is disturbed or shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure rated pipe. As in accordance with TCEQ's Chapter 290.44(e)(4)(B)(i).

4.2 - Temporary Facilities

4.2.0 General

4.2.1 Office at Site of Work

During the performance of this contract, the CONTRACTOR shall maintain a suitable office at or near the site of the Work which shall be the headquarters of his representative authorized to receive drawings, instructions, or other communication or articles. Any communication given to the representative or delivered at the CONTRACTOR'S office at the site of the Work in his absence shall be deemed to have been delivered to the CONTRACTOR. The site office or any other facility at the site shall not be used as a residence.

Copies of the Plans, Specifications, and other Contract Documents shall be kept at the CONTRACTOR'S office at the site of the Work and available for use at all times.

4.2.2 Water

Water in reasonable amounts for proper completion of the Work will be furnished by the OWNER without charge to the CONTRACTOR. The CONTRACTOR shall furnish necessary temporary pipe, hose, nozzles, and tools and shall perform all necessary labor required to connect to existing water facilities. Unnecessary waste of water will not be tolerated. Special hydrant wrenches shall be used for opening and closing fire hydrants. In no case shall pipe wrenches be used for this purpose.

An account of all water usage will be required. OWNER will provide CONTRACTOR with a reasonable amount of water meters including fire hydrant meters that shall be used to keep track of water usage during flushing of mains and filling of water trucks. CONTRACTOR shall be responsible to install and report meter readings a minimum of once a month to OWNER.

4.2.3 Power

The CONTRACTOR shall provide all power for heating, lighting, operation of the CONTRACTOR'S plant or equipment, or for any other use by the CONTRACTOR. Temporary heat and lighting shall be maintained until the Work is accepted.

4.2.4 Telephone Service

The CONTRACTOR shall make all necessary arrangements and pay all installation charges for telephone lines in his office at the site and shall provide all telephone instruments.

4.2.5 Sanitary Facilities

The CONTRACTOR shall furnish temporary sanitary facilities at the site, as provided herein, for the needs of all construction workers and other performing work or furnishing services on the Project.

Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. Number of facilities shall be in accordance with federal, state, and local requirements. The CONTRACTOR shall enforce the use of such sanitary facilities by all personnel at the site.

4.2.6 Maintenance of Traffic

The CONTRACTOR shall provide OWNER with site specific traffic control plans.

The CONTRACTOR shall conduct his work to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, the CONTRACTOR shall provide and maintain suitable and safe detours or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them.

4.2.7 Fences

All existing fences affected by the Work shall be maintained by the CONTRACTOR until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. The CONTRACTOR shall restore all fences to their original or better condition.

4.2.8 Damage to Existing Property

The CONTRACTOR will be held responsible for any damage to existing structures, Work, materials, or equipment because of his operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of, and at no additional cost to the OWNER.

The CONTRACTOR shall protect all existing facilities and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

The CONTRACTOR shall be responsible for all damage to streets, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work. The CONTRACTOR shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

4.2.9 Security

The CONTRACTOR shall be responsible for protection of the site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

4.2.10 Access Roads

The CONTRACTOR shall establish and maintain temporary access roads to various parts of the site as required to complete the Project. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project.

4.2.11 Parking

The CONTRACTOR shall provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

4.2.12 Noise Control

The CONTRACTOR shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

4.2.13 Dust Control

The CONTRACTOR shall take reasonable measures to prevent unnecessary dust. The CONTRACTOR shall limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original cover as long as practicable. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant and repeat as needed. Water shall be furnished by the CONTRACTOR and shall be clean and free from industrial wastes and other objectionable matter. Do not apply water in quantities to cause runoff. Dusty materials in piles or in transit shall be covered when practicable to prevent blowing.

4.2.14 Temporary Drainage Provisions

The CONTRACTOR shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.

Existing drainage channels and conduits shall be cleaned, enlarged or supplemented as necessary to carry all increased runoff attributable to the CONTRACTOR'S operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the OWNER'S facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided as necessary to prevent downstream flooding.

4.2.15 Pollution Control

The CONTRACTOR shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris and other substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse other than sanitary sewers. No sediment, debris or other substance will be permitted to enter sanitary sewers and reasonable measures shall be taken to prevent such materials from entering any drain or watercourse.

4.2.16 Erosion and Siltation Controls

The CONTRACTOR shall be responsible for complying with all applicable Local, State and Federal regulations concerning Erosion and Sediment Control. If required, the CONTRACTOR shall prepare and submit all required documentation, including but not limited to, “Notice of Intent” (NOI), “Notice of Termination” (NOT), and “Notice of Change” (NOC). The CONTRACTOR shall prepare and comply with the Storm Water Pollution Prevention Plan and Storm Water Management Plan. The plans shall be prepared by a Professional Engineer, Registered in the State of Texas, and show all necessary control measures in detail to effectively control erosion and sediment. Plans shall be submitted to the OWNER. The CONTRACTOR shall be responsible for all fees associated with the Permit.

The inspection and maintenance of the erosion prevention measures shall be the contractor's responsibility throughout all phases of the construction. All erosion control measures shall be in place prior to any construction activities. They shall remain in place until after construction is complete and the site has been stabilized.

The CONTRACTOR shall provide silt fencing and or erosion control blankets appropriate for erosion and siltation control, and shall maintain all such systems in effective operating condition throughout the entire construction process.

4.3 - Excavation and Backfill

4.3.0 General

4.3.0.1 Scope

This section covers excavation work and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; construction of fills and embankments; surfacing and grading pavement replacement, concrete blocking; and other appurtenant work. Excavation shall provide adequate working space and clearances for the work to be performed therein.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the OWNER. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

4.3.1 Classification of Excavated Materials

All excavation shall be classified as either common excavation or rock excavation. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work.

4.3.1.1 Common Excavation

Common excavation is defined as the removal of all material which is not classified as rock excavation.

4.3.1.2 Rock Excavation

Rock excavation is defined as the removal of all materials which, by actual demonstration, cannot in the OWNER's opinion, be reasonably excavated with standard excavation equipment.

The OWNER reserves the right to waive the demonstration of the material encountered as well defined rock. The term "rock excavation" shall be understood to indicate a method of removal and not a geological material. In addition, rock excavation may include removal of well-defined rock by the method of mechanical splitting. In the areas where rock removal is required, Technical Specification 4.43, "Vibration Monitoring Specification," shall be followed.

No payment will be made under "Rock Excavation" for any method of rock removal other than mechanical splitting. Measurement shall be the depth per linear foot. The depth is the difference in elevation between the theoretical bottom of bedding and the top of the original rock. The length or linear foot will be measured horizontally along the centerline of the trench.

4.3.2 Site Preparation

All areas of the site to be occupied by permanent construction or embankments shall be cleared of all trees, roots, brush, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and surface soils All waste materials shall be removed from the site and disposed of by and at the expense of the CONTRACTOR. Suitable surface soils shall be stockpiled on the site and used for final site grading. Excess surface soils, as determined by the OWNER, shall be removed at the CONTRACTOR`S expense.

4.3.3 Blasting

Blasting or other use of explosives for excavation will not be permitted without the consent of the OWNER.

4.3.4 Unauthorized Excavation

Except where otherwise authorized, shown, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the CONTRACTOR, with concrete placed at the same time and monolithic with the concrete above. Excess excavation of trenches shall be refilled with material approved by the OWNER.

4.3.5 Dewatering

Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations twelve inches (12”) or more.

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

The CONTRACTOR shall be responsible for the condition of any pipe or conduit which may be used for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

All dewatering activities shall be in compliance with the Texas Commission on Environmental Quality (TCEQ) rules and guidelines, i.e. limit erosion, sediment disposal and permitting. All dewatering shall also be in compliance with Technical Specification 4.2.14, “Temporary Drainage Provisions,” and Technical Specification 4.2.15, “Pollution Control.” of this project specification manual.

4.3.6 Stabilization

Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top shall be reinforced with crushed rock or gravel. The stabilizing material shall be spread and compacted to a depth of not more than four inches (4"). If the required depth exceeds four inches (4"), the material shall be spread and compacted by vibration. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the Plans.

4.3.7 Earth Fills and Embankments

Fills and embankments shall be constructed to lines and grades indicated on the Plans.

All material placed in fills and embankments shall be free from rocks or stones larger than four inches (4") in their greatest dimension, brush, stumps, roots, debris, and organic or other deleterious materials and shall be approved by the OWNER.

No rocks or stones shall be placed in the upper eighteen inches (18") of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments provided they are distributed so that they do not interfere with proper compaction.

4.3.8 Subgrade Preparation

After preparation of the fill or embankment site, the areas of the subgrade shall be leveled and compacted to ninety-five percent (95%) of modified proctor density as determined by ASTM D1557 at optimum moisture content.

4.3.9 Placement and Compaction

All fill and embankment materials shall be placed in approximately horizontal layers not to exceed eight inches (8") in uncompacted thickness. Material deposited in piles or windows by excavating and hauling equipment shall be spread and leveled before compaction.
Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to ninety-five percent (95%) of modified proctor density at optimum moisture content as determined by ASTM D1557. If the material fails to meet the density specified, compaction methods shall be altered.

Wherever a trench is to pass through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than twelve inches (12") or more than eighteen inches (18") above the top of pipe elevation before the trench is excavated.

4.3.10 Granular Fills

Granular fills shall be provided where required. Granular fills shall be placed on suitably prepared subgrades and compacted by vibration. Granular fill material shall be pea gravel, well

graded and clean, 2-inch to No.4, meeting all requirements of ASTM C33. Granular fill shall be compacted to eighty percent (80%) relative density as determined by ASTM 2049.

Bedding material for the installation of water and sewer mains shall be crushed stone or pea gravel that will remain firm and not permit displacement of the pipe either during pipe laying or backfilling or following completion of construction. Bedding material shall be from an approved bedding material source per the List of Approved Bedding Material Suppliers or meet the following gradation when tested in accordance with TXDOT Designation: TEX-200-F, Part I, and be approved by the City Engineer:

COSA Bedding Material Gradation	
Sieve Size	Cumulative % Retained
1/2"	0
3/8”	0-20
#4	40-90
#10	95-100
#20	99-100

4.3.11 Unsuitable Foundation Material

Soft, loose, or otherwise unsuitable foundation soils that occur shall be excavated and removed to the limits designated by the OWNER and replaced with compacted backfill. The compacted backfill shall comply with the requirements specified.

4.3.12 Trench Excavation

Trenches shall be excavated so that pipes can be laid straight at uniform grade, without dips or humps. All fill material shall be in compliance with the utility trench repair details shown in the Plans.

4.3.13 Minimum Cover

Where pipe grades or elevations are not definitely fixed by the contract Plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of thirty inches (30”) for pipe diameters of 12” and less and thirty-six inches (36”) for pipe diameters larger than 12” of backfill cover over the top of the pipe, including couplings or bells.

4.3.14 Limiting Trench Widths

Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment. Trench widths from the bottom of the trench to an elevation one-foot above the top of the installed pipe shall be as follows:

Nominal Pipe Size	Minimum Trench Width	Max. Trench width
<=16"	Pipe OD plus 12"	Pipe OD plus 18"
>16"	As specified by pipe manufacturer and approved by the OWNER	

4.3.15 Compacted Backfill

Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:

a) Where beneath surface construction, structures, or streets.

b) Where in future street right-of-ways.

c) Where beneath fills or embankments.

Compacted backfill shall be placed in eight inch (8") un-compacted thick layers and compacted at optimum moisture content to ninety-five percent (95%) modified proctor density as determined by ASTM D1557. Where the trench for one pipe passes beneath the trench for another pipe, backfill for the lower trench shall be compacted to the level of the bottom of the upper trench. The CONTRACTOR shall be responsible for providing all proctor data from all source pits used to be approved by the OWNER. The OWNER reserves the right to conduct density tests at any time, at the OWNER's expense.

Trench areas not required to have compacted backfill, shall be backfilled and stabilized by the water jetting method. Material shall be deposited in the trench in layers not exceeding two feet (2') thick. A water jet pipe shall be inserted at close intervals on opposite sides of the pipe and the material shall be adequately soaked so it will consolidate in the trench. Jetting methods shall be approved by the OWNER. Backfill not suitable for water jetting shall be placed by methods approved by the OWNER. Completed backfill shall be neatly rounded over the trench.

Where well pulverized or granular material is available from the trench excavation, which meets the approval of the OWNER for Backfill, the CONTRACTOR will be allowed to use the approved material from the excavation for Backfill as instructed by the OWNER.

4.3.16 Structure Backfill

The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for trench backfill. Backfill materials shall be deposited in layers not to exceed eight inches (8") in uncompacted thickness and compacted to at least ninety-five percent (95%) of modified proctor density at optimum moisture content as determined by ASTM D1557. Compaction of structure backfill by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Water jetting of structural backfill shall be allowed only upon permission of the OWNER.

No backfill shall be deposited or compacted in water. Particular care shall be taken to compact structure backfill which will be beneath pipes, surface construction, or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than twelve inches (12") above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

4.3.17 Final Grading and Placement of Topsoil

After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least four inches (4"). Topsoil may consist of the surface soils cleared from the site during site preparation and shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. Unless otherwise indicated, a slope of at least one percent shall be provided.

Final grading and surfacing shall be smooth, even, and free from clods and stones larger than one-inch in greatest dimension, weeds, brush, and other debris.

4.3.18 Disposal of Excess Excavated Materials

Insofar as needed, suitable excavated materials shall be used. All excess excavated materials together with all debris stones, stumps, and roots shall be removed from the site and disposed of by, and at the expense of, the CONTRACTOR. Excess material or material which cannot be made suitable for use in embankments will be declared surplus and shall become the property of the CONTRACTOR to dispose of offsite at a permitted fill site, without liability to the OWNER or any individual. Such surplus material shall be removed from the Work site promptly following the completion of the portion of the utility involved.

4.3.19 Shoring and Sheathing of Excavations

Wherever necessary to prevent caving, excavation shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, checked for defects and repaired if necessary and the trench backfilled to a depth of two feet (2') over the top of the pipe. The CONTRACTOR shall comply with all local, state and federal requirements for sheeting and shoring.

4.3.20 Settlement

The CONTRACTOR shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

The CONTRACTOR shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the OWNER.

4.3.21 Pavement Replacement

Pavement surface, concrete, caliche, limestone, or asphaltic, replacement shall be done by the CONTRACTOR at his expense as indicated on the Plans.

4.3.22 Concrete Blocking

Concrete blocking shall be placed at bends, tees, wyes, crosses, plugs, hydrants, etc., in the water line. The concrete blocking shall be placed so as to rest against firm undisturbed trench

walls. The supporting area for each block shall be sufficient to withstand the thrust, including water hammer. Each block, except those for upward thrusts, shall rest on a firm, undisturbed foundation of trench bottom. Where upward thrusts are to be blocked, the concrete blocking shall be of sufficient weight to resist the thrust and the concrete shall be reinforced as directed by the OWNER. Blocking shall not extend beyond any joints, cover any bolted connections or in any way restrict or inhibit the access to or workability of any component of the water line.

4.3.23 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.4 - Trench Safety Systems

4.4.0 General

4.4.0.1 Scope

This section shall govern for designing, furnishing, installing, maintaining and removal of Trench Safety Systems for trench excavation. Back-sloping and/or benching of the trench are not acceptable means of trench protection unless prior approval is obtained from the OWNER.

At a minimum, this work shall conform to the United States Department of Labor Rules 29 CFR, Part 1926 Occupational Safety and Health Administration (OSHA). The Competent Person(s) shall be on the project whenever workers are in an excavation trench.

Attention is called to the fact that excavations may contain potentially harmful environments or atmospheres. If working on or around the sanitary sewer system it has the capability of producing an environment that may be harmful to workers. The CONTRACTOR shall provide workers with personal protective equipment as necessary to provide adequate protection. The CONTRACTOR shall provide equipment to determine if a hazardous atmosphere exists prior to allowing workers to enter any areas that may contain a potentially harmful environment. The equipment shall be kept calibrated, maintained in good condition and all maintenance and calibration records kept on site for inspection.

At a minimum, the CONTRACTOR shall monitor and record atmosphere testing results for oxygen levels and the presence of combustible gases. These measurements should be made before lids are removed and shall be measured at various depths including the workspace. Testing shall continue as long as workers are present in the area.

4.4.1 Trench Safety System Plan Submittal

Prior to, or at the Pre-Construction Meeting, the CONTRACTOR shall submit to the OWNER a Trench Safety System Plan sealed by a registered Professional Engineer licensed in the State of Texas. The Trench Safety System Plan at a minimum shall conform to OSHA standards for sloping sides, utilization of trench boxes, and/or utilization of shoring, sheeting and bracing methods. The CONTRACTOR shall be responsible for obtaining all information necessary for the design of the Trench Safety System Plan. The Trench Safety System Plan submittal shall include:

a) A drawing or plan indicating specific designation of areas in which each type of system will be used, including length of trench to be opened, the length of time that trench will remain open, the means of egress, the storage of materials, allowable loads of trench walls, the methods for placing/compacting bedding/backfill within the safety system, any equipment restrictions and the subsequent removal of system,
b) Drawings or manufacturer's data, as applicable, that describes the various elements of the Trench Safety System in sufficient detail that the workers can properly install the Trench Safety System,
c) Recommendations and limitations for using systems.
d) Certification of Completion of an OSHA-approved program indicating that the CONTRACTOR's Competent Person(s) has received training in "Excavation Safety".

4.4.2 Construction

The CONTRACTOR's Competent Person(s) shall be responsible for the maintenance of a copy of appropriate OSHA regulations onsite and the implementation of OSHA trenching safety regulations at the work site. Trenching shall be completed to the lines and grades indicated on the Plans or as specified in various technical standard specification items requiring excavation and trenching and/or backfilling. The CONTRACTOR shall perform all trenching in a safe manner and shall maintain safety systems to prevent death or injury to personnel or damage to structures, utilities or property in or near the excavation.

If evidence of possible cave-ins or earthen slides is apparent or an installed trench safety system is damaged, the work in the trench shall immediately cease and personnel evacuated from the area. Personnel shall not be allowed to re-enter the excavation until necessary repairs or replacements are completed and are inspected and approved by the CONTRACTOR's Competent Person(s). Repair and/or replacement of the damaged safety system shall be at the CONTRACTOR's sole expense.

4.4.3 Changed Conditions

When changed conditions require modifications to the Trench Safety System, the CONTRACTOR shall provide to the OWNER a new design or an alternative Trench Safety System that is proposed by the CONTRACTOR's Trench Safety Engineer to address the changed conditions encountered. Copies of the new design or alternate system shall be provided to the OWNER in accordance with the requirements of Technical Specification 4.4.1, "Trench Safety System Plan Submittal". A copy of the most current Trench Safety System shall be maintained on site and made available to inspection and enforcement officials at all times.

Any changes to the Trench Safety System Plan that are initiated by the CONTRACTOR for operational efficiency or as a result of changed conditions will not be cause for cost adjustment.

4.4.4 Contractor's Responsibility

The CONTRACTOR has sole and exclusive responsibility for the sufficiency of the trench excavation safety systems utilized conforming fully to all State and Federal laws applicable inclusive of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) on excavation, trenching and shoring, which includes, but is not limited to, Subpart P, Part 1926, of the Code of Federal Regulations.

The CONTRACTOR shall specifically agree that neither the OWNER nor the Engineer nor any representative has such responsibility, and CONTRACTOR will not rely on the OWNER or the Engineer or any of their representatives for inspection, design, supervision, construction or any other aspect of trench excavation safety protection.

4.4.5 Measurement

Trench Excavation Protection shall be measured by the linear foot along the centerline of the trench.

4.4.6 Payment

All development, design, furnishing, installing the system, for dewatering, maintenance, replacement and removal of the Trench Safety Systems, for sloping, special clearing, excavation and work including material, plans and reports required to safely implement the trench safety system will be paid at the price bid and the units specified in the Bid Agreement Form for Trench Excavation Protection.

4.5 - Seeding for Erosion Control

4.5.0 General

4.5.0.1 Scope

This item shall govern for preparing ground, providing for sowing of seeds, seed bed fertilizer, watering, mulching with straw, hay, cellulose fiber, hydro mulch or and other management practices on all areas disturbed by the CONTRACTOR's operations. CONTRACTOR shall replace cover of all disturbed areas with the same type of vegetation in accordance with this item.

4.5.1 Materials

a) **Seed** - All seed must meet the requirements of the Texas Seed Law including labeling requirements for showing pure live seed (PLS = purity x germination), name and type of seed. Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine months of the time of use on the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety of seed shall be furnished for analysis and testing when directed by the OWNER. Buffalo grass shall be treated with a dormancy method approved by the OWNER. The species and varieties of seed shall as specified herein.

b) **Fertilizer** - Fertilizer shall conform to the requirements of Technical Specification 4.5.2, "Construction Methods," under "Fertilizer". The fertilizer shall conform to the specified analysis.

c) **Water** - Water shall be furnished by the CONTRACTOR and shall be clean and free from any impurities which will prohibit or hinder its use as specified.

d) **Mulch** -

a. Straw Mulch or Hay Mulch: Straw mulch shall be oat, wheat or rice straw. Hay mulch shall be prairie grass, Bermuda grass or other hay as approved by the OWNER. The straw mulch or hay mulch shall be free of Johnson grass or other noxious weeds and foreign materials. It shall be kept in a dry condition and shall not be molded or rotted.

b. Cellulose Fiber Mulch: It shall meet the requirements of and be approved by the OWNER. A list of pre-tested and approved materials can be obtained from the Texas Department of Transportation, Director of Maintenance and Operations.

c. Soil Retention Mulch: It shall meet the requirements of and be approved by the OWNER.

d. The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with fertilizers and other additives. The mulch shall be such that, when applied, the material shall form a strong, moisture-retaining mat without the need of an

asphaltic binder. It shall be kept in a dry condition and shall not be molded or rotted.

e) **Soil Retention Blanket** - Soil retention blanket shall conform to the requirements of TXDOT Specification Item 169, "Soil Retention Blankets".

f) **Tacking Agents** - Tacking agents for straw or hay mulch shall be SS-1, unless shown otherwise on the Plans. A biodegradable tacking agent may be used in lieu of the SS-1 tacking agent when approved by the OWNER.

4.5.2 Construction Methods

After designated areas have been completed to the lines, grades and cross sections shown on the Plans and as provided for in other items of this contract, seeding shall be performed in accordance with the requirements hereinafter described. Unless otherwise approved by the OWNER, all areas to be seeded shall be cultivated to a depth of at least four inches, unless the existing soils conditions are deemed acceptable by the OWNER for seeding. The seed beds shall be cultivated sufficiently to reduce the soil to a state of good tilth when the soil particle on the surface are small enough and lie closely enough together to prevent the seed from being covered too deeply for optimum germination. Cultivation of the seed bed will not be required in loose sand where depth of sand is four inches or more.

The cross section previously established shall be maintained throughout the process of cultivation. Any necessary reshaping shall be done prior to any planting of seed.

Planting Season and Seed Mixes - If construction is completed between February 1st to May 15th, or after a Cool Season Planting has been made, then the Warm Season Seeding Mixture should be planted. If construction is completed between May 16th to August 31st, Warm Season Seeding Mixture should be planted, supplemented with Foxtail Millet at 20 lbs./acre, until the appropriate time for the Cool Season Seed Mixture can be planted. If construction is completed between September 1st to November 30th, then the Cool Season Planting of Red Winter Wheat and the Warm Season Seeding Mixture should be conducted. If construction is completed between December 1st to January 31st, then the Cool Season Planting of Annual Rye Grass and the Warm Season Seeding Mixture should be conducted.

The pure live seed (PLS) planted per acre shall be of the type specified, with the mixtures as shown in tables below, except as noted on the Plans.

Warm Season Seeding Mixture		
Common Name	**Scientific Name**	**PLS/acre**
Green Sprangletop	Leptochloa dubia	0.7
Sideoats Grama (Haskell)	Bouteloua curtipendula	2.2
Buffalograss	Buchloe dactyloides	6.4
Little Bluestem	Schizachyrium scoparium	1.4
K-R Bluestem	Bothriochloa ischaemum	0.8

Cool Season Seeding Mixture		
Common Name	**Scientific Name**	**PLS/acre**
Annual Rye Grass	Lolium Multiflorum	4.0
Western Wheatgrass	Pascopyrum smithii	10.0
Wheat (Red, Winter)	Triticum aestivum	22.0

Drill Seeding - The seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the Plans or where directed by the OWNER. All varieties of seed, as well as fertilizer, may be distributed simultaneously provided that each component is uniformly applied at the specified rate. Seed shall be drilled at a depth of from 1/4 to 3/8 inch utilizing a pasture or rangeland type drill. All drilling shall be along the contour of the slope. After planting, the area shall be rolled with a roller integral to the seed drill, or a light corrugated drum roller or another type of roller approved by the OWNER. All rolling of slopes shall be on the contour of the slopes.

Mulching - Mulch shall be applied to all seeded areas within forty-eight (48) hours after all drill seeding operations have been completed. Material shall be applied from two separate and opposite (180 degrees) directions to prevent shadowing and to provide an even coverage. Mulching application shall be such that the ground surface, when viewed from opposite directions, is not visible. Under no circumstances is seed to be applied in the mulch mix.

Level to Gently Sloping Area Mulching. This area shall be mulched with a spray-applied cellulose fiber mulch with pre-mixed tackifier and fertilizer (see following section). The mulch shall be applied at 2,500 pounds per acre. The mulch shall have the following characteristics and shall be as manufactured by Profile Products, or other approved equal:

- Materials: Cellulose fiber, polymer tackifier, dark green dye.
- pH range: 7.0 ±2
- Moisture Content: 12 ±3% maximum
- Organic Content: 90.0 ±3%
- Ash Content: 10.0 ±3%
- Tackifier: 3% polymer tackifier
- Water Holding Capacity: 1050% minimum

Side-Slope Area Mulching. This area shall be mulched with a spray-applied bonded fiber matrix wood fiber with pre-mixed tackifier and crimped polyester fiber. The mulch shall provide for a strong mechanical and chemical bond. The mulch shall be applied at 3,000 pounds per acre. The mulch shall have the following characteristics and shall be as manufactured by Profile Products (Conwed 3000), or other approved equal:

- Materials: Wood fiber, crimped polyester fibers, polysaccharide cross-linked hydro-colloid polymer tackifier, dark green dye.
- pH range: 4.8 ±2
- Moisture Content: 12 ±3% maximum

- Degradable Crimped Polyester Fibers: 5 ±1%
- Polysaccharide Crosslinked Hydro-colloid Polymer Tackifier: 10 ±1%
- Wood Fiber Content: 85% maximum
- Organic Content: 95% minimum
- Ash Content: 5.0 ±1%
- Water Holding Capacity: 1500% minimum

Water - Water shall be supplied to the seeded areas with adequate moisture (three inches (3") to four inches (4") penetration) at ten (10) day intervals, if needed, for seed germination and plant growth until accepted by the OWNER. Water shall be spray applied to the seeded areas in a manner which will prevent erosion of the soil. CONTRACTOR shall furnish and apply all water.

Fertilizer - All fertilizer utilized shall be provided with the manufacture's label which presents the percent of nitrogen, phosphoric acid and potash nutrients, as determined by the methods of the Association of Official Analytical Chemists. The fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the Texas Fertilizer Law. Testing will be conducted at the expense of the OWNER unless the supplied fertilizer fails to meet the minimum specified content, in which case testing will be at the expense of the CONTRACTOR.

The fertilizer shall be 16-8-8 (percent of nitrogen, phosphoric acid and potash nutrients) unless otherwise specified on the Plans. The fertilizer shall be applied at the rate of 125 pounds per acre. The CONTRACTOR shall have the option of providing a fertilizer of a different analysis, if approved by the OWNER. However, the amount of each nutrient specified shall not be less than that specified.

Fertilizer shall be in an acceptable condition for distribution and shall be applied uniformly over the specified area and at the rate shown on the Plans. Distribution of fertilizer shall be approved by the OWNER. Limit fertilizer application if precipitation is forecasted within 24 hours of application, or as specified via label instructions. (TPDES GP TXR040000)

4.5.3 Establishment of Stand and Acceptance

Upon completion of the site preparation, mulching, fertilizing, seeding and maintenance of the seeded areas, the OWNER will observe the seeded areas periodically to determine the establishment success. The OWNER will consider soil coverage, purity of grass stand and maturity of the plants.

The OWNER will determine that a grassed area is established upon fulfillment of the following conditions:

a) The permanent grass stand uniformly covers the planting area, with no exposed soil areas more than thirty-six inches (36") across in any dimension.

b) The permanent grass stand is free of over-topping weed species which would compete for sunlight, moisture and nutrients. In addition, no area of pure weed species greater than thirty-six inches (36") across any dimension shall occur within a permanent grass stand.

c) The majority of the grass plants in a stand shall have a well-established root system to survive if irrigation is discontinued.

Establish the permanent grass stand before October 1st to preclude the need to perform Cool Season seeding. In the event a Cool Season seeding must be performed, the Warm Season Seeding Mixture may be applied in conjunction with the Cool Season seeding with prior approval of the OWNER. Upon final acceptance of the work under this contract, the OWNER will assume responsibility of maintaining the grassed areas.

4.5.4 Measurement and Payment

Measurement and payment for this item shall be subsidiary to pipe line installation. Payment includes full compensation for furnishing all materials, including water, mulching, tacking agents, fertilizer, seed, sod and for furnishing all labor, tools, equipment and all incidentals necessary to complete the work.

4.6 - Flexible Base (Backfill of Paved Areas)

4.6.0 General

4.6.0.1 Scope

The work covered by this section includes all necessary operations and materials involved with placing a flexible base or foundation course for surface course or other base courses and for pipe backfill zones. The flexible base shall be composed of crusher-run broken stone; and shall be constructed as herein specified in one or more courses in conformity with the typical sections shown on the Plans and to the lines and grades as established by the OWNER.

4.6.1 Material

4.6.1.1 Source

The material source shall be approved by the OWNER.

4.6.1.2 Crushed Stone

The material shall be crushed and shall consist of durable particles of stone mixed with approved binding material. Material shall meet all the provisions of Item 247, TxDOT specifications and shall be Type A, Grade 2. It shall consist of crushed limestone with the following physical requirements:

Grading Requirements		
Percent Retained		
1-3/4	**No. 4**	**No. 40**
0-10	45-75	60-85
Atterberg Limits		
LL	**PI**	
40 Maximum	12 Maximum	

4.6.2 Construction Methods

4.6.2.1 Preparation of Subgrade

The roadbed shall be excavated and shaped in conformity with the typical sections and to the lines and grades as established by the OWNER. All excess base material, sacrificial backfill and/or 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. Subgrade shall be compacted to a minimum depth of eight inches (8") and a minimum ninety-five percent (95%) of Modified Proctor density at ± 2 percentage points optimum moisture content.

4.6.2.2 Compaction

Flexible base material shall be placed in uniform horizontal layers and compacted by mechanical means to a minimum of 95% Modified Proctor density at ± 2 percentage points optimum moisture content.

4.6.3 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.7 - Asphaltic Concrete Pavement

4.7.0 General

4.7.0.1 Scope

The work covered by this section includes the placement of a surface course composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously approved flexible base or concrete cap. For trench repairs greater than sixty inches (60") wide asphalt shall be placed using a lay down machine.

4.7.1 Material

4.7.1.1 Prime Coat

The prime coat shall be of TXDOT MC-30 asphalt applied at the rate of 0.25 - 0.35-gallon per square yard of surface, unless otherwise approved by the OWNER.

4.7.1.2 Tack Coat

The tack coat shall be asphaltic materials approved by the OWNER and shall meet the requirements of TXDOT Item 300, "Asphalts, Oils, and Emulsions."

4.7.1.3 Asphalt Concrete Material

The asphaltic concrete surface coat material shall be of TXDOT Type D hot mix asphaltic concrete or hot mix - cold laid asphaltic concrete as approved by the OWNER.

4.7.2 Equipment and Machinery

4.7.2.1 General

It shall be the responsibility of the CONTRACTOR to assure that all equipment and machinery are of a type approved by the OWNER. Equipment shall include the spreading and finishing machine, motor grader, trench roller, and vibratory steel wheel roller.

Alternate equipment which will consistently produce satisfactory results and may be used only if written permission is obtained from the OWNER.

4.7.3 Inspection

4.7.3.1 General

It will be the CONTRACTOR's responsibility to provide safe and accurate means to enable inspection forces to take all required samples and to provide permanent means for checking the output of any specified metering device and to perform these calibration checks as required by the OWNER.

4.7.4 Construction Methods

4.7.4.1 General

It shall be the responsibility of the CONTRACTOR to produce, transport, place, and compact the specified paving mixture in accordance with these specifications and without delay to the lay-down operation.

If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture is fifty degrees (50ºF) or more below the temperature established by the OWNER, all or any part of the load may be rejected and payment will not be made for the rejected material.

4.7.4.2 Method A - Hot Mix Asphaltic Concrete Pavement

Place as follows:

a) Site Preparation:
All excavation and backfill shall be complete as otherwise specified in this contract. Sacrificial backfill and existing material, paving, etc. shall be removed to the extents defined in the trench repair detail. Sacrificial backfill shall be removed such that the resulting surface is smooth and uniform. All high areas shall be cut to the desired depth and all low areas shall be filled with processed flexible base and compacted. Once the sacrificial backfill has been removed the surface shall be compacted with a vibratory steel wheel roller (minimum 1-1/2 tons) to provide a smooth, uniform compacted surface. All holes, ruts, depressions and high spots shall be filled with approved materials. After correcting all deficiencies (holes, ruts, depressions, etc.) the surface shall be re-compacted until the smooth, uniform surface is achieved. If pavement borders were not previously saw cut, they shall be saw cut providing an area of uniform width and smooth edges for the ultimate placement of the surface course.

b) Prime Coat:
Before the prime coat is applied, the surface upon which the tack coat is to be placed shall be cleaned thoroughly, by sweeping or other approved methods, to the satisfaction of the OWNER. If deemed necessary by the OWNER, the surface shall be lightly sprinkled just prior to application of the asphaltic material. The asphaltic material (prime coat) shall be applied smoothly and evenly on the clean surface by an approved pressure distributor. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two distributor loads. The prime coat shall be allowed to cure for a period of not less than twenty-four (24) hours.

All storage tanks, piping, retorts, booster tanks, and distributors used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times. They shall be operated in such manner that there will be no contamination of the asphaltic material by foreign material. It shall be the responsibility of the CONTRACTOR to provide and maintain in good working order a recording thermometer at the storage heating unit at all times. The distributor shall have been recently calibrated and the OWNER shall be furnished an accurate and satisfactory

record of such calibration. After beginning of the work, should the yield on the asphaltic material applied appear to be in error, the distributor shall be calibrated in a manner satisfactory to the OWNER before proceeding with the work.

The OWNER will select the temperature of application based on the temperature-viscosity relationship. The recommended range for the viscosity of the asphalt is 100 to 125 centistokes. Hot Mix cannot be produced at more than 300º F The CONTRACTOR shall apply to roadway before it reaches 260º F.

The CONTRACTOR shall be responsible for the maintenance of the surface until the work is accepted by the OWNER.

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

c) Placing:
The surface coat shall be placed in two inch (2") horizontal layers and shall be compacted to ninety percent (90%) of the theoretical density. The OWNER reserves the right to conduct density tests at any time, at the OWNER's expense. The asphaltic mixture shall be dumped and spread on the approved prepared surface in such a 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 test. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures.

Adjacent to flush curbs, gutters, liners, and structures, the surface shall be finished uniformly high so that when compacted it will be slightly above the edge of the curb and flush structure.

Prior to placement of the asphaltic concrete materials, the compacted backfill shall be primed. Where a concrete cap is placed, it shall be allowed to cure for seventy-two (72) hours; then a tack coat shall be applied.

d) Compacting:
The pavement shall be compacted thoroughly and uniformly with dual drum rollers to obtain the density, stability, and the cross section of the finished paving mixture meeting the requirements of the Plans and Technical Specifications and the approval of the OWNER.

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 of compaction control followed, all rolling shall be completed before the mixture temperature drops below 175ºF.

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

4.7.4.3 Method B - Hot Mix - Cold Laid Asphaltic Concrete

Place as follows:

a) Site Preparation:
All excavation and backfill shall be complete as otherwise specified in this contract. Sacrificial backfill and existing material, paving, etc. shall be removed to the extents defined in the trench repair detail. Sacrificial backfill shall be removed such that the resulting surface is smooth and uniform. All high areas shall be cut to the desired depth and all low areas shall be filled with processed flexible base and compacted. Once the sacrificial backfill has been removed the surface shall be compacted with a vibratory steel wheel roller (minimum 1-1/2 tons) to provide a smooth, uniform compacted surface. All holes, ruts, depressions and high spots shall be filled with approved materials. After correcting all deficiencies (holes, ruts, depressions, etc.) the surface shall be re-compacted until the smooth, uniform surface is achieved. If pavement borders were not previously saw cut, they shall be saw cut providing an area of uniform width and smooth edges for the ultimate placement of the surface course.

b) Tack Coat:
Before the prime coat is applied, the surface upon which the tack coat is to be placed shall be cleaned thoroughly, by sweeping or other approved methods, to the satisfaction of the OWNER. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. The tack coat shall be applied with an approved sprayer at a rate not to exceed 0.05-gallon residual asphalt per square yard of surface, as directed by the OWNER. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material meeting the requirements for a tack coat. Where a concrete cap is placed, it shall be allowed to cure for seventy-two (72) hours; then a tack coat shall be applied.

c) Transporting of Asphaltic Concrete:
The asphaltic mixture, prepared as specified 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 rolling shall be completed during daylight hours. In cool weather or for long hauls, canvas covers and insulation of the truck body may be given a light coating of oil, lime slurry, or other material satisfactory to the OWNER, if necessary, to prevent mixture from adhering to the body. The material shall be loaded in such a manner as to prevent segregation.

d) Placing:
The surface coat shall be placed in two inch (2”) horizontal layers and shall be compacted to ninety percent (90%) of the theoretical density. The mixture shall be laid only on an approved base course or pavement which has been tack-coated as previously specified and shall be free of all foreign materials. All contact surfaces of curbs and structures and all joints shall be painted with a thin, uniform coating of cut-back or emulsified asphalt as required for tack coating the base. The mixture shall be

thoroughly aerated and then spread into place in a uniform layer of such depth that after compaction is complete, the requirements of the typical cross-sections will have been fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and structures.

Where more than one course of pavement is to be placed and the material is to be laid cold, no succeeding course shall be placed until the preceding course has been in place for a sufficient period of time for the preceding course to dry and cure out. The drying and curing period shall be not less than forty-five (45) days, in any case, unless a variation is authorized in writing by the OWNER.

e) Compacting:
The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the density, stability, and cross-section of the finished paving mixture meeting the requirements of the Plans and Technical Specifications and the approval of the OWNER.

For mixtures being placed cold, rolling patterns will be established at the beginning of the placement with the equipment necessary to give a uniform density, stability, and cross-section of the finished paving mixture meeting the requirements of the Plans and specifications and the approval of the OWNER. This pattern will be followed until such time as it is determined by the OWNER that it is no longer giving a satisfactory pavement. At such time, the paving operation will stop until necessary corrective measures can be accomplished that meet the approval of the OWNER.

f) Substitutions:
Limestone Rock Asphalt Pavement (LRA) as specified per TXDOT Item 330 is an approved substitution for Method B – Hot Mix-Cold Laid Asphaltic Concrete.

4.7.5 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.8 - Barricading Standards and Procedures

4.8 General

4.8.1 Scope

It shall be the responsibility of the CONTRACTOR to provide, erect, place, and maintain all warning signs, traffic control devices, and barricades. All such signs, devices, and barricades shall conform to standards set forth in the Texas Manual on Uniform Traffic Control Devices. The OWNER may authorize the use of different or special devices and equipment, if in its opinion, such equipment will be at least as effective for its intended purposes as that set forth above and when additional regulatory signs are deemed necessary by the OWNER. The CONTRACTOR shall be responsible for providing barricading for all work areas during the construction of this project. CONTRACTOR shall provide lighted barricades for use at night, and shall maintain all lighted barricades for the duration of the project.

4.8.2 Barricading Plan

The CONTRACTOR shall prepare and submit a barricading plan to the OWNER at the pre-construction conference. Plans shall be prepared by a Professional Engineer, Registered in the State of Texas, and show all necessary barricades, signs, etc., required to provide a safe work site. Plans shall be based on the recommendations in the Manual of Uniform Traffic Control Devices for control of traffic in a construction area. Plans shall be submitted and method of re-routing will be approved by the OWNER. Approval will be for routing and for length of time of barricading only.

4.8.3 Maintenance

It shall be the total responsibility of CONTRACTOR to maintain the barricades, lights, signs, and all other items involved in the detouring of traffic. CONTRACTOR shall designate an employee who will be responsible for the maintenance of the barricades and lighting system on a twenty-four (24) hour basis, and shall provide a phone number where the responsible party can be reached on a twenty-four (24) hour basis.

4.8.4 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.9 - Polyvinyl Chloride (PVC) Pressure Pipe

4.9 General

4.9.1 Scope

This section covers the furnishing and installation of all PVC pipe. The Plans show the sizes and general arrangement of all pipes; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" rests with the CONTRACTOR.

4.9.2 Material Specifications

PVC Pipe shall be the integral bell, elastomeric seal-type and meet the following requirements:

Nominal Diameter	
(in.)	**Requirements:**
$4" \leq d \leq 36"$	AWWA C900 CIOD, DR18

PVC pressure pipe is to be manufactured from Class 12454 virgin compound as defined in ASTM D1784. All pipe shall bear the National Sanitation Foundation (NSF) seal for potable water pipe. In addition, C900 shall be listed with Underwriters Laboratories, Inc. (UL).

Pipe joints shall be spigot and integral wall section bell with a solid cross section elastomeric or rubber ring gasket conforming to the requirements of the latest revisions of ASTM D3139 and ASTM F477. Gaskets shall be factory-assembled and secured in place to prevent displacement. Lubricant shall be as recommended by the pipe manufacturer and shall not adversely affect the potable qualities of the water to be transported. Pipe and fittings shall be assembled with a non-toxic vegetable soap lubricant which also meets the pipe manufacturer's specifications. Joints shall meet the applicable sections of the latest revision of AWWA C111. Each length of pipe shall be clearly marked with the manufacturer's trade name, the size and class, and the specifications that it meets. Fittings used with PVC pipe shall be ductile iron and comply with requirements as stated in Technical Specification 4.12,"Ductile Iron Pipe and Fittings."

4.9.3 General Installation

PVC pipe and fittings are to be installed at locations shown on Plans. The trench bottom should be smooth and free from stones greater than two inches (2") in diameter and large dirt clods. If the trench bottom is rocky or hard, as in shale, a four inch (4") layer of embedment material shall be placed to provide a cushion for the pipe. All pipe, fittings, and specials shall be lowered into the trench by some suitable means, and shall not be rolled or dumped into trench. All dirt or trash shall be removed from the ends of the pipe. Any damaged, defective or unsound material shall be suitably repaired or replaced before use. Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be approved by the OWNER and shall be within acceptable limits as suggested by the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day, the open end of the pipe is to be

effectively sealed against the entrance of all obstructions and especially water. Any pipe that becomes contaminated before or after installation shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

4.9.4 Bedding Material for Water Pipe

Bedding material for the installation of water and sewer mains shall be crushed stone or pea gravel that will remain firm and not permit displacement of the pipe either during pipe laying or backfilling or following completion of construction. Bedding material shall be from an approved bedding material source per the List of Approved Bedding Material Suppliers or meet the following gradation when tested in accordance with TXDOT Designation: TEX-200-F, Part I, and be approved by the City Engineer:

COSA Bedding Material Gradation	
Sieve Size	Cumulative % Retained
1/2"	0
3/8”	0-20
#4	40-90
#10	95-100
#20	99-100

4.9.5 Cutting and Beveling

When necessary, PVC pipe may be cut to properly locate appurtenances. Pipe may be cut with a fine toothed hacksaw, handsaw or portable skill-saw with a steel blade or abrasive discs. The pipe shall be marked around its entire circumference prior to cutting to assure a square cut. After the pipe is cut, the cut end shall be beveled. A factory beveled-end guide shall be used to determine the angle and length of the taper. The end may be beveled using a pilot plastic pipe beveling tool, coarse file, rasp or abrasive disc.

4.9.6 Joint and Pipe Testing

See Technical Specification 4.11, "Pressure Pipe Testing and Disinfection."

4.9.7 Blocking and Restraints

Concrete blocking shall be placed at bends, valves, tees, crosses and plugs in the pipe lines. The concrete blocking shall be placed so as to rest against firm, undisturbed trench walls, normal to the thrust. The supporting area for each block shall be at least as great as that indicated on the Plans or directed by the OWNER and shall be sufficient to withstand the thrust, including water hammer which may develop. The blocking shall, unless otherwise directed, be placed so that the pipe and fitting joints will be accessible for repair.

Mechanical restraints shall meet the requirements of AWWA C605, latest revision. Mechanical restraints (in addition to concrete blocking) shall be installed in the locations shown in the Drawing detail sheets. The devices shall meet the test requirements of the latest

version of ASTM F1674 (formerly UNI-B-13) “Standard Test Method for Joint Restraint Products for use with PVC Pipe.”

4.9.8 Wrapping of Ductile Iron Fittings

All sub-surface pipe and fittings shall be wrapped in two (2) layers of linear low-density polyethylene (LLDPE) film with a minimum thickness of eight millimeters (8mm). Wrapping shall precede placement of any required concrete (blocking, etc.). LLDPE film and installation shall meet the requirements of ANSI/AWWA C105/A21.5.

4.9.9 Connections with Existing Facilities

Where connections are made between new work and existing piping, such connections shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at the time and under conditions which will least interfere with service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

Couplings shall be of a gasketed, sleeve type. Each coupling shall consist of a steel middle ring, two (2) steel followers, two (2) rubber compounded wedge section gaskets, and sufficient track head stainless steel bolts to properly compress the gaskets. Couplings shall be of the type to match piping on which installed. Couplings shall be Smith-Blair Type 442 or Mueller MaxiFit-Xtra.

4.9.10 Measurement and Payment

Payment for this item will be based on the linear foot price bid. The measurement of pipe for payment purposes will be the horizontally measured length of the line along its main axis from center of fitting to center of fitting or end of pipe, without deduction for the length of intermediate fittings or valves. Payment will include full compensation for excavation, embedment, backfill, separation of excavated material for backfill according to the specifications, asphalt/concrete repair, surface restoration (unless specified elsewhere) furnishing, hauling and laying pipe, fittings (other than valves), testing, disinfection, etc., in accordance with the specifications, Plans, and/or instructions of the OWNER.

4.10 - Valves and Valve Installation

4.10.0 General

4.10.1 Section Includes

a) Resilient Seat Gate Valves
b) Butterfly Valves
c) Gate Valves and Ball Valves
d) Air Release Valves

4.10.2 General Description

Valves which are to be installed shall be the types and sizes and at the locations indicated on the Plans. Butterfly valves shall conform to AWWA C504, Class 150B and resilient seat gate valves shall conform to AWWA C509. All valves and fittings shall be 150 psi working pressure or better, unless otherwise specified in the Contract Documents. All valves shall turn counterclockwise to open. Unless otherwise shown on the Plans or directed by the OWNER, all valves shall be installed in the vertical position. Valves shall be equipped with slip-on, mechanical, or flanged joints suitable for use with the pipe on which they will be installed. Where practicable, valves installed underground shall be mechanical joint or slip-on, and valves installed above ground shall be flanged. All valves shall be furnished with the necessary bolts, nuts, glands, gaskets, and other accessories necessary for their complete installation. All manual operated valves shall have a two inch (2") square wrench nut for operation unless otherwise specified.

It is the intent of these specifications that all valves, valve boxes, and accessories furnished under this Contract shall be of the best quality for the use of purpose intended, and all materials incorporated shall meet the requirements of the service intended, regardless of the pressure specified for the valve.

All valves shall be fully supported by cast-in-place concrete. The concrete shall be placed on firm, undisturbed soil. The pipe and fitting joints shall remain accessible for repair. The minimum depth of concrete for valve foundations shall be six inches (6") for twelve inch (12") valves and smaller and shall be eight inches (8") for valves larger than twelve inches (12"). Reinforcement shall consist of 4x4 W2.9xW2.9 (6 gauge) or approved equal. The concrete shall extend a minimum of four inches (4") beyond all contact points with the valve.

4.10.3 Resilient Seat Gate Valves

All valves four inches (4") through thirty-six inches (36") shall be non-rising stem resilient seat gate valves, unless otherwise shown on the Plans or directed by the OWNER, as manufactured by American Darling, East Jordan Iron Works, J&S, Mueller, M & H or U.S. Pipe. The valves shall be tested for zero leakage past the seat at 200 psi and hydrostatically shell tested at 400 psi. The valves shall be wedge disc type and shall contain a machined surface in the valve body with solid guide lugs on the disc that travel within channels cast in the sides of the valve. The valve shall contain a bronze stem nut and O-ring seals above and below the thrust collar with a thermoplastic anti-friction washer above the thrust collar. Interior and exterior of the valve shall be epoxy coated, 8 millimeters, dry film thickness, minimum. For each valve eighteen

inches (18") and larger, the manufacturer shall provide an affidavit of compliance to demonstrate compliance with AWWA C509. Results of the Shell and Seat Tests shall be included with each affidavit. The affidavit shall demonstrate that the valves are of recent manufacture and that the valves have been tested within ninety (90) days of receipt. The CONTRACTOR shall operate each valve prior to installation to ensure free and proper functioning. During the operation, the CONTRACTOR shall allow the OWNER the opportunity to visually inspect and to operate the valves.

Resilient seat gate valves twenty inches (20") and larger shall be supplied with spur gear operators installed by the valve manufacture, unless otherwise specified on the Plans.

4.10.4 Butterfly Valves

Butterfly valves shall be solid shaft type. All keys and pins used in securing valve discs to shafts shall be stainless steel. Valve body shall be high-strength cast iron ASTM A126 Class B with 18-8 Type 304 stainless steel body seat. Valve vane shall be high-strength cast iron ASTM A48 Class 40, having rubber seat mechanically secured with an integral 18-8 stainless steel clamp ring and 18-8 stainless steel nylon locked screws. Valve seats shall be 18-8 stainless steel. Shaft seals shall be O-ring type. The interior and exterior of the valve shall be epoxy coated, 8mil dry film thickness, minimum.

4.10.5 Valve Bodies

a) Clear Water Opening: The diameter of the clear waterway opening through the valve shall be not less than the rated size of the valve.

b) Flanges: Flanges shall be furnished to true plane surfaces within a tolerance limit of 0.005 inch; the finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

c) Mechanical Joint Ends: Where mechanical joint ends are specified, either mechanical joint or push-on ends conforming to ANSI A21.11 will be acceptable.

4.10.6 Valve Operations

Operator mounting arrangements and handwheel positions shall be as indicated on the Plans or as directed by the OWNER.

4.10.6.1 Manual Operations

Unless otherwise required by the OWNER, the direction of rotation of the wheel or wrench nut to open each valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

Hand-wheel diameter shall be at least eight inches (8") but not more than twenty-four inches (24") for thirty inch (30") or smaller valves.

Wrench nuts shall be standard AWWA wrench nuts as described in Section 4.16 of AWWA C500.

4.10.7 Gate Valves and Ball Valves

Unless otherwise shown or specified, all two inch (2") valves shall be all brass, non-rising stem gate valves as manufactured by James Jones. Valves smaller than two inches (2") shall be brass ball valves as manufactured by James Jones.

4.10.8 Valves Boxes

All buried valves shall be provided with valve boxes. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover required. Valve boxes shall be not less than five inches (5") in diameter, shall have a minimum thickness at any point of 3/16-inch, and shall be provided with suitable cast iron bases and covers. Covers shall have cast thereon designation of the service for which the valve is used.

Valve and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

4.10.9 Air Release Valves

Air release valves shall be provided and installed by the CONTRACTOR at the locations as noted on the Plans. The air release valves shall be as specified on the Plans, or approved equal. Valve boxes shall be constructed as detailed on the Plans.

4.10.10 Drawings and Data

Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the submittals section.

4.10.11 Installation

For underground installations, valves shall be carefully lowered into position to prevent damage to any part of the valve. Place the valve in the proper position with stem truly vertical and securely hold until connections have been made. Furnish all bolts, nuts, gaskets and any other required hardware. The CONTRACTOR shall adjust the valve boxes to the proper length to conform to the finished or planned ground surface elevation. The CONTRACTOR shall provide a firm foundation for each valve. The firm foundation shall consist of compacting the sub-grade and placing minimum of six inches (6") of concrete with #3 rebar centered each direction. All sub-surface valves shall be wrapped in polyethylene sheeting of approximately 8 mil thickness. Wrapping shall precede concrete placement.

4.10.12 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid per valve. Payment will be full compensation for providing all materials, labor, machinery, blocking, valve box and incidentals needed for a complete in place facility.

4.11 - Pressure Pipe Testing and Disinfection

4.11.0 General

4.11.0.1 Scope

During the constructing operations utmost care shall be taken to see that parts of structures, inside of pipes, fittings, jointing materials, valves, etc., the surfaces of which will come in contact with the potable water, are maintained in a sanitary condition. Under no circumstances shall any part of a new line be placed in service prior to sterilization.

4.11.1 Testing

All new pressure lines shall be tested by the CONTRACTOR with a hydrostatic test pressure of 150 pounds per square inch. The test period shall be four (4) hours for sixteen inch (16") pipe and smaller and twenty-four (24) hours for pipe sizes greater than sixteen inches (16"). Any items found to be defective shall be removed and replaced by the CONTRACTOR and retested after repairs are completed. In order to determine the quantity of water lost through leakage in a section of pipe under the required test pressure, the CONTRACTOR will be required to measure all water used in the pressure test through an approved meter. The maximum leakage permitted on the basis of 150 pounds per square inch shall not exceed thirty (30) gal./inch dia./mile/day for asbestos cement pipe, ten (10) gal./inch dia./mile/day for PVC and ductile iron pipe, and fifty (50) gal./inch dia./mile/day for pretensioned concrete cylinder pipe.

The CONTRACTOR will be required to correct defects and bring the leakage within the specified limits before the contract is accepted by the OWNER. Permanent pavement shall not be placed over any pipe until all leakage tests on the section of pipe involved have been completed.

The cost of testing and finding the leaks, repairing and retesting, shall be at the expense of the CONTRACTOR.

4.11.2 Chlorination

When the entire pipe line or selected sections thereof have been completed, tested and are ready for turning over to the OWNER for use, the line or section shall be disinfected according to the following procedure:

a) A chlorinating material approved by the OWNER shall be injected at one end of the line, and water released from the opposite end until the coloring is present at the discharge end in such quantity to indicate a residual of fifty (50) parts per million (ppm). All valves shall then be closed, and the solution shall remain in the line for at least twenty-four (24) hours. All valves in the lines being sterilized shall be opened and closed several times during the contact period. The CONTRACTOR shall make all necessary taps into the pipe to accomplish chlorination of a new line.

b) After twenty-four (24) hours, the solution shall be discharged from the line and flushed by water direct from the City of San Angelo main until the residual chlorine content is approximately the same as treated City of San Angelo water.

c) A water sample shall be taken from a suitable tap (not through a fire hydrant) under the supervision of the OWNER for analysis. If the tests show a satisfactory quality of water, the line may be placed into service. If the sample shows an unsatisfactory quality of water, the process of disinfection shall be repeated until a satisfactory sample is obtained. At least one satisfactory sample shall be obtained for every 1,000 feet of new line.

4.11.3 Water Service

Before any existing water service is interrupted, or before any existing valves are operated, the OWNER shall be notified and shall be present when such operation is made.

4.11.4 Measurement and Payment

No additional payment shall be made for material furnished or work done under this item, which is considered subsidiary of the various pay items. The disinfection tests for each section of pipe line will be the responsibility of the CONTRACTOR. Any additional tests required due to unsatisfactory quality of water will be the responsibility of the CONTRACTOR.

4.12 - Ductile Iron Pipe and Fittings

4.12.0 General

4.12.0.1 Section Includes

This section covers the furnishing and installing of all ductile iron pipe and fittings. The Plans show the general arrangement of all pipes and fittings; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" rests with the CONTRACTOR. The ductile iron pipe and fittings shall be 250 psi working pressure or better, unless otherwise specified in the Plans or Contract Documents.

4.12.1 Material Specifications

All ductile iron pipe and fittings shall be manufactured in accordance with the various applicable specifications as listed below. Each length of pipe shall be clearly marked with the manufacturer's trade name, the size and class, and the specifications that it meets. Cast iron fittings are an acceptable alternate to ductile iron. The pipe and fittings furnished shall comply in all respects to the following American National Standards Institute Specifications:

- Pipe Properties and Materials ANSI A21.51 (AWWA C151)
- Cement Lining ANSI A21.4 (AWWA C104)
- Joint Detail ANSI A21.50 (AWWA C151)
- Fittings ANSI A21.10, ANSI A21.53 or ANSI B16.1 (AWWA C110, C153 and C111)
- Installation ANSI (AWWA C600)

Unless otherwise specified on the Plans or elsewhere in the Contract Documents, above ground joints shall be flanged, sub-surface joints shall be compression.

4.12.2 General Installation

Pipe, fittings and specials are to be installed at the line and grade shown on the Plans and as specified in these Contract Documents. Unless otherwise specified in the Plans or directed by the OWNER, the CONTRACTOR shall commence his work with a connection to an existing main carrying water or air and shall carry on his work progressively from such connection, and as each section of line is completed shall turn the line into service at the direction of the OWNER.

4.12.3 Pipe Handling

All pipe, fittings, and special casting shall be lowered into trench by suitable machinery and shall not be rolled or dumped into the trench. Pipe and fittings shall be handled in such a manner as not to damage the coating. Before lowering and while suspended, each piece of pipe shall be rung with a light hammer to detect flaws, and any unsound pipe shall be rejected. All dirt and trash that may be on the spigot or in the bell shall be removed while the pipe is suspended. Any pipe that has been contaminated with dirt, mud, debris, etc. shall be removed and replaced or cleaned to the satisfaction of the OWNER. All pipe and fittings shall be handled and lowered into the trench with slings. The use of hooks for handling pipe and fittings will not be permitted.

Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be approved by the OWNER and shall be within acceptable limits of the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt, trash, water, insects, and rodents. At the close of each operating day the open end of the pipe shall be effectively sealed with a water and air tight plug. Any pipe section that becomes contaminated shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

4.12.4 Mechanical Joints

The CONTRACTOR shall wire brush and thoroughly clean the surfaces with which the gasket comes in contact on the bell and spigot. The cleaned surfaces of the bell and spigot shall then be lubricated with a nontoxic vegetable soap lubricant suitable for use in a potable water system just prior to slipping the gasket over the spigot end and into the bell. The follower ring shall then be bolted into compression against the gasket. The gland shall be tightened toward the flange, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. If effective sealing is not attained at the maximum torque recommended by the manufacturer, the joint shall be disassembled and reassembled after thorough cleaning. Over stressing of bolts to compensate for poor installation practice will not be permitted.

4.12.5 Slip-on Joints

Slip-on type joints shall be made in the following manner. The gasket and the gasket seat inside the bell shall be wiped clean of all extraneous matter. The gasket shall be placed in the bell in the position prescribed by the manufacturer. A thin film of nontoxic vegetable soap lubricant shall be applied to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell. The spigot shall be forced home in the bell by use of a crow bar or a fork tool on sizes four inches (4”) through eight inches (8”), or by use of a jack on sizes ten inches (10”) and larger. When using a field cut plain end piece of pipe, the outside cut end of the pipe shall be tapered about 1/8-inch back at an angle of thirty degrees (30°) with a portable grinder or a coarse file before making up the joint.

4.12.6 Flanged Joints

Flanged connections shall be made by means of erection bolts and drift pins without undue forcing and with no restraint on the ends of the pipe or fitting which would prevent pressure from being evenly and uniformly applied to the gasket. The pipe or fitting must be free to move in any direction while bolting. Bolts shall be gradually tightened, each in turn, at a uniform rate around the entire flange. Flange bolts shall be installed with all bolt heads in one direction.

4.12.7 Blocking

For lines carrying water, concrete blocking shall be placed at bends, valves, tees, crosses and plugs in the pipe lines. The concrete blocking shall be placed so as to rest against firm, undisturbed trench walls, normal to the thrust. The supporting area for each block shall be at least as great as that indicated on the Plans or directed by the OWNER and shall be sufficient to withstand the thrust, including water hammer which may develop. The blocking shall, unless otherwise directed, be placed so that the pipe and fitting joints will be accessible for repair.

4.12.8 Wrapping of Ductile Iron Pipe and Fittings

All sub-surface pipe and fittings shall be wrapped in two (2) layers of linear low-density polyethylene (LLDPE) film with a minimum thickness of eight millimeters (8mm). Wrapping shall precede placement of any required concrete (blocking, etc.). LLDPE film and installation shall meet the requirements of ANSI/AWWA C105/A21.5.

4.12.9 Lining and Coating

Ductile iron pipe and fittings shall be lined with Type II cement mortar lining. Outside coating shall be manufacturer's standard coal-tar dip coating.

4.12.10 Connections with Existing Lines

Where connections are made between new work and existing piping, such connections shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at the time and under conditions which will least interfere with normal operation and as directed by the OWNER. If Solid Sleeves are utilized, only 'long' sleeves are approved unless prior approval is obtained from the OWNER.

4.12.11 Bedding

Unless designated otherwise on the Plans, bedding shall be Type II as detailed in the project drawings. Bedding material shall be a granular material that will remain firm and not permit displacement of the pipe either during pipe laying and backfilling or following completion of construction. The material shall consist of crushed gravel meeting the requirement of ASTM C33, Gradation 67 (3/4" to No. 4); Crushed stone or naturally round gravel meeting TxDOT Grade 5 gradation as per Tex-200-F, Part I; or other materials approved by the OWNER (such as Turner Pit 'D' Bedding).

4.12.12 Measurement and Payment

No additional payment shall be made for material furnished or work done under this item, which is considered subsidiary of the various pay items. Payment will include full compensation for excavation, embedment, backfill, furnishing, hauling and laying pipe, fittings (other than valves), testing, disinfection, etc., in accordance with the specifications, Plans and /or instructions of the OWNER.

4.13 - Fire Hydrants

4.13.0 General

4.13.0.1 Scope

Fire hydrants shall meet or exceed the minimum standard of AWWA Standard C-502 latest revision. Hydrants shall be traffic model with breakaway safety flange and stem coupling; "O" ring stem seals with sealed oil reservoir lubricating stem operation; compression type main valve 5-1/4 inch, closing with pressure; bronze seat ring shall thread into a bronze drain ring forming an all bronze drainway with positive sealing; and two bronze drain outlets; main valve gasket shall be 3/4 inch thickness 90 durometer neoprene; 1-1/2 inch all bronze pentagon operating nut with anti-friction washer opening left; two 1-1/2 inch hose nozzles and one 4-1/2 inch pumper nozzle with National Standard Hose Threads; openings shall be in line with each other. Hydrants shall have asphaltic base varnish on the outside of lower barrel and shoe. The inside of the shoe shall be epoxy coated, minimum eight (8) mils thickness. The Fire Hydrant shall be painted Sherwin Williams B54Y17 or 6170807, yellow, or equal. Hydrants shall be lowered into the trench, inspected, and joined to the pipe as specified. Reaction thrust blocking shall be provided for all hydrants. Hydrants shall be thoroughly cleaned prior to installation.

4.13.1 Location

Hydrants shall be located as specified on the plans or by the OWNER. Hydrants shall be located to provide complete accessibility and to minimize the possibility of damage from vehicles or injury to pedestrians. The following provisions shall govern unless the OWNER specifies otherwise:

a) The bowl of the hydrant placed behind the curb shall be set so that no portion of the hydrant or hose nozzle caps on the street side shall be less than twelve inches (12”) or more than forty inches (48”) from the face of the curb.

b) All hydrants shall be plumb.

c) Pumper nozzles shall be at right angles to and facing the curb.

d) The breakaway flange shall be at finish ground or curb level. It shall not be below or more than two inches (2") above the finished grade. If the hydrant exceeds these limits, it will not be accepted.

4.13.2 Connection to Main

Each hydrant shall be connected to the main with six inch (6”) pipe and shall be controlled by an independent six inch (6”) valve.

4.13.3 Drainage

Hydrants shall be set with a drainage pit. The pit shall be filled completely with coarse gravel or broken stone mixed with sand under and around the bowl of the hydrant to a level six inches (6”) above the drain opening. No hydrant drainage pit shall be connected to a sewer.

4.13.4 Measurement and Payment

Fire hydrants shall be shall be measured per each complete installed in place. Payment will be made at the unit price per each hydrant which includes the hydrants, the line from the main to the hydrant, the independent valve on the main, the hydrant installation and all miscellaneous fitting, blocking, materials, and labor for a complete working installation.

4.14 - Service Lines

4.14.0 General

4.14.0.1 Scope

This section covers the furnishing and installation of all service lines. The plans show the sizes and general arrangement of all service lines and fittings, however, the responsibility for furnishing exact lengths of the various lines for proper "make-up" rests with the CONTRACTOR. The CONTRACTOR shall provide all materials, fittings, equipment and resources required for complete installation.

4.14.1 Materials

All two inch (2") service lines will be Schedule 40 PVC. All two inch (2") services lines shall have a brass wheel installed with the brass gate valve.

All one inch (1") service lines will be Type K copper tubing.

4.14.2 Installation

It is intended that the line be laid to such a depth that there will be a minimum cover of thirty inches (30"). Where a line passes under the curb, the line shall be at least thirty inches (30") below the bottom of the curb. Where the existing meter location is more than three feet (3') behind the curb line, at the direction of the OWNER, the CONTRACTOR shall relocate the meter to within three feet (3') of the curb; including re-plumbing of the customer service line. Installation of a service line that replaces an existing service shall include disconnection and removal of the existing service line, installation of the new line, re-connection to the meter and re-connection of the private service line to the meter, resetting of the meter box and site grading and clean-up. The CONTRACTOR shall retain a Licensed Plumber for relocation of services on the customer side of the meter where applicable and shall obtain all permits and observe all plumbing code requirements of the City of San Angelo.

4.14.3 Relocation of Services

All existing alley services adjacent to the proposed water line street alignment shall be relocated to street side services, as noted on the plans. Where the existing meter location is more than three feet (3') behind the curb line, at the direction of the OWNER, the CONTRACTOR shall relocate the meter to within three feet (3') of the curb; including re-plumbing of the customer service line. For relocates, service lines on customer side of meter shall be a minimum of 1½" diameter but shall not be any smaller than the existing service line size. The CONTRACTOR shall retain a Licensed Plumber for relocation of services on the customer side of the meter where applicable and shall obtain all permits and observe all plumbing code requirements of the City of San Angelo.

4.14.4 Measurement and Payment

Service lines shall be measured per each by the various sizes, complete in place. Payment will be made at the unit price bid per each on the various sizes, which payment shall be full compensation for the service line installation complete in place, all in accordance with the plans and specifications.

4.15 – Highway, Creek, and River Crossings

4.15.0 General

4.15.0.1 Scope

This specification shall govern for the construction of water or sanitary sewer mains on or across streets, alleys, highways, creeks, or river crossings as detailed in the plans. The CONTRACTOR shall provide and employ adequate warning signs, barricades, light, watchmen, etc., to fully protect his workers and the traveling public. No changes shall be made in location as shown on the plans without prior authorization of the appropriate agency and the OWNER.

All crossings shall comply fully with the Plans and Technical Specifications, OWNER's direction, and the requirements of the agency of authority. If boring or tunneling is indicated or specified, the work shall be performed in accordance with the Highway/Railway Boring of Tunneling specification section of this document.

4.15.0.2 Blasting

Blasting will not be allowed without prior authorization of the appropriate agency and the OWNER.

4.15.1 State Highway Crossings

4.15.1.1 State Requirements

All highway crossings shall conform to the Texas State Department of Highways and Public Transportation Utility Accommodation Policy Manual Special Specifications and the following requirements.

4.15.1.2 Backfill

All Excavations within the right-of-way and not under surfacing shall be backfilled by compacting six inch (6") horizontal layers. All surplus material shall be removed from the right-of-way, and the excavation finish shall be flush with the surrounding natural ground.

4.15.1.3 Re-vegetation Requirements

Where sodding is disturbed by excavation or backfilling operations, such areas shall be reseeded. Re-vegetation will be performed in compliance with Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highway, Streets and Bridges (latest version).

4.15.1.4 Encasement Pipe

The diameter of encasement pipe shall be as shown on the plans. Encasement pipes shall be seamless or welded carbon steel. The CONTRACTOR is responsible for determining the thickness required for each bore. Steel casing shall be designed to support the load of the highway and all other superimposed loads, including loads placed on the casing during installation. Minimum thickness required for all pipe diameters is 1/4 inch. Regardless of the method used in installing the encasement pipe, it shall be installed with even bearing

throughout its length and all voids between the pipe and the earth or rock shall be filled with grout.

4.15.1.5 Method of installation

The pipe shall be installed by boring or tunneling in full conformance with the Highway/Railway Boring or Tunneling Specifications section of this document. The pipe shall be installed with even bearing throughout its entire length, and all voids between the pipe and the earth or rock shall be grouted per ASTM C476.

4.15.2 River Crossings

River crossings, siphons, and miscellaneous pipe structures shall be constructed according to the detail drawings. Any proposed alternate method of installation shall be submitted as designed by a registered engineer and approved by the OWNER.

4.15.3 Measurement and Payment

Measurement and payment for this item will be based on the linear foot of bore. Payment will include all trench protection, rock excavation, material, equipment, labor, and resources required for complete installation inclusive to the lump sum bid per each crossing and will be all casing pipe, carrier pipe, concrete blocking, trench protection, rock excavation, and all other materials and resources required for construction.

4.16 - Cast in Place Concrete

4.16.0 General

4.16.0.1 Scope

This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and other appurtenant work. All cast-in-place concrete shall be accurately formed and property placed and finished as shown on the Plans and specified herein and in accordance with the American Concrete Institute (ACI) 318.

The CONTRACTOR shall inform the OWNER at least twenty-four (24) hours in advance of the times and places at which he intends to place concrete.

4.16.1 Data and Drawings

All submittals of data and drawings shall be in accordance with the submittals section unless otherwise noted herein.

4.16.2 Materials

a) **Cement** - ASTM C150, Type I, II, or III

b) **Fine Aggregate** - Clean natural sand, ASTM C33.Artificial or manufactured sand will not be acceptable.

c) **Coarse Aggregate** - Crushed rock, washed gravel, or other inert granular material conforming to ASTM C33, except that clay and shale particles shall not exceed one percent.

d) **Water** - Clean and free from deleterious substances.

e) **Admixtures**:

1. **Retarder** - ASTM C494, Type D; Grace "Daratard-HC", Master Builders "MB-HC", Protex "Protard", or Sika Chemical "Plastiment".

2. **Plasticizer** - ASTM C494, Type A; Grace "WRDA-HC", or Master Builders "MBHC-N".

3. **Super Plasticizer** - ASTM C494, Type F, American Admixtures "Melment 10A", Gifford-Hill "PSI-Super", Sida "Sikament", or W.R. Grace "WRDA-19".

4. **Air-Entraining** - ASTM C260; Grace "Darex AEA", Master Builders "MB-AE10", Protex "AES", or Sika Chemical "AER".

f) **Reinforcing Steel** - Bars, Except ASTM A615 (and Supplement S1) Weldable Grade 60, deformed. Bars, Weldable ASTM A706 or A615 (and Supplement S1) Grade 60, deformed, with maximum carbon equivalent of 0.55.

g) **Welded Wire Fabric** - ASTM A185 or A497.

h) **Bar Supports** - CRSI Class 1, plastic protected, or Class 2, stainless steel protected.

i) **Forms** - Prefabricated Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", or Universal "Uni-form".

j) **Plywood** - Product Standard PS1, water-proof, resin-bonded, exterior type Douglas fir; face adjacent to concrete Grade B or better.

k) **Fiberboard** - Fed Spec LLL-B-810, Type II tempered, waterproof, creenback, concrete form hardboard.

l) **Lumber** - Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.

m) **Chamfer Strips** - Clear white pine, surface against concrete planed.

n) **Form Coating** - Non-Crete "Form Coating", L&M "Debond", Protex "Pro-Cote, or Richmond "Rich Cote".

o) **Wedge Inserts** - Malleable iron, with galvanized askew-head bolts, nuts, and washers; Hohmann and Barnard "HW", Richmond "Peerless", or Weston "WC50".

p) **Polyethylene Film** - Product Standard PS17; 6 mil. Membrane Curing Fed Spec TT-C-800, Type I,

q) **Compound and Floor** - Class 1; min eighteen percent (18%) solids.

r) **Sealer** - Non-yellowing; unit moisture loss 0.039 gm/cm^2 max; ProSoCo "Dure and Seal", Protex "Acrychlor", or Sonneborm Kure-N-Seal".

4.16.3 Preliminary Review

All tests and reports required for preliminary review shall be made by an independent testing laboratory at the expense of the CONTRACTOR. Reports covering the source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the OWNER for review before concrete work is started. Review of these reports will be for general acceptability only and continued compliance with all contract provisions will be required.

4.16.4 Aggregates

Reports on aggregates shall include the following information:

a) Fine Aggregate.
   - Source and type
   - Gradation.
   - Deleterious Substances.

b) Coarse Aggregate.
   - Source and type.

- Gradation and abrasion loss.
- Deleterious substances.
- Results of sodium or magnesium sulfate soundness test.

4.16.5 Mix Design

A tentative concrete mix shall be designed and tested for each size and gradation of aggregates and for each consistency intended for use in the work. Design quantities and test results of each mix shall be submitted for review. Mixes shall be adjusted in the field as necessary to meet the requirements of these specifications. The report for each tentative concrete mix submitted shall contain the following information:

a) Slump on which design is based.

b) Total gallons of water per cubic yard.

c) Brand, type, composition, and quantity of cement.

d) Specific gravity and gradation of each aggregate.

e) Ratio of fine to total aggregates.

f) Weight (surface dry) of each aggregate per cubic yard.

g) Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.

h) Air content.

i) Compressive strength based on seven (7) day and twenty-eight (28) day compression tests.

j) Time of initial set.

4.16.6 Testing

Aggregates shall be sampled and tested in accordance with ASTM C33. In addition, the bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

Two sets of compression test cylinders, three cylinders per set, shall be made from each proposed concrete mix. One set of three cylinders shall be tested at an age of seven (7) days and the other set shall be tested at an age of twenty-eight (28) days. Concrete test specimens shall be made, cured, and stored in conformity with ASTM C192 and tested in conformity with ASTM C39.

Slump shall be determined in accordance with ASTM C143 and total air content shall be determined in conformity with ASTM C231. Initial set tests shall be made at ambient temperatures of seventy degrees (70°F) and ninety degrees (90°F) to determine compliance

with the initial set time specified hereinafter. The test at seventy degrees (70°F) shall be made using concrete containing the specified plasticizing and air-entraining admixtures. The test at ninety (90°F) shall be made using concrete containing the specified retarding and air-entraining admixtures. Initial set shall be determined in accordance with ASTM C403.

4.16.7 Limiting Requirements

Unless otherwise specified, each concrete mix shall be designed and concrete shall be controlled within the following limits.

4.16.7.1 Cement Content

The quantity of Portland cement, expressed in pounds per cubic yard, shall be as shown in the following table. These minimum cement quantities shall apply only to concrete containing a specified water reducing admixture. If, for any reason, the water reducing admixture is omitted, the cement shall be increased ten percent (10%).

Concrete Slump (in.)	Course Aggregate Size (lbs. Cement per Cubic Yd.)		
	No. 4 to 2"	3/4"	1"
2	573	545	517
3	593	56	536
4	611	583	555
5	630	602	573
6	649	620	593

4.16.7.2 Total Water Content

Total water content of concrete shall not exceed six (6) gallons of water per hundred pounds of cement in the mix.

4.16.7.3 Slump

Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the OWNER, slump shall not exceed four inches (4”).

When Super plasticizer is used, slump, for concrete shall not exceed three inches (3”) prior to adding any super plasticizer. Slump for concrete after super plasticizer has been added shall be six inches (6”) plus or minus one inch (1”).

4.16.7.4 Ratio of Fine to Total Aggregates

The ratio of fine to total aggregates based on solid volumes (not weights) shall be:

Coarse Aggregate Size (in.)	Minimum Ratio	Maximum Ratio
2	0.40	0.55
3/4	0.35	0.50
1	0.30	0.46

4.16.7.5 Initial Set

The initial set as determined by ASTM C403 and after the water and cement are added to the aggregates. The quantity of retarding or accelerating admixture shall be adjusted to compensate for variations in temperature and job conditions.

4.16.7.6 Total Air Content

The total volumetric air content of concrete after placement shall be five to seven percent (5%-7%). Air may be omitted from interior slabs which are to be trowel finished.

4.16.7.7 Admixtures

Admixtures, other than air-entraining and water reducing admixtures will not be permitted unless approved by the OWNER. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendation for compliance with these specifications. A water reducing admixture shall be included in all concrete. No calcium chloride or admixtures containing chloride from other than impurities from admixture ingredients will be acceptable. At the option of the CONTRACTOR, a super plasticizer may be used in addition to any water reducing admixture in all concrete for the pre-stressed concrete reservoir. Super plasticizer shall be as specified, as recommended by the manufacturer, and acceptable to the OWNER. Easy verification of each admixture dose when dispensed at the site will be required. Super plasticizer shall be accurately proportioned for each load into a separate dispensing container prior to any discharge into the truck. When truck-mounted dispensers are used, no flushing or cleaning of the system with water will be allowed until after the entire load of concrete has been discharged. Redosing of concrete with super plasticizer may be done only once when acceptable to the OWNER. Redosing procedures shall be as recommended by the manufacturer and acceptable to the OWNER.

4.16.7.8 Chloride Content

Maximum water soluble chloride in the concrete shall be 0.06 percent by weight.

4.16.7.9 Storage of Materials

Cement shall be stored in suitable moisture-proof enclosures. Cement which has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials is prevented. The bottom six inches (6”) of aggregate piles in contact with the ground shall not be used.

Reinforcing steel shall be carefully handled and shall be stored on supports which will keep the steel from contact with the ground.

4.16.8 Forms

Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions shown on the Plans. Forms shall conform to ACI 347 and the following additional requirements.

Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with

plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and convex areas, within the tolerances specified herein.

Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes, basins, and reservoirs. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms and may be used as backing for form linings. Concrete forms are required above all extended footings. Flat segmented forms not more than 24-inches wide may be used for forming curved surfaces twenty-five feet (25') in diameter or larger. Where concrete is placed against gravel or crushed rock which does not contain at least twenty-five percent (25%) material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 6 inches. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high pressure hose.

4.16.8.1 Design

Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded.

Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template for concrete which is to be finished to a specified elevation, slope, or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than two feet (2') above the joint.

Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

4.16.8.2 Form Ties

Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie and the permanently embedded portion shall be at least one-inch back from the concrete face. Form ties for water bearing walls shall be provided with water-seal washers located on the permanently embedded portions of the ties at the approximate center of the wall. Permanently embedded portions of form ties which are not provided with threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. The type of form ties used shall be acceptable to the OWNER. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

4.16.8.3 Edges and Corners

Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners unless specifically shown otherwise on the Plans. Unless otherwise noted, bevels shall be 3/4- inch wide.

4.16.8.4 Form Removal

Forms shall not be removed or disturbed until the Concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

4.16.8.5 Reinforcements

Reinforcements shall be accurately formed and shall be free from loose rust, scale, and contaminants which reduce bond. Unless otherwise shown on the Plans or specified herein, the details of fabrication shall conform to ACI 315 and 318.

4.16.8.6 Shop Drawings and Bar Lists

Bar lists and drawings for the fabrication and placing of reinforcements shall be submitted for review to the OWNER.

4.16.8.7 Placements

Reinforcements shall be accurately positioned on supports, spacers, hangers, or other reinforcements and shall be secured in place with wire ties or suitable clips.

With the exception of contact splices, the clear distance between parallel bars shall be not less than two inches (2”). Where reinforcements in beams are placed in two (2) or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

Reinforcements shall not be installed for beams or slabs which are supported by concrete columns until after the concrete for the column has been placed.

4.16.8.8 Splices

Splices shall conform to the details shown on the Plans. Splices at locations other than those shown on the Plans shall be acceptable to the OWNER. Except where indicated on the Plans, welding or tack welding of reinforcement is prohibited. Where welding is indicated on the Plans, weldable reinforcing steel having a carbon equivalent of not more than 0.55 shall be provided, and preheating and welding shall conform to AWS D1.4. Reinforcements upon which improper or unauthorized welding has been done shall be removed and replaced.

4.16.9 Embedment’s

Anchor bolts, castings, steel shapes, conduit, sleeves, masonry anchorage, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel,

conduits shall be placed under the reinforcement. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form or template. A second nut shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

Embedments shall be clean when installed. After concrete placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

4.16.10 Batching and Mixing

Concrete shall be furnished by an acceptable read-mixed concrete supplier and shall conform to ASTM C94.

4.16.11 Consistency

The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

4.16.12 Delivery Tickets

A delivery ticket shall be prepared for each load of ready-mixed concrete. A copy of each ticket shall be handed to the OWNER by the truck operator at the time of delivery. Tickets shall show the mix identification, quantity delivered, the amount of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

4.16.13 Placement

The limits of each concrete pour shall be predetermined by the CONTRACTOR and shall be acceptable to the OWNER. All concrete within such limits shall be placed in one continuous operation. Before concrete is placed, forms, reinforcements, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces incrusted with dried concrete from previous placement operations shall be cleaned; and the entire installation shall be acceptable to the OWNER.

4.16.14 Bonding to Hardened Concrete

The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. The hardened surface shall be cleaned of all laitance, foreign substances (including curing compound), washed with clean water, and wetted thoroughly preceding placement of fresh concrete. Coarse aggregate shall be omitted from the concrete placed immediately adjacent to hardened concrete in wall or column forms. The mortar puddle shall cover the hardened concrete to a depth of one inch (1”). Standard concrete mix, as specified, shall then be placed over the mortar.

4.16.15 Conveying Concrete

Concrete shall be conveyed to the point of final deposit by methods which will prevent separation or loss of ingredients. Concrete shall be placed in final position without being moved laterally in the forms more than five feet (5’).

4.16.16 Placing Concrete

Concrete shall be placed in approximately horizontal layers of proper depth for effective compaction; however, the depth of a layer shall not exceed twenty-four inches (24”). Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than two feet (2’) per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed six feet (6’) of vertical height. Concrete in walls or columns shall settle at least two (2) hours before concrete is placed in the structural systems to be supported by such walls or columns. Concrete shall be thoroughly settled when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

4.16.17 Compaction

During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcements and embedments and into the corners of the forms. Mechanical vibrators shall be used which will maintain at least 9,000 cycles per minute when immersed in the concrete. Number and type of vibrators shall be acceptable to the OWNER. Jitterbugs will not be acceptable.

4.16.18 Cold Weather Concreting

Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete as the time of mixing shall be not less than that shown in the following table for corresponding outdoor temperature (in shade) at the time of placement:

Outdoor Temperature	Concrete Temperature
Below 30˚ F	70˚ F
Between 30˚ and 45˚ F	60˚ F
Above 45˚ F	45˚ F

Do not place concrete in contact with any material coated with frost or having a temperature of thirty-two degrees (32º F) or lower. Do not place concrete when the ambient temperature in the shade is below forty degrees (40º F) and falling unless approved. Concrete may be placed when the ambient temperature in the shade is thirty-five (35º F) and rising or above forty degrees (40º F). When placed, heated concrete shall not be warmer than eighty degrees (80˚F). Maintain temperature of all other concrete, including the bottom slab (footings) of culverts, placed on or in the ground above thirty-two degrees (32º F) for seventy-two (72) hours from the time of placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

4.16.19 Hot Weather Concreting

Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperatures of ninety degrees (90˚F) or above, concrete shall be kept as cool as possible during placement and curing. The temperature of the concrete when placed in the work shall not exceed ninety degrees (90˚F). Plastic shrinkage cracking, due to rapid evaporation of moisture, shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 pound per square foot per hour, as determined by Figure 2.1.5 in ACI 305.

4.16.20 Testing

Field control tests, including aggregate gradation tests, slump tests, air content tests, and making compression test cylinders, shall be performed by testing laboratory personnel. The testing laboratory shall provide all facilities and the services of one or more employees as necessary to assist with the field control testing activities. As stipulated in the quality control section, tests required during the progress of the work shall be made at the expense of the CONTRACTOR. The frequency hereinafter specified for each field control test is approximate. A greater or lesser number of tests may be made, as required by the OWNER.

Field testing prior to any addition of super plasticizer shall be as required by the OWNER to determine compliance with the specifications and shall be conducted as specified. Field testing after the addition of super plasticizer shall be conducted as specified and as required to determine that the concrete is in compliance with the specifications. Air tests shall be conducted whenever field tests are conducted.

4.16.20.1 Aggregate Gradation

Each 100 tons of fine aggregate and each 200 tons of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136.

4.16.20.2 Slump

A slump test shall be made for each fifty cubic yards (50 yd^3) of concrete. Slump shall be determined in accordance with ASTM C143.

4.16.20.3 Air Content

An air content test shall be made from one of the first three (3) batches mixed each day, and from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231.

4.16.20.4 Compression Tests

A minimum of one set of four (4) concrete compression test cylinders shall be made for each forty cubic yards (40 yd^3) of concrete that is placed. Two (2) additional sets shall be made from each additional 100 cubic yards, or major fraction thereof, placed in any one day. Two cylinders of each set shall be tested at an age of seven (7) days and the other cylinders shall be tested at an age of twenty-eight (28) days. Compression tests will be evaluated in accordance with ACI 214 and 318.

Tests cylinders shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39. Each set of compression test cylinders

shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.

4.16.20.5 Test Reports

Test reports shall be prepared in three (3) copies and shall be distributed by the testing laboratory directly to the OWNER and CONTRACTOR in accordance with the quality control section.

4.16.21 Construction Joints

Construction joints shall be made at locations indicated on the Plans or specified. Construction joints shall not be made at other locations without the concurrence of the OWNER.

4.16.22 Watertight Joints

Construction joints in the following locations shall be watertight and shall be provided with continuous water stops:

a) Walls in contact with liquid.

b) Other locations where specifically shown on the Plans.

Water stops shall be of the size and thickness indicated on the Plans and shall be clean and free from coatings that would weaken the bond with concrete. Each water stop shall be continuous throughout the length of the construction joint in which it is installed. Junctions between adjacent sections shall be lapped six inches (6") and securely bolted or welded together. All water stops shall be maintained in proper position until the surrounding concrete has been deposited and compacted. Water stops shall be constructed of material acceptable to the OWNER.

4.16.23 Finishing Unformed Surfaces

Buried and permanently submerged concrete blocking and encasement will require no finishing except that necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

4.16.24 Screeding

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities within a height or depth of 1/4-inch as measured from a ten foot (10') straightedge.

4.16.25 Floating

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial

floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating. Floating shall be performed with hand floats or suitable mechanical compactor-floats.

4.16.26 Broom Finish

Surfaces of exterior slabs shall be given a light broom finish providing a nonslip surface. Brooming shall be done after the second floating and at right angles to the normal traffic direction.

4.16.27 Edging

Unless specified to be beveled, exposed edges of floated surfaces shall be edged with a tool having 1/4-inch corner radius.

4.16.28 Curing

Concrete shall be protected from loss of moisture for at least seven (7) days after placement; however, when concrete is being protected from low temperatures, the time period for curing by saturation shall be one day less than the duration of the low temperature protection. Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period. All cast-in-place concrete in the water reservoir floor slab shall be water cured; membrane or film curing will not be acceptable.

4.16.29 Water Curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

4.16.30 Membrane Curing

Membrane curing compound shall be spray applied at coverage of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within thirty (30) minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out. Curing compound shall be suitably protected against abrasion during the curing period.

4.16.31 Film Curing

Except where otherwise required to be water cured, film curing with polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete, or will otherwise be covered or hidden from view.

Film curing shall begin as quickly as possible after initial set of the concrete. Polyethylene sheeting shall completely cover the surfaces. Sheeting shall overlap the edges for proper sealing and anchorage. Joints between sheets shall be sealed. All tears, holes, and other

damage shall be promptly repaired. Covering shall be anchored continuously at edges and shall be anchored on the surface as necessary to prevent billowing.

4.16.32 Repairing Defective Concrete

Defects in formed concrete surfaces shall be repaired within twenty-four (24) hours, to the satisfaction of the OWNER, and defective concrete shall be replaced within forty-eight (48) hours after the adjacent forms have been removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

4.16.33 Finishing Formed Surfaces

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be damp-proofed. A power grinder shall be used, if necessary, to remove projections and provide a flush surface.

4.16.34 Tie Holes

Tie holes in all formed surfaces shall be cleaned, wetted, and filled with patching mortar. Tie hole patches shall be finished flush and shall match the texture of the adjacent concrete.

4.16.35 Tolerances

Unless otherwise specified, tolerances for cast-in-place concrete work shall be as stipulated in ACI 347. Formed surfaces stipulated in Article 3.3.8 of ACI 347 shall be considered as Class C for all concrete work.

4.16.36 Surface Treatment

All concrete surfaces exposed to wastewater and/or sewer gases, inclusive of manholes, interior and exterior wall surfaces of vaults shall be coated with a minimum application of eighty (80) mils of Fosroc Epoxy Liner HBS, Poli-Brid 705, or OWNER approved equal. OWNER's approval will require submittal of product specification, history, and installation list for review at least ten (10) days prior to submission of bid package. Separate payment will not be made for surface treatment, all material, labor and resources are considered subsidiary to the item under construction.

4.16.37 Concrete for Pipe Blocking and Encasement

Concrete for buried blocking and encasement of pipe shall conform to the limiting requirements specified hereinbefore, except that air-entraining and water-reducing admixtures may be omitted and the cement factor and total water content may be adjusted to provide a minimum compressive strength of 3,000 psi at twenty-eight (28) days. Concrete shall have a slump of not less than two inches (2”) nor more than five inches (5”) when placed.

4.16.4 Measurement and Payment

No additional payment shall be made for material furnished or work done under this item, which is considered subsidiary of the various pay items. Any additional tests required due to unsatisfactory quality of work or material provided will be the responsibility of the CONTRACTOR.

4.17 - Water Meter Change Out

4.17.0 General

Work under this item shall consist of changing out existing water meters in the OWNER's distribution system.

4.17.1 Work Orders

The OWNER will provide CONTRACTOR with a work order for each location where a meter is to be changed out. The work order will specify the address and identifying information on the existing meter. CONTRACTOR will be required to enter on the work order all required information for the meter removed and new meter installed at the address. Information includes but is not limited to: record/verify old meter serial number, old meter size, old meter manufacture number, old meter reading, new meter size, new meter manufacture number, new meter serial number, new meter reading, list of any parts required for change-out, indicate if meter box was changed, indicate if existing meter box was damaged, etc. Work orders shall be picked up and returned from 7:00 am to 8:00 am daily to the Water Distribution Center at 1948 St. Ann Street. A maximum of (4) - Number is Project Specific work orders will be issued per work day (Monday through Friday, excluding OWNER's holidays) unless otherwise approved by OWNER. Additional work orders will not be issued until the previous work orders and their corresponding meters are completed and returned.

Work orders will be generated based on age of meter, meter locations (by zip codes and by address).

Meter change-out work will only be allowed from 8:00 am to 5:00 pm on Monday through Friday, excluding OWNER's holidays. CONTRACTOR will provide written notification to property indicating the work conducted and contact numbers in case of problems.

4.17.2 Meters and Related Appurtenances

Meter sizes that will be changed out are 5/8" x 3/4" and one inch (1"). OWNER will provide all meters, gaskets, meter spuds and meter risers to CONTRACTOR. Meters shall be picked up and returned daily to the Water Distribution Center. Broken and replaced parts will also be returned daily.

4.17.3 Meter Change-Out

CONTRACTOR shall make every attempt to notify occupants of building in person prior to turning off water service. If no answer is obtained, the CONTRACTOR shall verify that water is not being used. If water is being used, CONTRACTOR shall again attempt to notify occupants. If no answer is obtained, the CONTRACTOR shall note on the work order that water is being used. Once service is restored the CONTRACTOR shall note on the work order if water was again being used. Once the change-out is complete, the CONTRACTOR shall flush the service line by utilizing customer's facet, if available, and shall place a notice on the residence's door. Notices shall be approved by the OWNER prior to issuance by the CONTRACTOR. CONTRACTOR is responsible for providing all notices. CONTRACTOR shall be responsible for all work associated with change out of a meter. CONTRACTOR shall clean out each meter box prior to commencing work. All accumulated material (soil, leaves,

debris, etc.) shall be removed by means of water jetting and vacuum action to the bottom of the existing meter box or to the bottom of the existing meter whichever is greater. Work shall include but is not limited to; turning off water service line valve to meter, removing old meter, installing meter risers (required if top of existing meter is twelve inches (12") or more below existing ground), installing new meter, turning water back on, checking for and repairing any leak at the meter connections, digging up, removal and reinstalling the meter box if necessary to accomplish the change out. CONTRACTOR shall remain at the change out location until service has been restored (including any plumber repair work required). CONTRACTOR shall not proceed to next location until the customer's service has been restored.

4.17.4 Meter Boxes

Whenever CONTRACTOR discovers a broken meter box or lid; such broken unit shall be replaced by CONTRACTOR. Additionally, whenever the existing meter box is a concrete box; CONTRACTOR shall replace it with a new unit. OWNER shall supply all meter box replacement parts and complete boxes. Meter boxes and parts shall be picked up and returned to the Water Distribution Center. For the replacement of a concrete meter box; CONTRACTOR shall be compensated at the rate shown in the bid schedule. For all other replacement of meter boxes or parts; no additional compensation will be provided to CONTRACTOR and such work will be considered part of the meter change out. All additional parts required to complete the installation shall be duly noted on the corresponding work order. OWNER will not replace the part allotment provided to CONTRACTOR without proper work order documentation.

Meter boxes located such that demolition of existing asphalt or concrete is required to complete the meter change-out shall not be completed by CONTRACTOR. CONTRACTOR shall document circumstance on work order and return to OWNER. No additional compensation will be provided to CONTRACTOR.

4.17.5 Measurement and Payment

Water meters shall be measured per each by the various sizes, complete in place. Payment shall be at the unit price for each size of meter that is changed out. The unit price shall include full compensation for the water meter change-out complete in place, all in accordance with the plans and specifications, including all labor, tools, machinery, profit and overhead, insurance, etc.; required to accomplish the work.

4.18 - Temporary Line Stops - Potable Water Mains

4.18.0 General

4.18.0.1 Scope

Under this item CONTRACTOR shall furnish all materials, labor, and equipment to properly install a Temporary Line Stop into the existing potable water mains at the locations shown on the plans.

4.18.1 Experience

The design, installation and operation of the temporary stop system shall be the CONTRACTOR's responsibility, unless otherwise noted. The system shall include all concrete blocking and supports required for the operation. The CONTRACTOR shall employ the services of a "Stop Sub-Contractor" who can demonstrate to the OWNER the experience and competence through a history of successful completion of similar projects. The "Stop Sub-Contractor" shall provide, upon request, at least five (5) references of projects of a similar size and complexity as this project performed in the past three years. All "Stop Sub-Contractor's" must be pre-approved by City of San Angelo Water Utilities or Engineering Services prior to work commencing.

4.18.2 Preliminary Field Inspection of Mains

Dimensional, specification, and other data regarding the existing mains are provided for CONTRACTOR's convenience only. These data must be verified by field inspections. In addition, it is anticipated that exterior main conditions, service connections, or presence of adjoining utilities may require relocation of proposed taps.

The CONTRACTOR shall field measure the exact main O.D., ovality, and cylinder diameter of each stop location. All measurements shall be obtained by exposing the full circumference of each pipe. For concrete steel cylinders pipe, the CONTRACTOR shall expose the entire circumference section of the internal steel cylinder at the Pressure Tap location(s) in order to obtain data on the existing pipe. The area shall be repaired by applying Portland cement mortar to the exposed cylinder, filling the recess flush with the O.D. of the main. Mortar will be allowed to harden before backfilling.

If, in OWNER's opinion the proposed location is unsatisfactory due to previously unknown connections or fittings or unsatisfactory pipe conditions, the CONTRACTOR will relocate and excavate at another site.

4.18.3 Interruption of Flow

The main shall be returned to service as soon as possible and the CONTRACTOR shall allow a minimum of twenty-four (24) hours between each stop, unless otherwise approved by the OWNER. The CONTRACTOR shall install a minimum of three taps onto the existing main (unless taps are contained on the insertion/tapping equipment). The taps shall be located such that the pressure on each side of the stop can be measured. The third tap shall be located

between the stops and shall be located in the section of line that is to be removed unless an alternate location is approved by the OWNER. Taps sizes shall be a minimum of two inches (2"), larger sizes will require pre-approved by the OWNER. No work shall commence within the stopped area until the CONTRACTOR has sufficiently demonstrated to the OWNER that the stops have sealed sufficiently for the proposed work. CONTRACTOR is responsible for all outlets, valves, taps, etc. that may be required to sufficiently divert water that seeps through the stops in order to complete work specified within the stopped area. The CONTRACTOR shall obtain pre-approval from the OWNER for any fittings, outlets, valves, etc. that may be required to handle by-pass water flow from the temporary stops.

4.18.4 Reduction of Pressure

For concrete steel cylinder pipe, the entire operation of making the tap(s) shall be accomplished with the line of pressure operating at no more than the safety limit established by mathematical calculation of the hoop stress of the unsupported cylinder with the reinforcing (prestressing) wires removed. A safety factor of eighty percent (80%) of yield is normally used. This calculation will determine the maximum operating pressure at the time of the material installation and the tap.

4.18.5 Temporary Line Stop Fittings and Accessories

CONTRACTOR shall submit to OWNER five (5) sets of drawings, furnished by manufacturers, fully and distinctly illustrated and describing the tapping fittings, completion plug and any other fittings that are permanently attached to the main. Saddles shall conform to the following specifications; 304 stainless steel liner; rubber gasket suitable for use in potable water, with grid pattern glued in place to liner; 304 stainless steel armor plates bonded to liner; ductile iron flange or carbon steel with epoxy paint, with 150 lb. Drilling; rubber gasket suitable for use in potable water glued in place on flange face; 304 stainless steel hardware coated to prevent galling or seizing; 304 stainless steel test plug.

4.18.6 Installation of Temporary Line Fitting

CONTRACTOR shall power wire brush and grind the exterior of the main to remove any debris, corrosion deposits, or other surface irregularities that might interfere with proper seating and sealing of each tapping fitting against each main. Fittings shall be assembled onto the main following the manufactures' requirements. The CONTRACTOR shall pressure test the stop fitting to verify satisfactory gland/cylinder seal. Test pressure shall not exceed line pressure in the main to avoid collapsing the cylinder and liner.

4.18.7 Thrust and Support Blocking

Prior to mounting tapping valve and pressure tapping machinery, CONTRACTOR shall install concrete thrust and support blocking as per the manufactures' requirements. Blocking shall be allowed to reach the minimum cure strength specified by the manufacture before any valves or machinery shall be mounted onto the Stop fitting.

4.18.8 Cutting Operation

Drilling equipment shall be in good workable condition prior to initiation of work, and equipped with power drive to insure smooth cutting and to minimize shock and vibration. Cutting equipment shall be carbide tipped and capable of being renewed without removal from jobsite.

4.18.9 Temporary Line Stop Machinery

The equipment shall consist of folding plugging head that contains an elastomer sealing element. The plugging head is advanced into and from the main by means of a linear actuator. When retracted, the plugging head and carrier are housed in an adapter, bolted pressure tight between the tapping valve and the actuator. A minimum of one extra seal per line size and per stop shall be on-site.

4.18.10 Completion

The completion of the Stopping shall include the installation of the Completion Plug and a Blind Flange.

4.18.11 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for all trench protection, rock excavation, material, equipment, labor, and resources required for complete installation inclusive to the unit price bid.

4.19 - Insertable Valves for Potable Water Mains

4.19.0 General

4.19.0.1 Scope

Under this item CONTRACTOR shall furnish all materials, labor, and equipment to properly install a full bore resilient seat gate valve onto existing pressurized potable water mains at the locations shown on the plans. The complete operation shall be completed while maintaining pressure on the existing main.

4.19.1 Experience

The following systems are approved:

- Advanced Valve Technologies, LLC [approved for four inches (4") through sixteen inches (16")]

- Hydra-Stop Inserta-Valve [approved for four inches (4") through sixteen inches (16")]

Requests to approve additional systems shall be submitted in writing to the City Engineer, Department of Water Utilities at least fourteen (14) days prior to the original bid opening date. The request shall include the company's experience, at least five (5) references of projects of a similar size and complexity as this project performed in the past three years and a description of the equipment and methods employed.

4.19.2 Preliminary Field Inspection of Mains

Dimensional, specification, and other data regarding the existing mains are provided for CONTRACTOR's convenience only. These data must be verified by field inspections. In addition, it is anticipated that exterior main conditions, service connections, or presence of adjoining utilities may require relocation of proposed taps.

The CONTRACTOR shall field measure the exact main O.D., ovality, and cylinder diameter of each stop location. For concrete steel cylinders pipe, the CONTRACTOR shall expose the entire circumference section of the internal steel cylinder at the Pressure Tap location(s) in order to obtain data on the existing pipe. The area shall be repaired by applying Portland cement mortar to the exposed cylinder, filling the recess flush with the O.D. of the main. Mortar will be allowed to harden before backfilling.

If, in OWNER's opinion the proposed location is unsatisfactory due to previously unknown connections or fittings or unsatisfactory pipe conditions, the CONTRACTOR will excavate at another site.

4.19.3 Materials

Valves shall utilize the standard two inch (2") square nut for operation of valve. All materials utilized shall conform to the appropriate AWWA standards for material specifications. Clamps may be weld-on or bolted.

4.19.4 Installation

All valves shall be fully supported by cast-in-place concrete. The concrete shall be placed on firm, undisturbed soil. The pipe and fitting joints shall remain accessible for repair. The minimum depth of concrete for valve foundations shall be six inches (6") for twelve inch (12") valves and smaller and shall be eight inches (8") for valves larger than twelve inches (12"). Reinforcement shall consist of 4x4 W2.9xW2.9 (6 gauge) or approved equal. The concrete shall extend a minimum of four inches (4") beyond all contact points with the valve.

Valve boxes shall be provided as described in Technical Specification 4.10, "Valves and Valve Installation".

4.19.5 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for all trench protection, rock excavation, material, equipment, labor, and resources required for complete installation inclusive to the unit price bid.

4.20 - High Density Polyethylene (HDPE) Gravity Sewer Pipe

4.20.0 General

4.20.0.1 Scope

This section covers the furnishing and installation of high density polyethylene sanitary sewer pipe and fittings in sizes four inches (4") through fifty-four inches (54") joined by means of zero leak-rate heat-fusion, electrofusion and approved mechanical joints, meeting the following specifications. The plans show the sizes and general arrangement of all pipes; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" and for providing special items as may be required to simplify or facilitate the installation rests with the CONTRACTOR.

4.20.1 Material Specifications

The polyethylene pipe and fittings shall be made from virgin resins exhibiting a cell classification of PE 345464C as defined in ASTM D3350 with an established hydrostatic design basis of 1600 psi for water at 73.4°F. The resin shall be listed by PPI (Plastics Pipe Institute, a division of the Society of the Plastics Industry) in its pipe-grade registry Technical Report (TR) 4, *"Listing of Plastic Pipe Compounds"*.

4.20.2 Pipe and Fittings

Pipe OD sizes 4" to 54" shall be supplied in ductile iron pipe sizes (DIPS). All pipes shall be suitable for use as a fluid pressure conduit. Peak flow water velocity of five (5) feet per second shall be used in the hydraulics engineering design. Pipe and fittings material shall be fatigue (surge) tolerant to at least 3,000,000 cycles of stresses at fifty percent (50%) over-pressurization above WPR.

The net pressure capability shall be the working pressure rating (WPR) at 73.4°F as follows:

DR	WPR(psi)	WPR+ SURGE(psi)	HYDROTEST (psi)	NOMINAL BURST (psi)
32.5	50.8	76.2	76.2	203.2
26	64.0	96	96	256.0
21	80.0	120.0	120.0	320.0
17	100.0	150.0	150.0	400.0
15.5	110.3	165.5	165.5	441.4
13.5	128.0	192.0	192.0	512.0
11	160.0	240.0	240.0	640.0
9	200.0	300.0	300.0	800.0
7	266.7	400.0	400.0	1066.7

The wall thickness shall follow the Dimension Ratio (DR) system prescribed in ASTM F714. Laying lengths are forty feet (40') standard. The pipe is to be joined by heat fusion, other acceptable methods (flanges or other mechanical joint systems proven for HDPE pipes) must be pre-approved by the OWNER.

Pipe shall be designed for a minimum pipe stiffness of fifty (50) psi (minimum) at five percent (5%) deflection when calculated according to ASTM D2412.

Pipe and fittings shall be marked as prescribed in ASTM F714. Pipe markings will include nominal size, OD base (i.e.: fourteen inch (14") ductile iron pipe sizing, DIPS), dimension ration, pressure class, WPR, ASTM F714, manufacturer's name, manufacturer's production code including day, month, year extruded and manufacturer's plant and extrusion line.

4.20.3 General Installation

Pipe, fittings and specials are to be installed at locations shown on plans. The trench bottom should be smooth and free from stones greater than ½" diameter and large dirt clods.

All pipe, fittings, and specials shall be lowered into the trench by some suitable means, and shall not be rolled or dumped into trench. All dirt or trash shall be removed from the ends of the pipe. Any damaged, defective or unsound material shall be suitably repaired or replaced before use. Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection must be approved by the OWNER and shall be within acceptable limits as suggested by the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all obstructions and especially water. Any pipe that becomes contaminated before or after installation shall be removed and replaced unless a method to clean the pipe is approved by the OWNER.

4.20.4 Embedment and Bedding Material

Excavated material shall not be used as bedding material. All excavated materials together with all debris; stones, stumps, and roots shall be removed from the site and disposed of by, and at the expense of, the CONTRACTOR. The embedment zone for the gravity sewer pipe shall be Type II for installation with a minimum of thirty inches (30") of cover at finished grade unless otherwise noted in the plans and/or specifications. Piping with less than thirty inches (30") of cover at finished grade shall have Type V embedment unless otherwise noted in the plans and/or specifications. Bedding material shall be a granular material that will remain firm and not permit displacement of the pipe either during pipe laying and backfilling or following completion of construction. The crushed gravel meeting the requirements of ASTM Designation C33, Gradation 67 (3/4 in. to No. 4). Crushed stone or pea gravel meeting the TXDOT Grade 5 gradation per test method Tex-200-F, Part I, is acceptable. Bedding material on all subaqueous installations shall consist of one inch (1") non-angular washed river gravel.

4.20.5 Cutting and Joining

Cutting and joining of HDPE pipe shall follow the manufacturer's recommendations including type of fusion equipment acceptable. A test joint shall be completed and cut out for examination and/or destructive testing at the start of each day of work. An acceptable joint should be obtained prior to beginning joining operations for the day.

4.20.6 Joint and Pipe Testing

HDPE pipe should be hydrostatically pressure tested. See Technical Specification 4.28, "Sewer Line and Manhole Testing," for a description of the testing procedure.

4.20.7 Connections with Existing Facilities

Where connections are made between new work and existing piping, such connections shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at the time and under conditions which will least interfere with service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

4.20.8 Concrete Anchoring

When required, steel reinforced rectangular concrete blocks shall be attached to the HDPE pipe to provide ballasting required to keep the pipe on the floor of the body of water to be crossed. The concrete blocks may be bolted on to the pipe line using non-corrosive bolts, clamps, or straps. A compressible protective wrap shall be placed the pipe to prevent contact with the concrete weights. The protective wrapping shall consist of a minimum of 1/4 inch rubber sheet or other similar approved material and shall extend beyond both edges of the concrete block weights. Weights shall be sized such that spacing between each shall not exceed ten feet (10').

4.20.9 Measurement and Payment

Measurement and payment for this item will be based on the lump sum price bid. Payment will include full compensation for excavation, embedment, backfill, furnishing, hauling and laying pipe, fittings (other than valves), testing, etc., in accordance with the specifications, Plans, and/or instructions of the OWNER.

4.21 – 4.40 Sections removed for project

4.41 - Vibration Monitoring

4.41.0 General

4.41.0.1 Scope of Work

Work under this section includes, but is not limited to monitoring of any vibration producing activities completed for this project. Monitoring shall be conducted before, during and after any anticipated vibration producing activities such as, but not limited to, site excavation activities and demolition, installation of support of excavation systems, operation of construction equipment, construction traffic and activities related to the rehabilitation work for the duration of the activity, or until sufficient information has been collected to prove that no differing condition exists. The CONTRACTOR shall provide and install the necessary equipment to monitor any potential vibrations caused by their construction operations or as directed by the OWNER.

4.41.1 Quality Assurance

The CONTRACTOR shall employ the services a qualified seismologist with a minimum of five years of verifiable previous experience in the installation of vibration monitoring equipment and performing the required vibration-monitoring operations.

4.41.2 Submittals

Prior to the start of construction, the CONTRACTOR shall submit the following:
Verifiable qualifications of the seismologist.
Verifiable qualifications of the vibration-monitoring contractor.
Results of the pre-disturbance survey including all records, reports, video, photographs, and recommendations for peak particle velocity limits for all features surveyed that might be impacted by construction-induced vibrations.

A plan of the locations of the seismic monitoring sensors and equipment.
Pre-disturbance survey of all potentially impacted structures recommended by the seismologist.

During Construction:
Provide results of the testing to the OWNER at the end of each work day when vibration inducing activities are conducted.

Following Construction, the CONTRACTOR shall submit the following:
Results of the post-disturbance surveys including all records, reports, video, photographs for items that may have been impacted by construction-induced vibrations.

Post disturbance survey of all structures potentially impacted by the construction and recommended by the seismologist.

4.41.3 Construction Requirements

The CONTRACTOR shall make every effort to avoid damage to the existing sewer, appurtenances, structures or features within the influence of any construction-induced vibrations including the use of site access routes.

The CONTRACTOR is responsible for all construction related damages caused by, but not limited to, vibration or air blast from the CONTRACTOR's construction operations. Any damages caused by the CONTRACTOR's operations shall be repaired by the CONTRACTOR, at the CONTRACTOR's own expense, to the satisfaction of the OWNER.

Vibration monitoring is required for any vibration producing activity associated with this project.

Pre- and Post-Construction Surveys:
The CONTRACTOR must perform a documented pre- and post-construction survey as directed by the vibration-monitoring consultant as part of determining vibration effects on any existing features within the influence area of the proposed construction activities.
The pre-construction survey shall include tape-recorded observations; videotape and still photography and sketches as needed to fully describe the existing condition of each feature potentially affected by any construction induced vibrations.
This survey shall be completed at least thirty (30) days before initiating any vibration producing activity.
A report shall be prepared for each feature identified by the vibration-monitoring firm. The report shall include all of the recorded observations.
Following the completion of the vibration producing activities, a post-disturbance survey shall be performed for each feature that received a pre-disturbance survey. The pre-disturbance survey, photographs, video, descriptions and sketches shall be compared to the current condition to determine if any damage has occurred during the construction activities. The same individual or firm that performed the pre-disturbance survey shall perform the post-disturbance survey. A report will be prepared for each feature previously identified with a summary that documents any changes from the pre-condition survey and whether any of the changes noted were a direct result of the construction activities. The qualified seismologist shall attend the post-disturbance survey to provide impute. Changes in the condition of any feature impacted shall be documented with video, still photographs, and sketches and a detailed narration.

Upon the discovery of any damage, construction operations shall cease until the CONTRACTOR has the damage repaired to the satisfaction of the OWNER and provides suitable measures to control future disturbances.

Site Restoration: Any areas or items disturbed by the CONTRACTORs operations shall be restored to pre-existing conditions or replaced by the CONTRACTOR at no additional cost. The costs for any site restoration or replacement of items damaged as a result of the CONTRACTOR's work shall be included in the specific bid item for which the work is required.

4.41.4 Measurement and Payment

Measurement:
Measurement for vibration monitoring will not be made, but shall be included in the lump sum price bid on the Bid Sheet for specific items of work requiring the service.

Payment:
No separate payment will be made for vibration monitoring. The costs thereof shall be included in the specific prices bid in the Bid Sheet for work items which this work item is associated. The payment shall be inclusive of all items of work required to successfully complete the work.

4.42 - Concrete Curb, Elevated Concrete Curb, Gutter, Curb and Gutter

4.42.0 General

4.42.1 Scope

The work covered by this section includes the replacement of curb, gutter, or combined curb and gutter.

4.42.2 Material

4.42.2.1 Concrete

Concrete used in conventionally formed construction shall be Class A (3,000 psi) concrete with a seven-sack grout topping. Concrete for extruded (machine laid) construction shall be Class A concrete. Membrane curing materials shall be applied.

4.42.2.2 Reinforcing Steel

Reinforcing steel shall be standard billet steel deformed bars with minimum sixty kips per square inch (60 ksi) yield strength and will be required in those areas where the steel already exists, and shall be compatible with the existing sections.

4.42.3 Inspection

It will be the CONTRACTOR's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, and to provide permanent means for checking the output of any specified metering device and to perform these calibration checks as required by the OWNER.

4.42.4 Construction Methods

4.42.4.1 General Requirements

For conventionally formed concrete, the subgrade, foundation, or pavement surface shall be shaped to line, grade, and cross-section of the existing portions, and, if considered necessary by the inspector, hand-tamped and sprinkled. If dry, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon. Outside forms shall be of wood or metal, of a section satisfactory to the OWNER, straight, free of warp and of a depth equal to the depth required. They shall be securely staked to line and grade, and maintained in a true position during the depositing of concrete. Inside forms for curbs 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. The reinforcing steel, if required, shall be placed in position as required by the site location. Care shall be exercised to keep all steel in its proper location. After the concrete has been struck off and 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 otherwise specified on the plans, when the concrete has become sufficiently set, the inside form for curbs shall be carefully removed and the surface shall be plastered with a seven-sack grout topping. The mortar shall be applied with

a template made to conform to the dimensions of the existing curb. All exposed surfaces shall be brushed to a smooth and uniform surface. Membrane curing materials shall be applied. All concrete placed under the item shall contain 7% + 1-1/2% entrained air. The completed work shall be cured for a period of not less than seventy-two (72) hours.

4.42.5 Measurement and Payment

4.42.5.1 Measurement

Work and accepted material for concrete curb, elevated concrete curb, concrete gutter, or concrete curb and gutter will be measured by the linear foot, complete in place.

4.42.5.2 Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.43 - Concrete Cap and Rigid Pavement

4.43.0 General

4.43.1 Scope

The work covered by this section includes all necessary operations and materials involved with placing a concrete cap or rigid pavement at locations as required.

4.43.1.1 Concrete Cap

Concrete caps shall be used when specified by the OWNER, in areas where major traffic lanes create excessive wheel-loading or where compaction of the base and sub-base is prone to failure.

4.43.1.2 Rigid Pavement

Rigid Pavement shall be used when specified by the OWNER and in repair of utility trenches cut in rigid pavement.

4.43.2 Material

4.43.2.1 Concrete & Reinforcement

All concrete shall be Class P, 3,500 psi compressive strength and 555 psi flexural strength. Rebar shall be installed on eighteen inch (18”) centers each way and dowel in #4 rebar nine inches (9”) deep with twenty-four inch (24”) lap splice, or thirty-six pounds (36 lbs.) of Novamesh 850 per cubic yard with #4 rebar dowels nine inches (9”) deep and nine inches (9”) into the trench on eighteen inch (18”) centers.

4.43.2.2 Curing Material

All concrete shall be treated with a curing material capable of protecting the pavement from loss of moisture for a period of not less than seventy-two (72) hours.

4.43.2.3 Reinforcement Steel

Reinforcing steel shall be standard billet steel deformed bars with a minimum of sixty kips per square inch (60 ksi) strength.

4.43.3 Construction Methods

4.43.3.1 Concrete Caps

Concrete caps shall be six inches (6") in thickness and of a length and width sufficient to extend a minimum of six inches (6") beyond the edge of the utility trench. The concrete shall be properly placed and finished in accordance with OWNER's specifications and shall be allowed to cure without disturbance for a period of not less than seventy-two (72) hours.

4.43.3.2 Rigid Pavement

Rigid pavement shall be concrete a minimum of six inches (6") in thickness and extending six inches (6") each way transverse to the utility trench placed over existing subgrade. In order that the quality of the replacement pavement shall be consistent with or exceed the quality of

the original pavement, reinforcement bar sizes shall be equal to or larger than those in the existing pavement and at locations as close to the original installation as feasible. In no case shall reinforcement bars be smaller than #4 and on spacings greater than twelve inches (12") each way. New rigid pavement shall be doweled a minimum of twelve inches (12") into existing rigid pavement with minimum #4 bars twenty-four inches (24") in length on twelve inch (12”) centers.

The concrete shall be properly placed and finished in accordance with OWNER's specifications and shall be allowed to cure without disturbance for a period of not less than seventy-two (72) hours.

4.43.4 Measurement and Payment

4.43.4.1 Measurement & Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.44 - Site Clean-up

4.44.0 General

4.44.0.1 Scope

This section of the specifications outlines the responsibilities of site clean-up. Any work performed under this contract shall include site clean-up.

Areas in paved street roadways or alleys disturbed during construction shall be scraped and broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. No direct compensation will be made for this work.

Areas beyond the paved street roadway or alley disturbed during construction shall be scraped, raked, graded or broomed, as necessary, and left in a clean and neat condition to the satisfaction of the OWNER. Compensation for this work shall be at the hourly rate as bid on this item in the bid schedule.

All site clean-up shall be done before final acceptance of construction will be considered.

4.44.1 Trench Spoil Removal

Trench spoil is either spoil material removed from the trench by the OWNER or unsatisfactory backfill material left on site by the OWNER outside of the trench repair boundaries. This material will not include Temporary Backfill. The CONTRACTOR will remove and dispose of this material unless otherwise directed by the OWNER.

4.44.2 Measurement and Payment

4.44.2.1 Measurement

a) Hourly Site Clean-up: Prior to initiation of work on the site, the CONTRACTOR shall meet with the City of San Angelo Inspector to define the limits of site clean-up within the general area of the job site. The CONTRACTOR and the City of San Angelo Inspector shall come to a mutual agreement as to the amount of clean-up required outside the job site limits and set a reasonable time for the amount of hours required to clean-up.

b) Trench Spoil Removal: Measurement shall be for each cubic foot removed as determined by the City of San Angelo Inspector either by volume of trench work, trucked volume, or physical measurement.

4.44.2.2 Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for material furnished or work done under this section.

4.45 - Removal and Replacement of Driveways and Turnouts

4.45.0 General

4.45.0.1 Scope

This Item shall govern for the construction of new driveways and turnouts or the removal and replacement of driveways and turnouts. Driveways and turnouts shall be concrete of the design type specified and shall be constructed according to the Typical Sections and Details.

4.45.1 Materials

Base, stabilized base, asphalt surfacing, concrete pavement, reinforcing steel and other materials shall conform to the material requirements of the pertinent items.

4.45.2 Construction Methods

The driveways and turnouts shall be constructed according to the Typical Sections and Details. Unless otherwise directed by the OWNER, the CONTRACTOR shall provide uninterrupted access to the adjacent property.

Stabilization of subgrade will be required where specified on the plans in accordance with the construction methods of the pertinent stabilization items.

Base material shall be placed on the subgrade, sprinkled, bladed compacted and shaped to conform to the typical sections shown on the plans and specified in the construction methods of the pertinent base item.

The subgrade, foundation, or pavement surface shall be shaped to line, grade and cross sections and constructed in accordance with the details shown on the plans.

When concrete pavement is specified on the plans it shall be in accordance with the construction methods of the “Cast in Place Concrete” specification. Reinforcing steel shall be placed as shown on the detail drawings. Care shall be exercised to keep all steel in its proper location during concrete placement. Hand finishing will be permitted.

4.45.3 Payment

The work performed and materials furnished in accordance with this Item shall be measured and paid under the Rigid Pavement bid item and shall be full compensation for furnishing all materials required; all labor, tools, equipment, all excavation and hauling of excavated material, all removal, hauling and disposal of concrete driveways, curbs, and debris and all sprinkling, compacting and incidentals necessary to complete the work.

4.46 - AWWA HDPE Pipe

4.46.1 General

4.46.1 Scope

This section covers the furnishing and installation of all HDPE pipe. The Plans show the sizes and general arrangement of all pipes; however, the responsibility for furnishing exact lengths of the various pipes for proper "make-up" rests with the CONTRACTOR.

4.46.2 Material Specifications

The pipe and fittings shall be supplied and installed in accordance with the following standards:

a) AWWA C906 “Polyethylene pipe and fittings, 4 inch through 63 inch for water distribution”
b) ASTM F714 “Standard specification for polyethylene pipe (SDR PR) based on outside diameter”
c) ASTM F1962 “Standard guide for use of maxi-horizontal direction drilling for placement of polyethylene pipe or conduit under obstacles, including river crossings”
d) ASTM D2774 “Standard practice for underground installation of thermoplastic pressure piping”
e) ASTM F2164 “Standard practice for field leak testing of polyethylene (PE) pressure piping systems using hydrostatic pressure”
f) ASTM F2620 “Standard practice for heat fusion of polyethylene pipe and fittings”
g) ASTM D3261 “Standard specification for butt heat fusion polyethylene (PE) plastic fittings for polyethylene (PE plastic pipe and tubing”
h) ASTM D3350 “Standard specification for polyethylene plastic pipe and fitting materials” Pipe and fittings shall be PE4710 (ASTM F714) high density polyethylene,
i) With a minimum cell classification of 445574C as determined by ASTM D3350, DIPS (Ductile Iron Pipe Size).

Resin:
Pipe and fittings shall be PE4710 (ASTM F714) high density polyethylene, with a minimum cell classification of 445574C as determined by ASTM D3350, DIPS (Ductile Iron Pipe Size).

a) Color material (if required) shall be PE4710 (ASTM F714) high density polyethylene, with a minimum cell classification of 445574E as determined by ASTM D3350.
b) Pressure class and wall thickness as indicated on the Drawings.
c) Manufacturers shall be listed by PPI in TR-4.

Pipe Marking:
During extrusion production, the HDPE pipe shall be
continuously marked with durable printing following this format or an equal type format designating the same information:

a) Manufacturer name or trademark
b) Nominal Size
c) Sizing System – IPS or DIPS
d) Dimension Ratio
e) Standard Designation – ASTM, AWWA, or other

f) Material Classification
g) Certification Bases, e.g. NSF-61
h) Plant
i) Extruder Number
j) Date
k) Shift Letter

EXAMPLE: PIPELINE PLASTICS 12" IPS SDR 11, PE4710 PC200 AWWA C906 ASTM F714 NSF-61 TXL1 A052015

4.46.3 General Installation

HDPE pipe and fittings are to be installed at locations shown on Plans. The trench bottom should be smooth and free from stones greater than two inches (2") in diameter and large dirt clods. If the trench bottom is rocky or hard, as in shale, a four inch (4") layer of embedment material shall be placed to provide a cushion for the pipe. All pipe, fittings, and specials shall be lowered into the trench by some suitable means, and shall not be rolled or dumped into trench. All dirt or trash shall be removed from the ends of the pipe. Any damaged, defective or unsound material shall be suitably repaired or replaced before use. Where it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be approved by the OWNER and shall be within acceptable limits as suggested by the manufacturer. The pipe is to be kept clean during the laying operation and free of all sticks, dirt and trash, and at the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all obstructions and especially water. Any pipe that becomes contaminated before or after installation shall be removed and replaced unless a method to clean the pipe is approved by the OWNER. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, that section should be cut out and discarded.

4.46.4 Bedding & Backfill

Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.

Pipe embedment - Embedment material should be Class I, Class II, or Class III, materials as defined by ASTM D2321 Section 6. The use of Class IV and Class V materials is not recommended, however it may be used only with the approval of the engineer and appropriate compaction.

Bedding: Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321. Deviations shall be approved by the engineer.

4.46.5 Fittings and Connections

Where connections are made between new work and existing piping, such connections shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at the time and under conditions which will least interfere with service to customers affected thereby, and as authorized by the OWNER. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

a) Butt fusion fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All fittings shall meet the requirements of AWWA C906.
b) Connections from HDPE pipe to valves or other pipe materials shall be made with flange adapters or mechanical joint adapters. Flange adapters and MJ adapters shall be made from PE4710 material with no visible voids or inclusions. MJ adapters shall have an internal stainless steel stiffener.
c) Convoluted back up rings shall be used with HDPE flange adapters and shall follow the dimensions as per ANSI B 16.5 class 150 and shall be made from Stainless Steel as per ASTM A 351 CF8M (316).
d) Tie-ins between sections of HDPE pipe shall be made by butt fusion whenever possible. If butt fusion is not possible, sections shall be joined by flange adapters and convoluted back up rings. Mechanical restraint-type fittings are not allowed. Electrofusion couplings are not allowed, unless approved in advance by the project engineer.
e) Flange bolts. ASTM A193 Class 2, AISI Type 316, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Flange Nuts ASTM A194, AISI Type 316, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts.
f) Flange adapters shall be assembled and torqued according to PPI TN-38, "Bolt torque for polyethylene flanged joints."

4.46.6 Testing

Hydrostatic Tests - After installation, HDPE piping shall be hydrostatically tested for defective workmanship and materials. Hydrostatic leak testing shall comply with ASTM F2164. The required test pressure is the temperature adjusted pressure rating of the pipe at the low point in each test segment. The Contractor's Hydrostatic Leak Testing Plan shall show the test pressure adjusted for the actual pressure gauge elevation for each test segment. Selections for actual test segments and pressure gauge locations are at CONTRACTOR's discretion.

Leakage - All HDPE piping shall be watertight and free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of CONTRACTOR.

4.46.7 Fusion Procedures

This specification is intended to insure quality HDPE fusion welds are achieved. A properly trained fusion operator will use properly maintained equipment. Verification of sample joints can be destructively tested and records of all fusion joints can be reviewed against accepted fusion variables.

A fusion procedure that follows the guidelines of ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings must be documented on company letterhead.

A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F 2620.

4.46.8 Fusion Operator

All HDPE fusion equipment operators shall be qualified to perform pipe joining. Fusion equipment operators shall have current, formal training on all fusion equipment employed on

the project. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current. All operators shall be familiar with the requirements outlined in ASTM F 2620 and the HDPE supplier's requirements for fusion.

When the fusion machine operator is employed by the HDPE pipe and fusion machine supplier, the supplier shall maintain an ISO 9001 Certified Quality Management System.

4.46.9 Fusion Performance Qualification

Visual Examination:
For pipe sections, examine the full exterior circumference for bead uniformity before cutting. After cutting the pipe section, review the interior bead. All beads should have visually acceptable bead formation as shown in Fig 4 and Appendix X2 of ASTM F2620. In addition, the following characteristics are expected:

a) There shall be no evidence of cracks or incomplete fusing
b) Variations in upset bead heights on opposite sides of the cleavage and around the circumference of fused pipe joints are acceptable.
c) The apex of the cleavage between the upset beads of the fused joint shall remain above the base material surface
d) Fused joints shall not display visible angular misalignment, and outside diameter mismatch shall be less than 10% of the nominal wall thickness

Mechanical Tests:
Each pipe sample weld maybe subjected to testing at two locations 180 degrees apart from each other in the joint weld. All samples shall be labeled with operator information. Testing must be done at 73 degrees F plus or minus 5 degrees. The test temperature and sample size are critical to testing. Testing performed at cold or elevated temperatures may not give similar results to tests performed at ambient temperatures. Results of any mechanical test should be documented. Information on the weld and operator should be transferred from the sample to the testing record. All specimens maybe tested by one of the following methods:

a) Reverse Bend Test are allowed for pipe sizes 6" IPS or smaller. The specimens shall be removed and tested in accordance with ASTM F 2620, Appendix X4.
b) Guided Side Bend Test are allowed for all pipe sizes 4" IPS and larger. The specimens shall be removed and tested in accordance to standard methods.
c) High Speed Tensile Impact Test is allowed for pipe sizes 3"-63" for all wall thicknesses less than 2.5". The specimens shall be removed and tested in accordance to ASTM F 2634.
d) Hydrostatic Burst Test is allowed for pipe sizes 2"-24". The specimen length should measure 6 times pipe diameter with the butt fusion joint in the center of the specimen. The specimen should be tested in a tank filled with water, and testing conditions monitored and recorded with computerized equipment. The specimen will be tested at 4 times pipe rated pressure for 5 minutes with no failure of joint allowed.

Records showing the fusion device is up to date on all required calibration should be available for presentation when requested. All fusion welds should be traceable to the report (via operator and weld ID) with an indentation weld stamp or by permanent paint marker/pen next

to fusion weld. When requested prior to commencement of work, a weld location map may requested by the owner or owner's representative.

If the recorded data is outside the limits of the acceptable range, the joint is unacceptable. Records for test fusion joints should be reviewed immediately after the joint is completed. Fusion joints for jobsite fusions should be reviewed daily or before being covered with backfill

4.46.10 Measurement and Payment

Payment for this item will be based on the linear foot price bid. The measurement of pipe for payment purposes will be the horizontally measured length of the line along its main axis from center of fitting to center of fitting or end of pipe, without deduction for the length of intermediate fittings or valves. Payment will include full compensation for excavation, embedment, backfill, separation of excavated material for backfill according to the specifications, asphalt/concrete repair, surface restoration (unless specified elsewhere) furnishing, hauling and laying pipe, fittings (other than valves), testing, disinfection, etc., in accordance with the specifications, Plans, and/or instructions of the OWNER.

4.47 Weighted Collars

4.47.1 Scope

This section covers the furnishing and installation of weighted collars. The intent of the weighted collars is for submersion of periodic drained water pipe and maintaining the water pipe below a surface water body during and after construction operations.

4.47.2 Material Specifications

The weighted collars shall be constructed and designed such that it meets all AWWA standards (as applicable) and to resist the uplift buoyant forces exerted on an empty pipe, diameter shown on plans. All mechanical measures used to secure the weighted collars to the pipe shall be corrosion resistant, resistant to corrosion with full submersion in water and prevention from sliding along the pipe during and after installation.

Material specifications shall be submitted to the OWNER, for review and approval, prior to the start of any construction. The OWNER will provide written approval once approved. The material specification shall be submitted (at a minimum) on the manufacturer's letterhead with the manufacturer's contact information.

4.47.2 General Installation

Installation method shall be determined by the CONTRACTOR. The selected method of construction shall be submitted, in writing, to the OWNER three (3) weeks prior to construction for review and approval. The OWNER shall have a minimum of one (1) week to review construction method and will provide written approval once approved. The installation method shall be within standard installation procedures and as recommended by the manufacturer.

Installation shall not damage the integrity of the pipe in any manner. If the integrity of the pipe is compromised, replacement of the pipe and/or collar will be the responsibility of the CONTRACTOR.

4.47.3 Measurement and Payment

All work and material furnished under this section is considered subsidiary to the various pay items; therefore, no additional payment shall be made for work done under this section.