

Standard Specifications Manual

SERIES 500 - UNDERGROUND PIPED UTILITIES

Item No.

- 501 Jacking or Boring Pipe
- 502 Tunneling
- 503 Frames, Grates, Rings and Covers
- 504 Adjusting Structures
- 505 Concrete Encasement and Encasement Pipe
- 506 Manholes
- 507 Bulkheads
- 508 Miscellaneous Structures and Appurtenances
- 509 Trench Safety Systems
- 510 Pipe
- 511 Water Valves
- 551 Pipe Underdrains
- 558 Structural Plate Structures
- 559 Portland Cement Concrete Box Culverts
- 591 Riprap for Slope Protection
- 593 P.C. Concrete Retards
- 594 Gabions and Revet Mattresses

ITEM NO. 501
JACKING OR BORING PIPE

501.1 Description

This item shall govern furnishing and installing of encasement pipe by methods of jacking or boring as indicated on the Drawings and in conformity with this specification. This item shall also include, but not be limited to other constructions activities such as traffic control measures, excavation, removal of all materials encountered in jacking or boring pipe operations, disposal of all material not required in the work, grouting, bulkhead installation, backfilling and re-vegetation.

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

501.2 Submittals

The submittal requirements for this specification item shall include:

- A. Shop drawings identifying proposed jacking or boring method complete in assembled position
- B. Trench Safety Plan including pits, trenches and sheeting or bracing if necessary,
- C. Design for jacking or boring head,
- D. Installation of jacking or boring supports or back stop,
- E. Arrangement and position of jacks and pipe guides, and
- F. Grouting plan,

501.3 Materials

- A. Pipe

Carrier pipe and encasement pipe shall conform to Standard Specification Item Nos. 505, "Concrete Encasement and Encasement Pipe" and 510, "Pipe" and shall be size, type, materials, thickness and class indicated on the Drawings, unless otherwise specified.

- B. Grout

Grout for void areas shall consist of 1 part Portland cement and 4 parts fine, clean sand mixed with water.

501.4 Construction Methods

A. General

The Contractor is responsible for:

1. Adequacy of jacking and boring operations,
2. Installation of support systems as indicated on the Drawings,
3. Provision of encasement and carrier pipe, and
4. Execution of work involving the jacking operation, the wet or dry method of boring and the installation of encasement pipe simultaneously.

The Contractor shall have sole responsibility for the safety of the jacking and boring operations and for persons engaged in the work. The Contractor's attention is directed to the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29 FR 1926/1920) as published in U.S. Department of Labor publication OSHA 2207, latest revision, with particular attention to Subpart S. The Contractor shall conform to the requirements in accordance with Standard Specification Item No. 509, "Trench Safety System" and shall provide an appropriate Trench Safety Plan.

When the grade of the pipe at the jacking or boring end is below the ground surface, suitable pits or trenches shall be excavated to provide sufficient room to conduct the jacking or boring operations, joining pipe, and for placement of the pipe and appurtenances. In order to provide a safe and stable work area, the excavated area shall be securely sheeted and braced to prevent earth caving in accordance with the Trench Safety Plan.

The location of the work pit and associated traffic control measures required for the jacking or boring operations shall conform to the requirements of the City of Round Rock and Texas Manual on Uniform Traffic Control Devices.

Where installation of pipe is required under railroad embankments, highways, streets, or other facilities by jacking or boring methods, construction shall be undertaken in such a manner that it will not interfere with operation of any railroad, street, highway, utility or other facility and shall not weaken or damage any embankment or structure. All appropriate permits shall be acquired prior to the initiation of the work.

During construction operations, and until the work pits are backfilled and fill material compacted, traffic barricades, signs, and warning lights to safeguard traffic and pedestrians shall be furnished and maintained by the Contractor. The Contractor shall submit the proposed pit location and traffic control plan for review by the Engineer or designated representative. The Review by the Engineer or designated representative, however, will not relieve the Contractor from his responsibility to obtain specified results in a safe, workmanlike manner.

The pipe shall be jacked or bored from the low or downstream end, if possible. Minor lateral or vertical variation in the final position of pipe from line and grade established by Engineer or designated representative will be permitted at the

discretion of Engineer or designated representative provided that such variation is regular and occurs only in one direction and that the final grade of the flow line conforms to the specified direction.

When conforming to details indicated on the drawings, but the bottom of the work pit is unstable or excessively wet or the installation of water and wastewater pipe will result in less than 30 inches (750 mm) of cover, the Contractor shall notify the Engineer or designated representative. The Engineer or designated representative may require the Contractor to install a concrete seal, cradle, cap or encasement or other appropriate action.

Immediately after jacking or boring is complete and the encasement pipe is accurately positioned and approved for line and grade, the clear space between the pipe and the surrounding excavated material shall be completely filled by pressure grouting for entire length of installation.

After placement of the carrier pipe is complete, the ends of the encasement pipe shall be bulkheaded with a manufactured boot, brick, concrete blocks or stones of sufficient mass to prevent the intrusion of backfill, etc. into the encasement pipe. The bulkhead shall also be provided with sufficient number and placement of weep holes to facilitate the escape of the contents of carrier pipe should failure occur.

As soon as possible after the carrier pipe(s) and bulkheads are completed, the work pits or trenches, which are excavated to facilitate these operations, shall be backfilled. The backfill in the street ROW shall be compacted to not less than 95 percent of the maximum density conforming to TxDOT Test Method Tex-114-E, "Laboratory Compaction Characteristics & Moisture-Density Relationship of Subgrade & Embankment Soil". Field density measurements will be made in accordance with TxDOT Test Method Tex-115-E, "Field Method for Determination of In-Place Density of Soils and Base Materials".

Where the characteristics of soil, size or size of proposed pipe dictate that tunneling is more satisfactory than jacking or boring, a tunneling method may be submitted for acceptance by Engineer or designated representative. Tunneling shall conform to Standard Specification Item No. 502, "Tunneling".

B. Jacking

Heavy duty jacks suitable for forcing the encasement pipe through the embankment shall be provided. In operating the jacks, an even pressure shall be applied to all jacks used so that the pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides properly braced together, to support the section of the pipe and to direct it in the proper line and grade. The complete jacking assembly shall be placed in order to line up with the direction and grade of the pipe. In general, the embankment material shall be excavated just ahead of the pipe, the material removed through the pipe and the pipe forced through embankment by jacking, into the space thus provided.

The excavation for the underside of the pipe, for at least 1/3 of the circumference

of the pipe, shall conform to the contour and grade of the pipe. A clearance of no more than 2 inches (50 mm) may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where excavation conforms to contour of pipe.

The distance that excavation shall extend beyond the end of the pipe depends on the character of material encountered, but it shall not exceed 2 feet (0.6 meter) in any case. This distance shall be decreased, when directed by the Engineer or designated representative, if the character of the material being excavated makes it desirable to keep the advance closer to the end of the pipe.

The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of pipe with inside angles or lugs to keep the cutting edge from slipping back onto the pipe.

When jacking of the pipe is begun, all operations shall be carried on without interruption, insofar as practical, to prevent the pipe from becoming firmly set in the embankment.

Any pipe damaged in jacking operations shall be removed and replaced by the Contractor at his entire expense.

C. Boring

The boring shall proceed from a work pit provided for the boring equipment and workmen. Excavation for the work pits and the installation of shoring shall be as outlined in the Trench Safety Plan. The location of the pit shall be approved by the Engineer or designated representative. The boring shall be done mechanically using either a pilot hole or the auger method.

In the pilot hole method, an approximate 2 inch (50 mm) pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.

When the auger method is used, a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augers shall be of sufficient diameter to convey the excavated material to the work pit.

Excavated material will be removed from the working pit and disposed of properly. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Water jetting will not be permitted.

In unstable soil formations, a gel-forming colloidal drilling fluid, that consists of at least 10 percent of high grade carefully processed bentonite, may be used to consolidate the drill cuttings, seal the walls of the hole and furnish lubrication to facilitate removal of the cuttings from the bore.

D. Tunneling

Where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic sewer would make the use of tunneling more satisfactory than jacking or boring; or when indicated on the drawings, a tunneling method may be used, with the approval of the Engineer or designated representative. The tunneling shall be in accordance with Standard Specification Item No. 502, "Tunneling".

E. Joints

If reinforced concrete pipe is used, the joints shall be in accordance with TxDOT Specification Item 464, "Reinforced Concrete Pipe".

501.5 Measurement

Jacking or boring pipe will be measured by the linear foot (meter: 1 meter equals 3.281 feet) of pipe complete in place. Such measurement will be made between the ends of the pipe along the central axis as installed.

501.6 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid price per linear foot for "Jacking or Boring Pipe" as the case may be, of type, size and class of encasement pipe indicated on the Drawings. The price shall include full compensation for furnishing, preparing, hauling and installing required materials, encasement pipe, bulkhead, for grouting and for labor, tools, equipment and incidentals necessary to complete work, including excavation, backfilling and disposal of surplus material.

The Carrier pipe shall be paid at the unit price bid for Standard Specification Item 510, "Pipe".

Payment when included as a contract pay item, will be made under one of the following:

Jacking or Boring ___ In. Pipe, Class ___ Per Linear Foot.

End

SPECIFIC Cross Reference Materials

Specification Item 501, "Jacking or Boring Pipe"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 502	Tunneling
Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 509	Trench Safety Systems
Item No. 510	Pipe

TxDOT Standard Specifications For Construction And Maintenance Of Highways, Streets, And Bridges

<u>Designation</u>	<u>Description</u>
Item 464	Reinforced Concrete Pipe

TxDOT Testing Procedures

<u>Designation</u>	<u>Description</u>
Tex-114-E	Laboratory Compaction Characteristics & Moisture Density Relationship of Subgrade & Embankment Soil
Tex-115-E	Field Method for Determination of In-Place Density of Soils and Base Materials

TxDOT Manual on Uniform Traffic Control Devices (MUTCD)

<u>Designation</u>	<u>Description</u>
MUTCD Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
MUTCD Section 6C	Channelizing Devices
MUTCD Section 6C-8	Barricade Design
MUTCD Section 6C-9	Barricade Application
MUTCD Section 6E	Lighting Devices
MUTCD Section 6F	Control of Traffic Through Work Areas
Section 8	Traffic Control
Section 8.5.5.E	Typical Applications/Bore Pits

RELATED Cross Reference Materials

Specification Item 501, "Jacking or Boring Pipe"

TxDOT Standard Specifications

<u>Designation</u>	<u>Description</u>
Item 476	Jacking, Boring or Tunneling Pipe
Item 502	Barricades, Signs and Traffic Handling

**ITEM NO. 502
TUNNELING**

502.1 Description

This item shall govern excavating, furnishing and installing a pipe or a smooth walled structure by tunneling methods as indicated on the Drawings and in conformity with this specification. This item shall also include all equipment, mobilization, materials, handling and disposal of all materials encountered, all drainage, pumping and dewatering, all tunnel support, lining, installing pipe, grouting, ventilation, lighting and wiring, telephone system shafts and all other appurtenant work.

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

502.2 Submittals

The submittal requirements of this specification item include:

- A. The Contractor's Engineer work experiences
- B. The Contractor's Engineer tunnel-related experience
- C. Method of ground water and surface water flood control
- D. Tunnel Design
- E. Equipment Plan
- F. Tunneling Procedures
- G. Material Selection for Linings
- H. Sequence of Placement
- I. Construction

502.3 Materials

Where the use of the following materials is required, such material shall conform to the following:

Material	Reference Specification
Concrete	CORR Standard Specification Item Nos. 403, 410
Structural Steel	CORR Standard Specification Item No. 720
Steel Ribs	ASTM A 36
Steel Plates	ASTM A 36, A 283
Rock Bolts	ASTM F 432
Steel Liner Plates	Armco "Standard", Commercial Shearing, Stamping Company "Commercial"
Lumber and Timber	Hardwood, sound or better, as defined by Commercial Standard CS60
Fine Aggregate	CORR Standard Specification Item No. 403.2 (4)

- A. Shotcrete

Shotcrete shall conform to Standard Specification Item No. 404, "Pneumatically Placed Concrete" of the class indicated on the Drawings, except for measurement and payment.

B. Grout

Grout shall consist of not less than 6 sacks per cubic yard (335 Kilograms per cubic meter) Portland cement and clean washed sand mixed with water. An air entraining admixture may be added to facilitate placement when acceptable to Engineer or designated representative.

502.4 Equipment

A. Surveying

A laser system shall be used to maintain line and grade at all times.

B. Excavating, Handling and Disposal.

The Contractor shall select the "Excavation, Handling and Disposal" equipment compatible with the support system selected. In soft ground conditions a shield system shall be used. A tunnel boring machine may be employed on the project.

C. Special Methods

The Contractor shall select "special equipment" required to complete the work in a timely schedule.

502.5 Construction Methods

A. General

The Contractor shall have sole responsibility for the safety of the tunnel and of persons engaged on the work. The Contractor's attention is directed to the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29FR 1926/1920) as published in the U.S. Department of Labor publication OSHA 2207, latest revision October 1, 1979, with particular attention to Subpart S.

The Contractor is solely responsible for the adequacy of the tunnel and support system, lining placement and the faithful execution of the work covered by the Contract.

The Contractor shall engage a Registered Professional Engineer, licensed in the State of Texas, who is experienced in the design of tunnels, support systems and linings, to prepare and seal all designs, calculations, recommendations and drawings required for the site conditions anticipated and encountered.

The Contractor will have the option of selecting the method of excavation, supporting system, primary lining, final lining or a combination of the above, from the typical sections indicated on the Drawings.

The Engineer or designated representative shall review the submittal materials (see Section 502.2, "Submittals"); however the review by the Engineer or designated representative shall not be construed in any way as relieving the Contractor of its sole and final responsibility for the faithful execution of the work covered by the Contract.

In the event that the timely completion of the work cannot be met by the methods proposed in the bid, the Contractor shall submit a new plan to the Engineer or designated representative to insure the completion of the project in a timely manner.

B. Excavation.

The hours of work and permitted noise levels for this project shall be indicated on the Drawings, the Special Provisions to this item or as directed by the Engineer or designated representative.

There will be no classification for excavated materials and the term "excavation" shall include all materials excavated or removed from the tunnel, regardless of the type, character, composition or condition of the material so excavated.

Portals and shafts shall be located as shown on the Drawings or as approved by the Engineer or designated representative. The portals and shafts shall be designed and constructed to withstand all imposed loads, including saturated soil conditions, dynamic loads from equipment and surcharge loads from materials. The portal and shaft sites shall be graded to prevent surface water from entering the excavation. All excavation for portals and shafts shall be to the lines and grades indicated on the Drawings.

Open cut excavation may be performed at the portals if conditions are favorable to obtain a stable and suitable portal opening. Shafts may be constructed using Raised Boring Machines or other equipment listed with the Bid and approved by the Engineer or designated representative.

The tunnel shall be excavated to the lines, grades and dimensions indicated on the Drawings using a Tunnel Boring Machine (TBM) or other equipment listed with the bid and approved by the Engineer or designated representative. The tunnel excavation may begin at either end or at a shaft, but the Contractor shall control the drift of any heading to maintain the lines and grades.

Determination of a proper tunnel size and section to meet the requirements of these Specifications is the entire responsibility of the Contractor and it shall be expressly understood and agreed that the dimensions and shape indicated on the Drawings represent the minimal dimensions acceptable to the Engineer and do not necessarily represent a tunnel size or section large enough for the construction methods or the operational procedure which may be proposed or conducted by the Contractor. The Manning "n" value for water conveyance tunnels shall be 0.012 and 0.015 for other uses.

Grouting of the final lining shall not exceed 1 inch (25 mm) and shall be limited to the joints unless otherwise indicated on the Drawings.

Construction equipment to be used in tunnel excavation shall be operated by electricity, compressed air or another approved power source. Use of gasoline engine powered equipment within the tunnel is prohibited. Diesel engine powered equipment may be used provided each piece of equipment is in first-class condition and is equipped with a special ventilation system designed in accordance with U.S. Bureau of Mines recommendations.

The propulsion system of Mechanical Excavating Machines shall be equipped to prevent backward movement of the shield or machine if the propulsion system fails. The machine shall be equipped with a detection and alarm system for immediate warning of toxic or flammable gases. All electrical components shall be treated for hazardous areas, Class I, Division I Group in accordance with the National Electrical Code.

The machine shall contain sufficient brake jacks, breast tables or both and such additional bracing as necessary to fully support the face. The system shall be equipped with manually operated backup controls for emergency closing of the tunnel face if the mechanical system is inoperable.

C. Blasting

The Contractor shall comply with all laws, ordinances, applicable safety code requirements, Uniform Fire Code Articles 77, "Explosive Materials" and 80, "Hazardous Materials" and any regulations relative to handling, storage and use of explosives. Protection of life and property shall conform to "General Conditions" and Section 01550, "Public Safety and Convenience" of the Standard Contract Documents.

The Contractor shall be responsible for all damage caused by his blasting operations.

The Contractor shall erect signboards of adequate size stating that blasting operations are in progress over the area. The signs shall be located that they are clearly visible at all points of access to the area. The Contractor shall utilize a reliable audible warning system to ensure that any personnel in the area are forewarned of the impending detonation of explosives.

Appropriate precautions shall be taken during thunderstorms to prevent unintentional firing of charges due to static electricity.

The Contractor shall space his production blasting drill holes and schedule the delays of caps so that all shots break toward a free-face. Lifters shall not be used.

Controlled blasting shall be performed in such a manner to yield a minimum of overbreakage. Excavation of the tunnel and faces of cut slopes through rock shall be performed by presplitting, cushion blasting, line drilling or other approved methods.

Presplitting shall be defined as the establishment of a free surface or shear plane in the rock by the controlled usage of explosives and blasting accessories in appropriately aligned and spaced holes.

Cushion blasting shall be defined as the establishment of a free surface or shear plane in the rock by controlled usage of explosives and blasting accessories in appropriately aligned and spaced holes, except that the holes along the neat lines shall be detonated last.

Line drilling shall be defined as a technique of controlled blasting where a single row of closely spaced unloaded holes are used along the neat excavation line.

The holes shall provide a plane of weakness to which the primary blast can break and which also will cause some of the shock waves created by the primary blast to be reflected.

Explosives shall be limited in quantity and shall be placed in such locations as will not tend to open bedding planes or to crack or damage rock outside the limits of excavation.

Tunnel faces, slopes or faces shattered and/or loosened outside the proposed excavation lines by blasting or any other cause shall be excavated beyond the lines.

Overbreak within the tunnel shall be replaced with grout as specified on the Drawings.

All rock surfaces shall be clean and free from oil, grease, mud, objectionable coatings, loose, unsound or semi-detached rock fragments and other deleterious materials.

Immediately following each blast, the newly excavated surfaces shall be inspected and the tunnel roof and sidewalls shall be scaled of all loose materials.

The cleaning of the excavated rock surfaces shall be accomplished by high velocity air jets, brooming, barring, chipping and other such machine work as required. Special care shall be given to the cleaning of all cracks, crevices, joints and openings within the tunnel.

It is the intent of this section to control vibrations (shock waves) sufficiently to prevent structural damage to surface structures or interruption of surface activities. To ensure that this criteria is met, blasts within 50 feet (15 meters) or any portal or manhole shaft or any surface structure shall be monitored. Blasting will not be permitted in places where vibrations (shock waves) may affect existing gas pipelines. A recording seismograph should be used and a permanent record should be maintained throughout the project.

It is anticipated that the maximum explosive charge weight per time delay can be calculated using a scaled distance of $50 w^{1/2}$ feet ($22.6 w^{1/2}$ meters), where w = weight (mass) of individual explosive charge in pounds (kilograms: 1 kilogram equals 2.205 pounds). If the measured maximum particle velocity exceeds 2.0 inches per second (50 mm per second) within 50 feet (15 meters) of a portal or manhole shaft, the explosive charge weight (mass) shall be reduced. "Maximum particle velocity" is defined as the vector sum of 3 component amplitudes measured at a common time on a seismograph record. A permanent record of "Maximum Particle Velocity" on strip paper shall be maintained by the Contractor for review by the Engineer or designated representative.

The Contractor shall monitor vibration levels for each blast with a seismograph. The location of the seismographs shall be acceptable to the Engineer or designated representative.

Excess excavated material shall be removed from the site and disposed of at a permitted disposal site, unless otherwise indicated on the Drawings. The

disposal of excess excavated materials, including hauling, handling, leveling, clearing and compacting shall be subsidiary to tunneling.

D. Access

The work areas provided by the Owner/Developer are indicated on the Drawings. The Contractor shall arrange for employee access and parking, as well as material storage, hoisting, surplus material transfer and the construction office as indicated on the Drawings or within this space. The Contractor shall comply with other contract conditions for additional space.

The tunnel portals and intermediate shafts for permanent manholes can be used as access for personnel and material handling for work within the tunnel. Any additional temporary intermediate shafts required shall be located by Contractor. No construction shafts or other construction activity will be allowed without the written permission of the Engineer or designated representative.

E. Removal of Water

The Contractor shall keep the tunnel floor free from standing water. The Contractor may provide an open drainage channel in the tunnel floor to transport water to the portal or may excavate sumps at intervals to collect water and pump the water through pipe drains to the portal or shafts.

All water removed from the tunnel shall be free of suspended solids, oil or any other deleterious substances prior to discharge to area streams. All work and materials in connection with water removal shall be considered a subsidiary to tunneling.

F. Lighting and Wiring

Adequate and satisfactory electric lighting shall be provided by the Contractor in the tunnel. Electric lights shall be placed every 20 feet (6 meters) or as required to ensure proper work and inspection. Attention shall be particularly paid to the amount of illumination at the tunnel face and at places where supports or forms are being erected or where pipe laying or concreting is being performed.

All wiring for lighting and power shall be installed and maintained in first-class condition. All wiring shall conform to the National Electrical Code and shall be thoroughly insulated. Lighting and power circuits shall be separated and in addition shall be kept as far as possible from telephone wires and from wires used for firing blasts, if used. Special precautions shall be taken to avoid short circuits in any part of the wiring system.

All work and materials in connection with tunnel lighting and wiring shall be considered a subsidiary to tunneling.

G. Ventilation

The Contractor shall maintain tunnel air in a condition suitable for the health of workmen and clear enough for surveying operations. Whenever personnel are in the tunnel area, proper ventilation and gas detectors shall be maintained to keep atmosphere free of toxic or flammable gases. The ventilation system shall have

sufficient capacity and shall meet all applicable ventilation requirements of the U.S. Bureau of Mines, the U.S. Occupational Safety and Health Administration and the State of Texas.

Ventilating piping shall be of approved size, well supported and maintained airtight.

During grouting or concreting operations, the Contractor shall cool and ventilate the tunnel continuously to remove excess heat of hydration released by curing concrete.

All work and materials in connection with tunnel ventilation shall be considered a subsidiary to tunneling.

H. Telephone System

The Contractor shall install and maintain a telephone, in good working order at the working face in the tunnel, that is connected with a portal or access shaft to afford prompt communication with personnel outside the tunnel. The telephone system shall be available for use at all times during tunnel excavation, support erection and pipe laying or concreting operations.

All work and materials in connection with the telephone system shall be considered a subsidiary to tunneling.

I. Lining

1. General

The Contractor shall select a lining system from the typical sections indicated on the Drawings. The lining system to be used at any location will depend on the type of material encountered. It shall be the responsibility of the Contractor to determine whether or not a primary lining will be required at a given location and he shall notify the Engineer or designated representative in writing of his decision to begin or end any supports.

All primary supports used shall be protected against damage from blasting or other construction operations. Any damage that occurs shall be promptly repaired. Supports, which in the opinion of the Engineer or designated representative, cannot be satisfactorily repaired, shall be removed and replaced at the expense of the Contractor.

The Contractor shall be responsible for protecting all existing surface structures and utilities from disturbances caused by tunnel construction.

2. Rock Bolts

Except where otherwise specified herein, rock bolts shall conform to ASTM F 432 and shall be of the resin anchored type. Rock bolts shall be provided complete with all accessories including bearing plates, retaining washers, lock nuts, couplings and resin cartridges. Rock bolts shall be 3/4 inch (19 mm) minimum diameter. Holes for rock bolts shall be drilled to the diameter recommended by the rock bolt manufacturer. Spacing and

length of the rock bolts will be determined by the rock conditions encountered. Rock bolts shall not be bent. Where bolt length exceeds the tunnel diameter, couplings, as recommended by the manufacturer, shall be used.

After the holes have been drilled and adequately cleaned of debris, the resin cartridges and rock bolts shall be installed in accordance with the manufacturer's instructions. Two copies of the manufacturer's instructions shall be submitted to the Engineer or designated representative. Where a torque limiting impact wrench is used to tension rock bolts, such wrench shall be calibrated at the initiation of rock bolt installation and recalibrated as often as specified on the Drawings or required by the Engineer or designated representative.

Rock bolt installations shall follow, as closely as possible, the advancement of the tunnel heading. At the end of each day's work, the length of unsupported tunnel shall not be greater than the interval between tunnel supports.

3. Wire Reinforcement Steel

Wire woven chain link fence, zinc coated, 9 gage (3.76 mm) conforming to AASHTO M 181.

4. Shotcrete

Shotcrete shall conform to ACI 506.2, except no calcium chloride shall be used. For tunnel primary support systems not providing continuous support, the Contractor shall apply a protective coating of shotcrete on all exposed surfaces except massive limestone in the tunnel and access shaft excavations. The excavated surfaces shall be protected within 2 hours after exposure. Surfaces to be coated shall be cleaned of all loose material, dirt, dust, mud and other foreign matter. Temporary protective coverings accepted by the Engineer or designated representative shall be permitted, if necessary, until the permanent shotcrete coating is applied. Protective coating damaged by frost, heat, traffic or other causes shall be removed and replaced or repaired by the Contractor.

Where shotcrete is the only primary liner to be installed, adequate wire mesh reinforcing shall be provided to support all loads.

The non-reinforced shotcrete coating shall be not less than 2 inches (50 mm) in thickness and 3 inches (75 mm) when reinforced. The nozzelman shall select a water cement ratio [by weight (mass)] between 0.32 and .40, which will produce the minimum rebound. The placement of the placing machine and its operation shall be subject to the approval of the Engineer or designated representative.

The shotcrete shall be cured by membrane curing or by water curing, at the option of the Contractor, subject to approval by the Engineer or designated representative. Curing shall be such as to prevent the

development of an objectionable degree of cracking due to rapid loss of moisture following placement.

5. Tunnel Liner Plate

The design and shape of liner plates shall be such that erection and assembly can be accomplished entirely from inside the tunnel. Plates shall be installed to form a cylindrical tube having an outside diameter not less than that indicated on the Drawings. Liner plates shall be capable of withstanding the ring thrust load and transmitting this from plate to plate and shall conform to ASTM A 569.

Thickness of the plates shall be sufficient to support the loads above and around the tunnel with deflection of the liner plate tunnel not exceeding 3 percent of the nominal tunnel outside diameter at any point, measured diametrically.

The thickness of liner plate to be used shall be determined by the Professional Engineer engaged by the Contractor to design the primary support system of the tunnel, in accordance with Table 1 as a minimum.

Sufficient liner plate sections shall be provided with 2 inch (50 mm) grouting holes, located near the centers, so that when the plates are installed there will be one line of holes on each side of the tunnel below the springline and one at the crown; the lower line of holes on each side shall not be more than 18 inches (450 mm) above the invert. The holes in each line shall not be more than 9 feet (2.75 meters) apart and, unless otherwise approved, shall be staggered. Grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes.

After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter, zinc or equal, shall be applied at the rate of not less than 3 ounces per square foot (920 grams per square meter) of finished plate or 1-1/2 ounces (460 grams) each side. Spelter coating shall be of first class commercial quality, free from injurious defects such as blisters, flux and uncoated spots. All nuts and bolts shall be galvanized.

The plates shall be given a bituminous coating meeting in all respects the A.R.E.A. Specifications for bituminous-protected corrugated metal pipe. As an alternative the plates may be spray coated in the field prior to installation.

The tunnel liner plates may be either 2 flanged or 4 flanged type, 16 inches (400 mm) or 18 inches (450 mm) in width.

Bolts used with lapped-seam type (2 flange) liner plates shall be not less than 5/8 inch (16 mm) diameter. Bolts shall conform to ASTM A 449 for plate thickness equal to or greater than 0.209 inch (5.3 mm) and to ASTM

A 307 for plate thickness less than 0.209 inch (5.3 mm). The nuts shall conform to ASTM A 307.

Bolts and nuts used with the 4 flanged type shall be not less than 1/2 inch (12 ½ mm) diameter for plate thickness up to and including 0.179 inch (4.5 mm) and not less than 5/8 inch (16 mm) diameter for plates of greater thickness. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A 307, Grade A.

The plates shall be new and unused prior to fabrication. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated in order to permit complete erection from the inside of the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnels shall be interchangeable.

Structures on which the spelter coating has been bruised or broken, either in the shop or in shipping or which shows defective workmanship, shall be rejected. The following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

- a) Uneven laps
- b) Elliptical shaping
- c) Variation from a straight center line
- d) Ragged edges
- e) Loose, unevenly lined or spaced bolts
- f) Illegible brands
- g) Bruised, scaled or broken spelter coating
- h) Dents or bends in the metal itself.

The minimum thickness gauge, joint strength and wall buckling strength shall meet or exceed the values tabulated in Table 1, which are calculated by the design methods of the AASHTO "Design Specifications for Tunnel Liner Plates".

TABLE 1: 2 FLANGE LINER PLATE, H-20 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
Feet, inches	meters, m	Gage	mm	Feet	meters, m
7' & less	2.1m & less	12	2.7	all fill heights	
7'2" to 9'	2.15m to 2.7m	10	3.4	all fill heights	
9'2" to 11'	2.75m to 3.3m	8	4.2	all fill heights	
11'2" to 13'	3.35m to 3.9m	8	4.2	to 15'	To 4.5m
11'2" to 13'	3.35m to 3.9m	7	4.6	15' to 70'	4.5m to 21m
13'2" to 15'	3.95m to 4.5m	7	4.6	to 15'	to 4.5m
13'2" to 15'	3.95m to 4.5m	5	5.3	15' to 60'	4.5m to 18m

Note: For diameters larger than 15 feet (4.5 meters) or for any diameter with unstable soil conditions, consult the manufacturer.

TABLE 2: 2 FLANGE LINER PLATE, RAILROAD E-80 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
Feet, inches	meters, m	Gage	mm	Feet	meters, m
6' and less	1.8m and less	12	2.7	all fill heights	
6'2" to 9'	1.85m to 2.7m	10	3.4	all fill heights	
9'2" to 10'	2.75m to 3.0m	8	4.2	all fill heights	
10'2" to 12'	3.05m to 3.60m	7	4.6	maximum 70'	maximum 21m
12'2" to 14'	3.65m to 4.20m	5	5.3	maximum 60'	maximum 18m
14'2" to 15'	4.25m to 4.50m	3	6.1	maximum 60'	maximum 18m

Note: For diameters larger than 15 feet (4.5 Meters) or any diameter with unstable soil conditions, consult the manufacturer.

TABLE 3: 4 FLANGE LINER PLATE, H-20 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
feet, inches	meters, m	Gage/inches	mm	feet	meters, m
7' or less	2.10m and less	10 gage	3.4	all fill heights	
7'2" to 9'	2.15m to 2.70m	8 gage	4.2	all fill heights	
9'2" to 11'	2.75m to 3.30m	7 gage	4.6	to 28'	to 8.4m
9'2" to 11'	2.75m to 3.30m	5 gage	5.3	Over 28'	over 8.4m
11'2" to 13'	3.35m to 3.90m	5 gage	5.3	to 15'	To 4.5m
11'2" to 13'	3.35m to 3.90m	5/16"	7.9	15' to 40'	4.5m to 12m
13'2" to 15'	3.95m to 4.50m	3 gage	6.1	To 15'	To 4.5m
13'2" to 15'	3.95m to 4.50m	3/8"	9.5	15 to 40'	4.5m to 12m

Note: For diameters larger than 15 feet (4.5 meters) or any diameter with unstable soil conditions, consult the manufacturer.

TABLE 4: 4 FLANGE LINER PLATE, RAILROAD E-80 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
feet, inches	meters, m	Gage/inches	mm	feet	meters, m
6' and less	1.80m and less	10 gage	3.4	all fill heights	
6'2" to 8'	1.85m to 2.40m	8 gage	4.2	all fill heights	
8'2" to 9'	2.45m to 2.70m	7 gage	4.6	all fill heights	
9'2" to 10'	2.75m to 3.00m	5 gage	5.3	all fill heights	
10'2" to 11'	3.05m to 3.30m	3 gage	6.1	maximum 70'	maximum 21m
11'2" to 12'	3.35m to 3.60m	5/16"	7.9	maximum 60'	maximum 18m
12'2" to 15'	3.65m to 4.50m	3/8"	9.5	maximum 60'	maximum 18m

Note: For diameters larger than 15 feet (4.5 meters) or any diameter with unstable soil conditions, consult the manufacturer.

When the liner plates are being installed, care shall be taken to maintain alignment, grade and the circular shape of the tunnel. Units in consecutive rings shall be installed so that the longitudinal joints in adjacent rings are staggered and not aligned more often than every second ring. The clear inside diameter of tunnel liner shall be within 4 inches (100 mm) of the nominal diameter indicated on the Contractor's submittal drawings.

All space between the lining and the earth or rock shall be filled with grout forced in under low pressure. The grout shall be mixed in the volumetric proportions of 1 part Portland cement, 1 part Bentonite and not to exceed 5 parts of sand. Enough water shall be used to produce, when well mixed, a grout having the consistency of thick cream. As the pumping through any hole is stopped, it shall be plugged to prevent backflow or flow of grout. Grouting shall closely follow the liner plate installation, since it is extremely important that firm contact exist between the liner plates and the surrounding ground. Not more than 1 day's or 1 shift's (if more than 2 shifts per day) time shall elapse between the installation of liner plates and the placement of grout behind the plates. If necessary, grout stops shall be placed at the end of the lining to permit grouting to or near the forward end of the erected liner plate tunnel.

A secondary liner shall be required with this support system.

6. Steel Sets and Lagging

Steel sets shall be fabricated in accordance with all applicable provisions of the AISC "Steel Construction Manual". Blocking shall be installed between each rib set and the rock at not less than 4 points, if tunnel is excavated by blasting. Blocking shall consist of wood or steel adequately wedged in place. Blocking shall be maintained and kept tight until the final secondary liner is in place.

The Contractor shall furnish and install wood or steel lagging between steel ribs, as necessary, to maintain the tunnel excavation. Lagging may be used (a) to support rock, (b) to retain backpacking in excessive overbreak areas and (c) to divert water. All wood lagging shall be placed outside the minimum secondary tunnel liner thickness as indicated on the Drawings. The quantities and type of lagging shall be determined by the Contractor.

A secondary liner shall be required with this support system.

7. Precast Concrete Segmental Tunnel Liner

The Contractor may use precast concrete segmental tunnel liner providing primary support and secondary liner are installed in a single operation. Precast concrete segmental rings shall be fastened together.

The precast concrete segments shall be furnished by a manufacturer having a minimum of 5 years experience in the fabrication of precast concrete segmental tunnel liners. A list of job references of the manufacturer shall be submitted to the Engineer for review. The Contractor shall also employ a person whose prime occupation for a minimum of the past 5 years has been installation of precast concrete segmental tunnel liner. Employee references shall be submitted to the Engineer or designated representative for review.

The alkalinity of the concrete shall be a minimum calcium carbonate equivalency of 65 percent.

Cement:	ASTM C 150, Type I, II or III, containing not more than 5 percent tri-calcium aluminate.
Fine Aggregate:	Clean natural sand, ASTM C 33. Artificial or manufactured sand will not be acceptable
Coarse Aggregate:	Clean natural aggregate, ASTM C 33. Coarse Aggregate shall be limestone.
Reinforcement:	Wire conforming to ASTM A 82 or A496, wire fabric conforming to ASTM A 185 or A 497 or bars of grade 40/60 (SI yield levels of 300/420 mPa) steel conforming to ASTM A 615.
Joint Packing Material:	Precut bituminous material, 3/8 inch (9.5 mm) minimum thickness for circumferential joints and 1/8 inch (3.2 mm) minimum thickness for longitudinal joints.
Bolts, Nuts & Washers	IFI-104, Grade 303 or 305 stainless steel
Dowels:	Lock-up dowel assemblies for circumferential joints shall conform to the manufacturer's recommendations. Detailed specifications to satisfy ring retention, joint compression, erection and articulation shall be furnished for Engineer or designated representative approval.

All materials shall be stored and handled in such a manner as preserve their quality and condition to the standards specified. Care shall be taken to avoid damage or contamination. Location and facilities for storage of materials shall be subject to review by the Engineer or designated representative.

The precast concrete segmental tunnel liner plates shall be manufactured in the vicinity of Round Rock, Texas and access to the facility shall be provided to the Engineer or designated representative. The mold bases for forming the segments shall be machined metal or concrete and shall be rigid and deflection free during placing and setting of concrete. Segments shall be cast with sufficient accuracy and uniformity of dimensions that all similar segments shall be interchangeable. Concrete shall not be placed when the ambient temperature is below 40°F (5°C). Concrete shall be maintained below 90° F (32°C) at the time of placement.

All segment joint faces shall have a minimum 3/4 inch (19 mm) deep by 1/8 inch (3 mm) wide caulking recess. Each segment shall be provided with at least one grout hole.

All reinforcement shall be bent cold. No heating or rebending will be permitted. Spacers to position reinforcement shall be corrosion resistant stainless steel. Minimum concrete cover on reinforcement shall be 1 1/2 inches (38 mm).

All segments shall have the date of manufacture permanently and clearly marked at the time of manufacture. Also, all tapered rings for curves shall

have each segment marked with the radius and the location of the segment within the ring clearly marked. Segments shall be symmetrically tapered. All marking materials shall be inert and indelible to the extent of identification for manufacturing and installation.

The cement, fine aggregate, coarse aggregate and water shall be proportioned to obtain a dense, workable and durable concrete of specified strength. A minimum of 564 pounds of cement shall be used for each cubic yard (306 kilograms of cement for each cubic meter) of concrete. The concrete shall have an average strength of 6,000 psi (41.4 mPa) at 28 days and a maximum absorption of 5.5 percent.

Quality control tests shall be made in accordance with ASTM C 39 on standard concrete cylinders vibrated, cured and stored in the same manner as the segments. At least 6 test cylinders, for compressive strength tests, shall be cast from each day's concreting. One-half of the cylinders shall be tested at 7 days to determine when the concrete has attained sufficient strength for delivery. The remainder shall be tested at 28 days. The average of strength tests shall be equal to or greater than the specified compressive strength and no individual cylinder shall be less than 5,500 psi (37.9 mPa). If the average of the 7 and 28 days compressive strength test results are less than 5,500 psi (37.9 mPa), all segments cast during that day's production shall be marked as rejected and retained at the manufacturer's site. Rejected units at the construction site shall be returned by Contractor to manufacturer and retained with other rejects.

In addition to cylinders, representative cores shall be cut from a test segment selected at random from each lot of 500 segments. The compressive strength of each core tested shall be equal to or greater than the specified compressive strength. The segments used for core samples may be repaired and used after being inspected by the Engineer or designated representative.

Absorption test shall be conducted in accordance with ASTM C 497 on samples representing each day's production. The concrete segments shall be cured by water or steam curing. The segments shall be cured for a sufficient time so the concrete will attain specified strength in 28 days or less. The segments shall be confined under a curing cover for a minimum of 8 hours and the concrete shall have a minimum compressive strength of 1,500 psi (10.3 mPa) before being removed from the molds.

Segments shall be handled carefully and stored in an adequate onsite location subject to acceptance by the Engineer or designated representative. Wire ropes, chains or hooks shall be kept from contact with concrete surfaces at all times.

The quality of materials, the process of manufacture and the finished segment shall be subject to inspection, testing and review by the Engineer or designated representative. Segments shall be rejected on account of any of the following:

- a) Defects that indicate any imperfect mixing and casting.
- b) Surface defects indicating honeycombed or open texture.
- c) Damaged ends preventing a satisfactory joint.
- d) Improper reinforcement.
- e) Improper fit of joints which produces turbulence or excess head loss.

The alkalinity of the concrete for wastewater linings shall be verified by an independent testing laboratory selected by Owner/Developer at the expense of the Contractor. Samples of the interior concrete shall be obtained for alkalinity determination by use of a 1 inch (25 mm) diameter carbide concrete drill. The depth of the drill hole will be equal to the depth of cover over the reinforcing steel. The ground (pulverized) concrete from this drilling shall be the sample material used for the alkalinity determination.

Drill hole samples shall be obtained and tested from a single section selected by the Engineer or designated representative for each day's production. The alkalinity test shall be conducted in accordance with the method described in the Encyclopedia of Industrial Chemical Analysis, Vol. 15, page 230, Interscience Publishers Division, John Wiley and Sons.

In the event that the average value of alkalinity for the test section is less than the specified value of alkalinity, two additional sections shall be selected from the same production period and alkalinity determinations made for these two sections. If either of the two retest sections fail to meet the specified alkalinity value, all sections in the failed production lot shall be tested prior to acceptance. If both retest sections meet the specified alkalinity value, the production lot will be accepted.

Certified copies of the alkalinity test results will be forwarded weekly to the Engineer or designated representative for review.

The drill holes in test sections may be repaired. The repaired section may be used on the project after being inspected and approved by the Engineer or designated representative at the site.

Segments shall be manufactured to the following tolerances:

Minimum thickness:	Not less than Class III, C-76 Wall C Reinforced Concrete Pipe, after deduction for concrete cover over reinforcement.
Minimum concrete cover over reinforcement on inside face of linerplate:	2 1/2 inches (62.5 mm)
Circumferential length:	± 1/16 inch (± 1.6 mm)
Radius of curvature:	± 1/8 inch (± 3.2 mm)
Thickness (on back surface only):	0 to +1/4 inch (+ 6.3 mm)
Width	± 1/16 inch (± 1.6 mm)
Internal diameter of ring:	± 1/8 inch (± 3.2 mm)
Bolt hole positions:	± 1/16 inch (± 1.6 mm)

During production, a trial ring shall be assembled on a horizontal surface to check the dimensional accuracy. This ring will be used as a pattern to check the accuracy of subsequent rings. One completed ring segment in every 200 rings or more frequently, as determined by the Engineer or designated representative, shall be selected at random and placed on the guide ring at the manufacturer's site to form a second ring for comparison.

The Contractor shall erect the precast concrete liner segments in accordance with the specifications and the recommendations of the manufacturer. A tunnel boring machine shall be used for the tunnel excavation if precast concrete segmental tunnel liner is used.

When ground conditions dictate, the segments shall be erected within a shield having a full tail skin and a mechanical erector. The shield shall be designed to withstand all imposed loads and shall be fitted with suitable tail seals to enable grouting of the rings as soon as possible after erection and prevent ingress of material into the tail skin. The invert of the tail skin shall be readily accessible, kept free from debris and cleaned as required prior to ring erection.

The lining shall be capable of being built with longitudinal joint rotation. The rings shall be erected in their final position as work proceeds. The faces of all joints shall be cleaned before fastening. Erection of the linings shall commence with the invert segment and any temporary struts or braces required to maintain the diameter and shape of the rings until the annulus has been grouted. Preformed jointing sealants shall be applied, per the manufacturer's recommendations, to all joint faces during erection and compressed within the meeting faces of all rings by a positive means using bolts and/or stressed loops and pins. Care shall be taken to ensure continuity of the joint sealants. Dowel and/or bolt connections shall be used to produce a self-aligning, circular, internal surface, which gives a circumferential face, which remains plane.

The circumferential joints between rings shall be able to withstand the jacking pressures of the tunnel boring machine. Even distribution of

jacking forces to the lining is essential. Any damaged segments due to jacking forces shall be subject to replacement as determined by the Engineer or designated representative.

After the secondary liner has been installed, grouting shall be performed to fill all cavities between the liner and rough tunnel bore surfaces and any void spaces within the supports, if used. If precast concrete segmental tunnel liner is used, grouting shall be done daily and no more than 100 feet (30 meters) of tunnel liner shall be left ungrouted after the segments are in place. A minimum of 3 inches (75 mm) of grout shall be provided between the outside wall of the precast concrete segmental tunnel liner and the inside of the rough bore tunnel.

Grout pipes and fittings shall be provided in the secondary liner to permit the attachment of grout pumps. All grout and vent pipes shall have a minimum 1 1/2 inch (38 mm) diameter and consist of stainless steel pipe as specified in ASTM A 312.

Care should be taken to avoid premature clogging of grout pipes and any grout pipe that becomes clogged or obstructed before completion of operations shall be cleaned out or repaired if required.

All grout pipes and fittings shall be cleaned thoroughly of all dirt, grease, grout and mortar immediately prior to installation.

8. Cast in Place Concrete Lining

Lining may be a single, two stage or a secondary liner. The single or two stage lining shall be placed immediately behind the excavation and completely fill the space between the rock and the lining. Suitable weep devices shall be incorporated into the pour to prevent a hydrostatic buildup behind the concrete while curing.

When cast in place concrete is used as a secondary liner, it shall be constructed in the excavated tunnel using the unsupported tunnel wall or primary lining for the outside form as indicated on the Drawings.

9. Pipe in Tunnels

All pipe shall be laid to the required line and grade through the tunnel previously prepared. Pipe shall be handled and placed in tunnels by the use of proper skids, wedges, guide rails or other approved means and care shall be taken that once the pipe is in place to line and grade, it shall not be disturbed or become displaced.

All water and wastewater pipe in tunnels shall be supported on a cradle bedding of Class B concrete conforming to Standard Specification Item No. 403, "Concrete for Structures", except the cement content may be reduced to not less than 4 sacks per cubic yard (225 Kg per cubic meter), provided that in no case shall the 28 day minimum compressive strength be less than 2,250 psi (15.5 mPa). The concrete bedding shall be so placed and compacted that it is in contact with the bottom portion of the

pipe for at least 90 degrees in the cradle area or to details indicated on the Drawings.

a) Reinforced Concrete Pipe

Unless otherwise specified on the Drawings, reinforced concrete pipe shall conform to the City of Round Rock Standard Specification Item No. 510, "Pipe".

b) Corrugated Galvanized Steel Pipe Unless otherwise specified on the Drawings, corrugated galvanized metal pipe shall conform to Item No. 510, "Pipe".

c) Concrete Lined Corrugated Metal Pipe Unless otherwise specified on the Drawings, concrete lined corrugated metal pipe shall conform to Item No. 510, "Pipe".

10. Tunnel Shield

A tunnel shield shall be used for all tunnel excavation requiring tunnel liner plate for support. The upper half of the tunnel heading shall be supported, whenever ground conditions indicate potential raveling of the crown. Over excavation of the tunnel cross section shall be limited to that required to maintain the proper grade and alignment of the tunnel shield. The tunnel heading shall be completely closed off whenever tunneling work is not being performed.

11. Patching and Cleanup

Upon completion of tunnel grouting, the Contractor shall remove or cut off all grout pipes and fittings from the cast in place concrete or precast concrete pipe to a minimum depth of 1 inch (25 mm), measured from the inside finished face. All holes or depressions thus formed shall be patched in accordance with the manufacturer's procedures with a non-shrinking chemical grout suitable for use in sewers and hydrogen sulfide corrosive atmospheres. All surface areas to be patched shall be clean and free of contamination. The patching shall be done in a neat and workmanlike manner so as to provide a surface smoothness at least equal to undisturbed areas of the concrete lining.

During the work, the Contractor shall provide for adequate disposal of all wash wastewater and shall remove all waste grout caused by his operations. Prior to final acceptance of the work, the interior surface of the tunnel lining shall be thoroughly cleaned.

Verification of the adequacy of the grouting operation will be required. Verification will be accomplished by coring the tunnel lining at locations determined by the Engineer or designated representative. Any voids discovered will be filled with grout as directed by the Engineer or designated representative.

12. Construction Tolerances

The finished tunnel liner shall be constructed to the following tolerances:

Alignment:	± 3 inches (± 75 mm)
Grade	± 3 inches (± 75 mm)
Diameter of Lining:	± 1/2 inch (± 12.5 mm)
Maximum offset between adjacent edges of adjacent rings in the invert of precast liner segments:	3/16 inch (4.8 mm)

13. Permanent Station Markers

Permanent markers shall be installed in the interior crown of the permanent lining of the tunnel at 100 feet (30 meters) intervals along the pipeline stationing as indicated on the Drawings.

14. Drawings and Data

Drawings, specifications, samples and other data showing details of fabrication, construction and installation of the tunnel, together with complete data covering all materials, shall be submitted prior to commencing any tunnel excavation work. The above information shall be submitted to the Engineer or designated representative for reference and record purposes.

502.6 Measurement

Tunneling will be measured by the lineal foot (meter: 1 meter equals 3.281 feet) along the centerline of completed tunnel of the various sizes of lining in accordance with these specifications and the Drawings, complete in place and accepted by the Engineer or designated representative including all excavation, blasting, ventilation, supports, primary and final lining, grouting, survey monuments, portal and backfilling, unless otherwise specified.

Transitions will be measured by the lineal foot (meter) along the centerline of the completed tunnel for the largest size of lining.

502.7 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" shall be paid for at the unit bid price per lineal foot. This price shall include full compensation for:

- (a) furnishing all materials, pipe, liner materials required for tunnel operations,
- (b) all preparation, hauling and installing of same and
- (c) all labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

Payment when included as a contract pay item will be made under one or more of the following:

Tunneling, _____ Per Lineal Foot.

End

<u>SPECIFIC</u> Cross Reference Materials
--

Standard Specification Item Number 502, "Tunneling"

TxDOT Specifications

<u>Designation</u>	<u>Description</u>
Item 7.9	Use of Explosives
Item 421	Portland Cement Concrete
Item 431	Pneumatically Placed Concrete

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 510	Pipe

Uniform Fire Code

<u>Designation</u>	<u>Description</u>
Article 77	Explosive Materials
Article 80	Hazardous Materials

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
ASTM A 36/A 36M	Specification for Structural Steel
ASTM A 82/A 36M	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 185	Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A 283 /283M	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A 307	Specification for Carbon Steel Externally Threaded Standard Fasteners
ASTM A 312	Specification for Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 449	Specification for Quenched and Tempered Steel Bolts and Studs
ASTM A 496	Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A 569	Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality
ASTM A 615	Specification for Deformed and Plain-Billet Steel Bars for Concrete Reinforcement
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 150	Specification for Portland Cement
ASTM C 497/497M	Method of Testing Concrete Pipe, Sections or Tile
ASTM F432	Specification for Roof and Rock Bolts and Accessories

American Association of State Highway and Transportation Officials (AASHTO)

<u>Designation</u>	<u>Description</u>
M181	Chain Link Fence

American Concrete Institute (ACI)

<u>Designation</u>	<u>Description</u>
ACI 506.2	Specification for Shotcrete

ITEM NO. 503
FRAMES, GRATES, RINGS AND COVERS

503.1 Description

This item shall govern furnishing and installation of frames, grates, rings and covers for inlets, manholes and other structures indicated on the Drawings.

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

503.2 Submittals

The submittal requirements of this specification item include manufacturer, model number, description, painting requirements and characteristics of frames, grates, rings, covers, height adjustment insert and nuts and bolts required for completion of the work.

503.3 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is the kind and quality that satisfies the specified functions and quality. Items shall conform to the items shown on the Drawings, called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the Engineer or designated representative.

A. Welded

Steel Welded steel grates and frames shall conform to the number; size, dimensions and details indicated on the Drawings and shall be welded into an assembly in accordance with those details. Steel shall conform to the requirements of ASTM A 36/A 36M, "Specification for Structural Steel".

B. Castings

Castings, whether Carbon-Steel, Gray Cast Iron or Ductile Iron shall conform to the shape and dimensions indicated on the Drawings and shall be clean substantial castings, free from sand or blowholes or other defects. Surfaces of the castings shall be free from burnt on sand and shall be reasonably smooth. Runners, risers, fins and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Pairs of machined castings shall be matchmarked to facilitate subsequent identification at installation with the exception of water and wastewater manhole and valve castings. These manhole and valve castings shall be fabricated with such draft, tolerances, bolt hole spacing, etc., that all rings and covers of a particular type or class are interchangeable and match-marking will not be required.

Steel castings shall conform to ASTM A 27/27M, "Specifications for Steel Castings, Carbon, for General Application". Grade 70-36 (480-250) shall be

furnished unless otherwise specified on the Drawings.

Cast iron castings shall conform to ASTM A 48, "Specification for Gray Iron Castings", Class 30.

Ductile Iron castings shall conform to ASTM A 536, "Specification for Ductile Iron Castings". Grade 60-40-18 (415-275-125) shall be used unless otherwise indicated on the Drawings.

C. Manhole Cover Riser Rings

Height-adjustment inserts for wastewater manhole rings, which are used for raising standard manhole covers, shall be as shown on the Drawings unless otherwise approved by the Engineer or designated representative.

D. Nuts and Bolts

Nuts and bolts shall be hex head 5/8" x 2.5" (16 mm x 63.5 mm) #11 National Coarse Thread, Type 316 stainless steel. For bolted manhole covers, a thin film of an approved "Anti-freeze" compound, approved by the Engineer or designated representative, shall be applied to all bolts.

E. Mortar

Unless otherwise specified or approved by the Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part Portland cement and three (3) parts sand and sufficient water to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for Grade No. 1, Item No. 403, "Concrete for Structures".

503.4 Construction Methods

Frames, grates, rings and covers shall be constructed of the specified materials in accordance with the details indicated on the Drawings. The Frames, grates, rings and covers shall be placed carefully to the lines or grades indicated on the Drawings or as directed by the Engineer or designated representative.

All welding shall conform to the requirements of the ANSI/AWS Structural Welding Code D1.1. Welded frames, grates, rings and covers shall be given 1 coat of a commercial grade red lead oil paint and 2 coats of commercial grade aluminum paint. All coats shall be a minimum of 1.5 mils (0.4 mm), dry.

Painting of gray iron castings will not be required, except when used in conjunction with structural steel shapes.

503.5 Measurement and Payment

Frames, grates, rings and covers will not be measured and payment for furnishing all materials, tools, equipment, labor and incidentals to complete the Work will be included in the Bid Items which constitute the complete structures.

End

SPECIFIED Cross Reference Materials

Standard Specification Item Number 503, "Frames, Grates, Rings and Covers"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 403	Concrete for Structures

American Society for Testing Materials (ASTM)

<u>Designation</u>	<u>Description</u>
A36/A36M	Specification for Structural Steel
A27/A27M	Specification for Steel Castings, Carbon, for General Application
A48	Specification for Gray Iron Castings
A536	Specification for Ductile Iron Castings

ANSI/AWS

<u>Designation</u>	<u>Description</u>
Code D 1.1	Structural Welding Code

RELATED Cross Reference Materials

Standard Specification Item Number 503, "Frames, Grates, Rings and Covers"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 504	Adjusting Structures
Item No. 510	Pipe

TxDOT Specifications

<u>Designation</u>	<u>Description</u>
Item 421	Portland Cement Concrete

ITEM NO. 504 ADJUSTING STRUCTURES

504.1 Description

This item shall govern the removal and replacement of surfacing, furnishing of materials, adjusting and/or repositioning existing structures, valve boxes, pull boxes, survey monument boxes and water meters in accordance with these specifications to the locations or elevations indicated on the Drawings or as directed by the Engineer or designated representative. This item shall also govern any pumping, bailing and drainage required to complete the Work and Standard Specification Item No. 509, "Trench Safety Systems" for trench walls when indicated on the Drawings.

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

504.2 Submittals

The submittal requirements of this specification item include:

- A. Aggregate type, gradations and physical characteristics for the Portland cement concrete mix.
- B. Proposed proportioning of materials for the mortar mix.
- C. Type of structures and proposed adjustment technique (lowering, raising, lateral displacement).
- D. Type of structure, repair technique and materials to be furnished (new replacement or reuse of existing). Type of mixing plant and associated equipage including chart indicating the calibration of each cold bin.

504.3 Materials

Precast reinforced concrete rings and castings in good condition, which are removed from the structures to be adjusted, may be reused with the written approval of the Engineer or designated representative. Additional materials required shall conform to the details indicated on the Drawings.

- A. Portland Cement Concrete The Portland cement concrete shall be Class A conforming to Standard Specification Item No. 403, "Concrete for Structures".
- B. Mortar Unless otherwise specified or approved by the Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part Portland cement and three (3) parts sand, by volume based on dry materials. Sufficient water will be added to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403, "Concrete for Structures".

504.4 Construction Methods

All adjustments shall be completed prior to the placement of the final surface.

Pull box and valve box components scheduled for reuse shall be carefully removed and the contact areas shall be cleaned of all mortar, concrete, grease and sealing compounds. Any items broken in the process of removal and cleaning shall be replaced in kind by the Contractor at his own expense.

If the adjustment involves slight lowering or raising a valve box or survey monument box, the outside shell of a slip or screw casing shall be excavated to its full length and adjusted to the proposed grade. Pipe castings shall be excavated to the depth required to cut from or weld a section to the casing as may be needed to adjust the ring to the proposed elevation. The ring shall be welded to the casing prior to pouring concrete around the casing.

If the adjustment involves a vertical (lowering or raising) or a horizontal reassignment of a water meter and the property owner's cut off valve, this work shall be completed in accordance with the Drawings.

After the adjustments have been completed and cured, structures within the paved area shall be paved as indicated on the Drawings.

504.5 Measurement

The work performed and materials furnished as prescribed by this item as indicated shall be measured per each.

504.6 Payment

The work performed, materials furnished and measures as provided above, will be paid by the unit bid price per each. The price shall include full compensation for furnishing all materials, handling, placing, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Adjusting Water Meters -	Per Each
Repositioning & Adjusting Water Meters -	Per Each
Adjusting Gas Valve Boxes to Grade -	Per Each
Adjusting Survey Monument Boxes to Grade -	Per Each
Adjusting Water Valve Boxes to Grade -	Per Each
Adjusting Pull Boxes to Grade -	Per Each

End

<u>SPECIFIC</u> CROSS REFERENCE MATERIALS
--

Specification 504, "Adjusting Structures"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 403	Concrete for Structures
Item No. 509	Trench Safety Systems

<u>RELATED</u> CROSS REFERENCE MATERIALS

Specification 504, "Adjusting Structures"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 501	Jacking or Boring
Item No. 502	Tunneling
Item No. 503	Frames, Grates, Rings and Covers
Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 507	Bulkheads
Item No. 508	Miscellaneous Structures and Appurtenances
Item No. 511	Water Valves

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

<u>Designation</u>	<u>Description</u>
Item No.421	Portland Cement Concrete

ITEM NO. 505
CONCRETE ENCASEMENT AND ENCASEMENT PIPE

505.1 Description

This item shall govern the furnishing of materials and the methods of constructing a Portland cement concrete encasement or encasement pipe.

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

505.2 Submittals

The submittal requirements of this specification item include:

- A. Type of pipe, construction methods and sequence,
- B. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix,
- C. Proposed proportioning of materials for the mortar mix.

505.3 Materials

- A. Portland Cement Concrete

The Portland cement concrete shall conform to Class B Concrete, Item No. 403, "Concrete for Structures".

- B. Pipe

Portland Cement concrete pipe shall conform to ASTM C-76, Class III or better.

Corrugated Metal Pipe (CMP) shall conform to Section 510. 2 (8)(o) of the City of Round Rock Standard Specification Item No. 510, "Pipe".

Steel Pipe shall conform to ASTM A134 with a minimum thickness of 3/8 inch (9.5 mm) for pipe with a diameter of 16 inches (400 mm) and greater.

- C. Grout

Grout shall consist of not less than 6 sacks Portland cement per cubic yard (335 kilograms Portland cement per cubic meter) and clean washed sand mixed with water. The grout shall have a consistency such that the grout will flow into and completely fill all voids. If allowed by the Engineer or designated representative, an air entraining admixture may be added to facilitate placement.

505.4 Construction Methods

When indicated on the Drawings or acceptable to Engineer or designated representative, concrete encasement or encasement pipe shall be placed to protect the pipe. Unless approved by the Engineer or designated representative

- (a) the top of the pipe would have less than 30 inches (60 mm) of cover,
- (b) ground water invades the trench, or
- (c) the trench bottom is of unstable material.

If any of these conditions is encountered, the Engineer or designated representative shall be notified and may direct the Contractor to:

- (a) encase the pipe with concrete,
- (b) change pipe material,
- (c) use a higher strength class of pipe, or
- (d) provide an encasement pipe.

Concrete encasement shall extend from 6 inches (150 mm) below to 6 inches (150 mm) above the outer projections of the pipe over the entire width of the trench.

The ends of encasement pipe shall be bulkheaded (Standard Specification Item No. 507) with manufactured boots or, concrete blocks, bricks or stones, dry-stacked without mortar, sufficient to prevent the intrusion of trench backfill material into the encasement, but fitted loosely enough to facilitate the escape of water from the encasement should carrier pipe leakage or failure occur.

505.5 Measurement and Payment

Concrete encasement will be measured by the lineal foot (meter: 1 meter equals 3.281 feet), for size of pipe being encased, complete in place. The measurement will be made between ends of the encasement, along the central axis as installed.

Encasement pipe will be measured by size of encasement installed, complete in place. The measurement will be made between the ends of the pipe, along the central axis as installed.

505.6 Payment

Work performed and materials furnished as prescribed by this item will be subsidiary to Item No. 510, "Pipe" unless included as a separate pay item in the contract. When included for payment, it shall be measured as provided under "Measurement" and will be paid at the unit bid price per lineal foot for "Concrete Encasement" or "Encasement Pipe" of the size indicated on the Drawings. The unit bid price shall include full compensation for furnishing all materials, pipe for all preparation, hauling, installation and for all labor, tools, equipment and incidentals necessary to complete the work, including bench excavation and disposal of surplus material.

Payment, when included as a contract Pay Item, will be made under one of the following:

Concrete Encasement for ___ Dia. Pipe -	Per Lineal Foot
Encasement Pipe ___ Dia., Type ___, -	Per Lineal Foot.

End

SPECIFIC Cross Reference Materials

Standard Specification Item No. 505, "Encasement and Encasement Pipe"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item 403	Concrete For Structures
Item 510	Pipe
Section 510.2(8)(o)	Corrugated Metal Pipe (CMP)

City of Round Rock Standard Details

<u>Designation</u>	<u>Description</u>
Detail 501-1	Encasement Detail w/ Casing Spacers

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
A-134	Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
C-76/C-76M	Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

RELATED Cross Reference Materials

Standard Specification Item No. 505, "Encasement and Encasement Pipe"

TxDOT Specifications

<u>Designation</u>	<u>Description</u>
Item 421	Portland Cement Concrete
Section 421.9	Quality of Concrete
Section 421.2(8)	Mortar and Grout
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 593	Concrete Retards

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Section 510.2(8)(c)	Concrete pipe
Section 510.2(8)(m)	Steel Pipe

**ITEM NO. 506
MANHOLES**

506.1 Description

This item shall govern construction of manholes, complete in place, and the materials used therein, including excavation, installation, backfilling and surface restoration. It shall also include furnishing and installing rings, covers, and appurtenances, as well as any pumping and drainage necessary to complete the work. Wastewater manholes shall be 'acceptance tested' by the Contractor.

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work are of the kind and quality that satisfies the specified functions and quality as specified or presented in the Drawings.

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

506.2 Submittals

The submittal requirements of this specification item include:

- A. Type, size and manufacturer of manhole (diameter of water or wastewater manhole), structure (precast, cast in place; Standard, Tee, etc), and materials and equipment to be furnished (brick, concrete, seals, rings, covers, etc.)
- B. Aggregate types, gradations and physical characteristics for the Portland cement concrete mix.
- C. Proposed proportioning of materials for the mortar mix.
- D. Proposed Acceptance testing procedure and associated test equipment and materials. Type of structures and proposed adjustment technique (lowering, raising, lateral displacement).
- E. Proposed product for coating the interior surface of new and/or existing wastewater manholes.

Submittal of test Records is required and shall include as a minimum the following items. The test records shall also be included as part of the Project records turned in with the acceptance package.

- Name of the manhole manufacturer
- Interior surface coating type and application method for Wastewater Manholes
- Model and manufacturer of vacuum tester
- Date tested/date re-tested
- Passed/failed and state what was done to correct the problem
- Test Method Used
- Location/station of manhole
- Precast/cast-in- place bottom
- Any repairs made to the joints.

506.3 Materials and Components

A. Concrete and Cement Stabilized Sand

All concrete shall conform to Standard Specification Item No. 403, "Concrete for Structures". Cast in place concrete shall be Class A, and precast concrete manhole base sections, riser sections and appurtenances shall conform to the requirements of ASTM C478/C478M, "Standard Specification for Precast Reinforced Concrete Manhole" with Class I concrete. All interior surfaces of wastewater manholes shall receive a coating by an application method acceptable to the Engineer or designated representative or shall be otherwise acceptably protected from the acidic effects of municipal wastewater. Concrete for backfill of over-excavated areas shall be Class A or Class J as indicated on the Drawings. Cement stabilized sand for bedding or backfilling, when indicated or required on the Drawings, shall contain 2 bags of Portland Cement per cubic yard (112 kilograms of Portland cement per cubic meter). The sand shall meet the requirements for "Fine Aggregate" in Standard Specification Item No. 403, "Concrete For Structures".

B. Mortar

The mortar shall be composed of one part Portland cement, one part masonry cement (or 1/4 part hydrated lime), and sand equal to 2-1/2 to 3 times the sum of the volumes of the cements and lime used. The sand shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403 "Concrete For Structures".

C. Reinforcement

The reinforcing steel shall conform to the requirements of Standard Specification Item No. 406, "Reinforcing Steel".

D. Brick

The brick for ring adjustment courses and for stormwater manholes shall be of first quality, sound, hard burned, perfectly shaped brick conforming to the requirements of ASTM C 62, Grade SW, or concrete brick meeting the requirements of ASTM C 55, Grade N-1.

E. Rings and Covers

Rings and covers shall conform to the requirements of City of Round Rock Standard Specification Item No. 503 "Frames, Grates, Rings and Covers".

1. Replacement Rings and Covers, 24 in. (610 mm) Diameter Lids.

This ring and cover shall be used for the replacement of broken rings and covers, minor manhole adjustment, or as otherwise directed by the Engineer or designated representative.

2. Rings and Covers, 32 in. (813 mm) Diameter Lids.

This ring and cover shall be used for all new manhole construction, except as otherwise directed by the Engineer or designated representative.

F. Bulkheads.

Bulkheads shall meet the requirements of City of Round Rock Standard Specification Item No. 507 "Bulkheads".

G. Precast Base Sections, Riser Sections, and Cones.

Precast concrete base sections, riser sections, and cones shall conform to the requirements of ASTM C 478. The width of the invert shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped with a minimum depth of three fourths of the largest pipe diameter. The invert shall have a minimum difference of 0.10 feet (30 mm) between the inlet and outlet. Where lines enter the manhole up to 24 inches (610 mm) above the flowline of the outlet, the invert shall be filleted to prevent splashing and solids deposition. A drop pipe shall be provided for a sewer entering a manhole at more than 24 inches (610 mm) above the flowline of the outlet.

Joints for wastewater base sections, riser sections, and cones shall conform to the requirements of ASTM C 443. Additionally, joint dimensions for 48-inch (1.22 meters) inside diameter wastewater manhole sections and cones shall comply with City of Round Rock Standard Details. Precast bases for 48 inch (1.22 meters) inside diameter manholes shall have preformed inverts. Inserts acceptable to the Engineer or designated representative shall be embedded in the concrete wall of the manhole sections to facilitate handling; however, through-wall holes for lifting will not be permitted. Any voids between the pipe and invert shall be filled to the springline with a product recommended by the manhole manufacturer to prevent solids collection.

H. Precast Junction Boxes.

Precast junction boxes shall be allowed only where indicated on the Drawings or acceptable to the Engineer or designated representative. Joints for wastewater junction boxes shall conform to the requirements of ASTM C 443.

I. Pipe-to-Manhole/Junction Box Assemblies

Precast bases and precast junction boxes shall have flexible, resilient and non-corrosive boot connectors or ring waterstops acceptable to the Engineer or designated representative conforming to the requirements of ASTM C 923 on all wastewater pipe connections.

J. Precast Flat-Slab Transition/Junction Box Lids.

Unless more stringent requirements are specified on the Drawings, precast slab transitions and lids shall be designed to safely resist pressures resulting from loads which might result from any combination of forces imposed by an HS-20 loading as defined by the American Association of State Highway and Transportation Officials (AASHTO). The joints of precast slab transitions and of lids for wastewater applications shall conform to the requirements of ASTM C443.

K. Precast-Prefabricated Tee Manholes.

Tee manholes shall be allowed only where indicated on the Drawings or as directed by the Engineer or designated representative. The main pipe section shall conform to the requirements of City of Round Rock Standard Specification Item No. 510, "Pipe". The vertical manhole portion (tee) above the main pipe shall conform to the requirements of the precast components.

The manhole tee shall have a minimum inside diameter of 48 inches (1.22 meters) and shall rise vertically centered or tangent to the main pipe, as indicated on the Drawings or as directed by the Engineer or designated representative. An access hole less than 48-inches (1.22 meters) in diameter shall be cut into the main pipe to allow a ledge for support of access ladders. Unless otherwise specified on the Drawings, the main pipe portion of the tee manhole shall be paid subsidiary to the unit tee manhole price.

L. Grade Rings

Rings shall be reinforced Class A or I concrete, or as indicated on City of Round Rock Standard Details.

1. Grade Rings, 24-1/2 inches (622 mm) Inside Diameter:

This adjustment ring shall be used only for adjusting existing manholes with 24 inch (610 mm) lids and for Wastewater Access Device. Inside to outside diameter dimension of ring shall be 6 inches (152 mm) with a thickness of 3 inches to 6 inches (76 mm to 152 mm).

2. Grade Rings, 35 inches (889 mm) Inside Diameter:

This adjustment ring shall be used for all new manhole construction with 32 inches (813 mm) lids. Inside to outside diameter dimension of ring shall be 6 inches (152 mm) with a thickness of 4 inches to 6 inches (102 mm to 152 mm).

M. New Manhole Construction and Minor Manhole Adjustment:

New manhole construction and minor manhole adjustments shall be performed as indicated on City of Round Rock Standard Details, and shall consist of adding grade rings to adjust the manhole to final grade.

For new manhole construction, the maximum vertical allowable ring adjustment, including the depth of the ring casting, shall be limited to 18 inches (450 mm). For adjustments of existing manholes that fall within the limits of overlay and street reconstruction projects, the maximum vertical allowable, including the depth of the ring casting, shall be limited to two feet (600 mm). All other existing manholes shall have a maximum allowable ring adjustment, including the depth of the ring casting, of one foot (300 mm). Any adjustment that will exceed these requirements shall be accomplished as described below in subsection (N). All manholes not located in paved areas shall have bolted covers.

N. Major Manhole Adjustment:

Any adjustment that exceeds the requirements of subsection (M) Minor Manhole Adjustments, shall be accomplished as indicated and shall consist of any combination of removing the concrete rings, and/or the manhole cone section, and/or the straight riser section of the manhole in order to bring the manhole to final grade. All manholes not located in paved areas shall have bolted covers.

O. Waterproofing Joint Materials.

O-rings and wedge seals for the joints of all wastewater manholes, and for stormwater manholes when indicated on the Drawings, shall conform to the requirements of ASTM C443. Cold applied preformed plastic gaskets for stormwater manholes shall be as specified in City of Round Rock Standard Specification Item No. 510, "Pipe". The connections between reinforced concrete wastewater manhole structures and pipes shall meet the requirements of ASTM C923.

P. Interior Surface Coatings for Wastewater Manholes

The interior surfaces of all wastewater manholes shall be coated with a product as specified on City of Round Rock Standard Details.

Q. Abandonment of Existing Manholes

When designated on the Drawings for abandonment, existing manholes shall be removed to a level not less than four feet (1.2 meters) below grade. The inlets and outlets shall be securely plugged and the structure filled with material in accordance with the Drawings or as directed by the Engineer or designated representative.

506.4 Construction

All manholes shall have a minimum inside diameter of 48 inches (1.22 meters). Manhole base section or junction box dimension shall be appropriately increased to accommodate all converging pipe. A minimum horizontal clearance of 12 inches (300 mm) shall be maintained between adjacent pipes. Pipe ends within the base section or junction box walls shall not be relied upon to support overlying manhole dead and live load weights. All wastewater branch connections to new or existing mains shall be made at manholes with the influent pipe crown installed at the elevation of the effluent pipe crown. Where lines enter the manhole up to 24 inches (600 mm) above the flowline of the outlet, the invert shall be sloped upward to receive the flow, thus preventing splashing or solids deposition. Where the springline of an influent pipe is 24 inches (600 mm) or more above the springline of the effluent pipe, a drop manhole shall be used. Construction of extensions to existing systems shall require placement of bulkheads at locations indicated or directed by the Engineer or designated representative. Unless otherwise indicated on the Drawings, stormwater manholes shall have eccentric cones; wastewater manholes shall have concentric cones, except on manholes over large mains where an eccentric cone shall be situated to provide access to an invert ledge. Eccentric cones may be used where conflicts with other utilities dictate. Flat-slab tops may be used where clearance problems exist [see

506.3(J) above].

Manholes shall be founded at the established elevations on uniformly stable subgrade. Unstable subgrade shall be over-excavated a minimum of 12 inches (300 mm) and replaced with a material acceptable to the Engineer or designated representative. Precast base units shall be founded and leveled on a 6 inch (150 mm) coarse aggregate bedding. A pipe section with a prefabricated tee manhole and half the length of the adjoining pipe sections on each side shall be founded on a minimum of 6 inch (150 mm) unreinforced Class A concrete (City of Round Rock Standard Specification Item No. 403, "Concrete For Structures). The cast-in-place concrete cradle shall be placed against undisturbed trench walls up to the pipe's springline.

All adjustments shall be completed prior to the placement of the final surface.

Manhole components to be reused shall be carefully removed and the contact areas shall be cleaned of all mortar, concrete, grease and sealing compounds. Any items broken in the process of removal and cleaning shall be replaced in kind by the Contractor at his expense.

If the adjustment involves lowering the top of a manhole, a sufficient depth of grade rings shall be removed to permit reconstruction. The mortar shall be cleaned from the top surface remaining in place and from all brick or concrete rings to be reused and the manhole rebuilt to the required elevation. The manhole ring and cover shall then be installed with the top surface conforming to the proposed grade.

If the adjustment involves raising the elevation of the top of the manhole in accordance with 506.3 (M), "New Manhole Construction and Minor Manhole Adjustment", the top shall be cleaned and built up vertically to the new elevation, using new grade rings and the ring and cover installed with the top surface conforming to the proposed grade.

Cast-in-place foundations shall have a minimum depth of 12 inches (300 mm) at the invert flowline. The widths of all manhole inverts shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped with a minimum depth of three fourths of the largest pipe diameter. The invert shall have a minimum fall of 0.10 of a foot (30 mm) between the inlet and outlet. The lowermost riser section may be set in the Portland cement concrete, while still green, after which the foundation shall be cured a minimum of 24 hours prior to proceeding with construction of the manhole up to 12 feet (3 2/3 meters) in depth. The foundation shall be cured an additional 24 hours prior to continuing construction above the 12 foot (3 2/3 meters) level. Manhole depth shall be measured from the invert flowline to the finish surface elevation.

Wastewater manholes having cast in place foundations may be constructed over existing wastewater pipes, and the top of the pipe removed to facilitate invert construction. Existing pipes shall be anchored sufficiently so that they are not displaced during manhole construction. The manhole bottom shall rise from the springline elevation of the pipe, approximately one inch for each 12 inches (80 mm per meter) of run (8%). Wastewater manholes with lines larger than 18 inches (450 mm) shall require precast bases; manholes constructed over in-service mains however, may be built on cast-in-place foundations if the flow cannot be interrupted. Precast and cast-in-place wastewater junction boxes shall be allowed only where indicated on the Drawings or

acceptable to the Engineer or designated representative. The floors of stormwater manholes also, shall rise outwardly from the springline on a slope of 1:12 or 80 mm per meter (8%).

Wastewater lines, except reinforced concrete pipe, set in cast-in-place foundations, shall require a waterstop seal or gasket acceptable to the Engineer or designated representative around the outside perimeter of the pipe. It shall be approximately centered under the manhole section wall.

Cast-in-place stormwater manholes, junction boxes and flat-slab transitions shall be reinforced, Class A concrete (Standard Specification Item No. 403, "Concrete for Structures"). All structural concrete work shall conform to Standard Specification Item No. 410, "Concrete Structures". Forms will be required for all cast-in-place walls and foundation. Where the surrounding material can be trimmed to a smooth vertical face, outside forms may be omitted.

Backfilling for manholes shall conform to the density requirements of City of Round Rock Standard Specification Item No. 510, "Pipe". Manhole construction in roadways may be staged to facilitate base construction. Manholes constructed to interim elevations shall be covered with steel plates of sufficient thickness to support vehicular traffic. Steel plates on wastewater manholes shall be set in mortar or other provisions, acceptable to the Engineer or designated representative, shall be made to minimize inflow. Manholes shall be completed to finish elevation prior to placement of the roadway's finish surface. The excavation for completion of manhole construction shall be backfilled with cement stabilized sand with 2 sacks of cement per cubic yard (112 kilograms of cement per cubic meter) up to the bottom of Portland Cement pavement slabs or to within 2 inches (50 mm) of finish elevation of asphaltic concrete pavements. The cement stabilized sand shall be a minimum of 12 inches (300 mm) thick.

After rings and covers are set to grade, the inside and outside of the concrete rings shall be wiped with mortar so placed as to form a durable water-tight joint, smooth and even with the manhole cone section. No grouting shall be performed when the atmospheric temperature is at or below 40°F (5°C), and when necessary, because of a sudden drop in temperature, joints shall be protected against freezing for at least 24 hours.

506.5 Acceptance Testing of Wastewater Manholes

Manholes shall be tested separately and independently of the wastewater lines.

A. Test by the Vacuum Method:

A vacuum test shall be performed by the Contractor prior to backfilling manholes where detouring of vehicular traffic is required. A second vacuum test will not be required after backfilling and compaction is complete unless there is evidence that the manhole has been damaged or disturbed subsequent to the initial vacuum test.

For manhole installations which do not require detouring of vehicular traffic, the vacuum method is recommended and may be used by the Contractor prior to backfilling the manhole to insure proper installation so that defects may be located and repaired; however, a vacuum test shall be performed after

backfilling, and compaction are complete. Testing after backfill and compaction are complete will be the basis for acceptance of the manhole.

1. Equipment:
 - a) The manhole vacuum tester shall be a device approved for use by the Engineer or designated representative.
 - b) Pipe sealing plugs shall have a load resisting capacity equal to or greater than that required for the size of the connected pipe to be sealed.
2. Procedures - applicable to new 4'-0" (1.22 meter) diameter manholes.
 - a) Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before installation or unless it is applied at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints.
 - b) After cleaning the interior surfaces of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer. Plugs and the ends of pipes connected by flexible boots shall be blocked to prevent their movement during the vacuum test.
 - c) The vacuum test head shall be placed on the top of the cone section or, inside of the top of the manhole cone section, and the compression seal band inflated to the pressure recommended by its manufacturer. The vacuum pump shall be connected to the outlet port with the valve open. When a vacuum of 10 inches (254 mm) of mercury [(-5 psig) {-35 kPa}] has been attained, the valve shall be closed and the time noted. Tampering with the test equipment will not be allowed.
 - d) The manhole shall have passed the test if the vacuum does not drop below 9 inches (229 mm) of mercury [(-4.5 psig){-31 kPa}] within three (3) minutes of the time the valve was closed. The actual vacuum shall be recorded at the end of the three (3) minutes during which the valve was closed.
 - e). When the standard vacuum test cannot be performed because of design or material constraints (examples: T-Type manholes, T-Lock Liners, or other reasons acceptable to the Engineer or designated representative), testing of individual joints shall be performed as directed by the Engineer or designated representative.

B. Test by the Exfiltration Method:

At the discretion of the Engineer or designated representative, the Contractor may substitute the Exfiltration Method of testing for the Vacuum test described in Section 506.5. A above. This method may only be used when ground water is not present. If ground water is present a Vacuum Test shall be used unless otherwise directed by the Engineer or designated representative. All backfilling and compaction shall be completed prior to the commencement of testing.

The procedures for the test shall include the following:

1. Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before field assembly, or at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints.
2. After cleaning the interior surface of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer.
3. Concrete manholes shall be filled with water or otherwise thoroughly wetted for a period of 24 hours prior to testing.
4. At the start of the test, the manhole shall be filled to the top with water. The test time shall be 1 hour (60 minutes). The Construction Inspector must be present for observation during the entire time of the test. Permissible loss of water in the 1 hour test time is 0.025 gallons per diameter foot, per foot of manhole depth (1.0 liter per diameter in meters, per meter of manhole depth). For a 4 foot (1.22 meter) diameter manhole, this quantity converts to a maximum permissible drop in the water level (from the top of the manhole cone) of 0.05 inches per foot (4 mm per meter) of manhole depth or 0.5 inches for a 10 foot (12.5 mm for a 3 meter) deep manhole.

C. Failure to Pass the Test - Records of Tests.

If the manhole fails to pass the initial test method as described in (A) Test by the Vacuum Method and, if allowed, (B) Test by the Exfiltration Method, or if visible groundwater leakage into the manhole is observed, the Contractor shall locate the leak, if necessary by disassembly of the manhole. The Contractor shall check the gaskets and replace them if necessary. The Contractor may re-lubricate the joints and re-assemble the manhole, or the Contractor may install an acceptable exterior joint sealing product on all joints and then retest the manhole. If any manhole fails the vacuum and/or exfiltration test twice, the Contractor shall consider replacing that manhole. If the Contractor chooses to attempt to repair that manhole, the manhole must be retested until it passes. In no case shall cold applied preformed plastic gaskets be used for repair. Records of all manhole testing shall be made available to the Engineer or designated

representative at the close of each working day, or as otherwise directed by the Engineer or designated representative. Any damaged or visually defective products, or any products out of acceptable tolerance shall be removed from the site.

D. Inspection.

The Engineer or designated representative shall make a visual inspection of each manhole after it has passed the testing requirements and is considered to be in its final condition. The inspection shall determine the completeness of the manhole; any defects shall be corrected to the satisfaction of Engineer or designated representative.

506.6 Measurement

All junction boxes and manholes of the type indicated shall be measured as units complete in place.

New manholes constructed to interim elevations to facilitate stage construction shall be measured as one unit regardless of the number of interim elevations constructed. All labor, materials and other expenses necessary for the stage construction shall be considered subsidiary to the completed unit. Abandonment of existing manholes shall be considered subsidiary to the completed unit, unless a specific pay item is indicated on the Drawings and identified on the Bid Form.

506.7 Payment

Payment for completed junction boxes and manholes of the type indicated shall be made at the unit bid price for each. The unit bid price shall include all labor, equipment, materials, time and incidentals necessary to complete the work. When indicated in the Drawings, abandonment of existing manholes shall be made at the unit price for abandonment.

The intended use of each item shall be designated by a two-letter code (Wastewater = WW; Stormwater =SW) in the spaces provided after the pay item number:

New Manhole Construction, ___ Dia.	Per Each
Special Manhole, ___ Dia.	Per Each
Drop Manhole, ___ Dia.	Per Each
Centered Tee Manhole, ___ Dia. x ___ Dia.	Per Each
Tangent Tee Manhole, ___ Dia. x ___ Dia.	Per Each
Junction Box, ___ Ft x ___ Ft	Per Each
Major Manhole Adjustment, ___ Dia.	Per Each
Minor Manhole Adjustment, ___ Dia.	Per Each
Abandonment of existing Manholes:	Per Each

End

SPECIFIC Cross Reference Materials

Standard Specification Item No. 506, "Manholes"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item 403	Concrete For Structures
Item 410	Concrete Structures
Item 406	Reinforcing Steel
Item 503	Frames, Grates, Rings and Covers
Item 504	Adjusting Structures
Item 507	Bulkheads
Item 510	Pipe

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
ASTM C 55	Specification for Concrete Building Brick
ASTM C478/C478M	Standard Specification for Precast Concrete Manhole
ASTM C443/C443M	Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C923/C923M	Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures Pipes

RELATED Cross Reference Materials

Standard Specification Item No. 506, "Manholes"

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
ASTM C 62	Specification for Building Brick (Solid Units Made from Clay or Shale)
ASTM C478/C478M	Specification for Precast Reinforced Concrete Manhole Sections

American Association of State Highway and Transportation Officials (AASHTO)

<u>Designation</u>	<u>Description</u>
M306	Standard Specifications for Drainage Structure Castings

**ITEM NO. 507
BULKHEADS**

507.1 Description

This item shall govern furnishing and installing plywood or end caps as a temporary utility plug at locations indicated on the Drawings or as directed by the Engineer or designated representative. The work will be placed in conjunction with installation of a pipe where a continuation of the utility system will be performed later.

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

507.2 Submittals

The submittal requirements of this specification item include the type (wood, plastic, rubber, etc.) and application (pipe characteristics and location) of bulkheads.

507.3 Material

Plywood shall be construction grade, 3/4 inch (19 mm) thick and need not be new or treated. End caps may be plastic, vitrified clay pipe, rubber or concrete.

507.4 Construction Methods

After installation of the utility requiring temporary bulkheading, an end cap or a section of plywood, having dimensions at least 6 inches (150 mm) in excess of the outside pipe diameter shall be attached to the exposed bell or spigot and backfilled immediately after installation. Care shall be exercised to prevent the backfill material from entering the pipe.

Bulkheads used with staged construction shall be sound, reasonably free of knots and warps and have a 3 inch (75 mm) nominal thickness.

507.5 Measurement and Payment

Bulkheading will not be measured and paid for separately but shall be considered subsidiary to the pipe or manhole for which payment is made.

END

RELATED Cross Reference Materials

Standard Specification Item No. 507, "Bulkheads"

City of Round Rock Standard Specification

<u>Designation</u>	<u>Description</u>
--------------------	--------------------

Item No. 506	Manholes
--------------	----------

Item No. 510	Pipe
--------------	------

**ITEM NO. 508
MISCELLANEOUS STRUCTURES AND APPURTENANCES**

508.1 Description

This item governs the construction of miscellaneous structures and appurtenances, complete in place or to the stage detailed and/or indicated in the Drawings, using the materials specified herein, including the excavation, installation, backfilling, placement of concrete and when required, the furnishing and installation of frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated on the Drawings.

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

508.2 Submittals

The submittal requirements of this specification item include:

- A. Type of structure and appurtenances (inlets, headwalls, frames, grates, energy dissipators, etc.), construction methods and sequence (precast, cast in place), materials (bolts, nuts, plates, angles, etc.)
- B. Aggregate types, gradations and physical characteristics for Portland cement concrete mix.
- C. Proposed proportioning of materials for mortar mix.
- D. Analysis and thickness calculations for temporary steel covers.

508.3 Types

The various types of structures and appurtenances such as inlets, headwalls, energy dissipators, etc., are designated on the Drawings for the particular design of structure to be constructed in accordance with the details indicated on the Drawings. Unless otherwise indicated on the Drawings, the Contractor may have the option of furnishing cast in place or precast structures.

508.4 Materials

- A. Portland Cement Concrete

Portland cement concrete shall conform to Item No. 403, "Concrete For Structures", with the following classes:

Cast in Place Concrete	Class	A
Precast Concrete	Class C	

- B. Mortar

Mortar shall be composed of 1 part Portland cement and 2 parts clean, sharp mortar sand suitably graded for the purpose by conforming in other respects to the provisions of Standard Specification Item No. 403, "Concrete for Structures"

for fine aggregate. Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight (mass) of the total dry mix.

C. Reinforcement and Steel

Reinforcing Steel shall conform to Standard Specification Item No. 406, "Reinforcing Steel".

Structural Steel shall conform to Standard Specification Item No. 720, "Metal for Structures".

D. Frames, Grates, Rings and Covers

Frames, grates, rings and covers shall conform to City of Round Rock Standard Specification Item No. 503, "Frames, Grates, Rings and Covers".

E. Safety End Treatment for Structures

The safety end treatment for structures shall conform to TxDOT Specification Item No. 467, "Safety End Treatment".

1. Bolts and Nuts. All bolts, nuts and associated hardware shall meet the specifications of ASTM A 307.
2. Plates and Angles. All plates and similar angles and brackets shall meet the specifications of ASTM A 36.
3. Pipe Runners. Pipe Runners shall conform to the requirements of ASTM A53, Grade B.
4. Galvanizing. All hardware including nuts, bolts and plates listed above shall be galvanized conforming to ASTM A 123 or A 153.

F. Miscellaneous Items

Cast iron for supports, steps and inlet units shall conform to the shape and dimensions indicated on the Drawings. The casting shall be clean and perfect, free from sand or blowholes or other defects. Cast iron castings shall meet the requirements of ASTM A 48, Class 30. Steel for temporary covers when used with stage construction shall be adequate for the loads imposed.

508.5 Construction Methods

All concrete work shall be performed in accordance with Standard Specification Item No. 410, "Concrete Structures". Forms will be required for all cast-in-place concrete walls, except where the nature of the surrounding material is such that it can be trimmed to a smooth vertical face (the outside form for concrete bases). Where cast in place concrete is used in wall construction of storm sewers, the steps shall be cast into the wall when the concrete is placed.

Inlets shall be completed, as soon as is practicable after installation is complete of the lines to the inlet. All lines shall be cut neatly at the inside face of the walls of the inlet and pointed up with mortar.

Bases for cast in place inlets may be placed prior to, or at the Contractor's option, after the line is constructed.

Manholes may be constructed prior to backfilling or if the Contractor so elects, the manhole opening may be covered temporarily with a steel plate to facilitate the compaction of backfill for the sewer as a whole. Thereafter, required excavation for the manhole shall be made and the manhole constructed and backfilled.

The inverts in inlets shall be shaped and grouted across the floor of the inlet as indicated on the Drawings. This shaping may be accomplished by adding shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

All miscellaneous structures shall be completed in accordance with the details indicated on the Drawings. Backfilling shall be in accordance with the provisions of the appropriate items and as directed by the Engineer or designated representative.

Energy dissipators and headwalls shall be constructed in accordance with the Drawings.

508.6 Measurement

All miscellaneous structures and safety end treatments satisfactorily completed as indicated on the Drawings will be measured as completed units per each.

Concrete removal, excavation and backfill, riprap, pipe, headwalls, wing walls, collars and apron slabs will not be measured under this item but will be considered subsidiary to the other items.

Frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated will not be measured and paid for but shall be considered subsidiary to one of the pay items identified in the bid.

508.7 Payment

A. Inlets

Payment for Inlets of the type indicated in place in accordance with these specifications and measured as prescribed above will be made at the unit bid price for each Inlet, of the type specified.

B. Energy Dissipators and Headwalls

Payment will be made at the unit price bid per each.

C. Safety End Treatment

Payment for Safety End Treatment, complete in place, will be made at the unit bid price for each unit of the type indicated on the Drawings.

Payment will be made under one of the following:

Energy Dissipators, _____ In. Dia. -	Per Each.
Headwalls, Type _____, ____ In. Dia. Pipe -	Per Each.
_____ Grate Inlet -	Per Each.
Safety End Treatment, Type ____ Size ____	Per Each
_____ Foot Standard Inlet -	Per Each.

End

SPECIFIC Cross Reference Materials

Standard Specification Item No. 508, "Miscellaneous Structures and Appurtenances"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 403	Concrete For Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 720	Structural Steel
Item No. 503	Frames, Grates, Rings and Covers

TxDOT Standard Specifications For Construction And Maintenance
Of Highways, Streets, And Bridges

<u>Designation</u>	<u>Description</u>
Item 467	Safety End Treatment

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
ASTM A36/36M	Specification for Structural Steel
ASTM A48	Specification for Gray Iron Castings
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Specifications for Carbon Steel Externally Threaded Standard Fasteners
ASTM C913	Specifications for Precast Concrete Water and Wastewater Structures

RELATED Cross Reference Materials

Standard Specification Item No. 508, "Miscellaneous Structures and Appurtenances"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 504	Adjusting Structures
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 510	Pipe

TxDOT Specifications

<u>Designation</u>	<u>Description</u>
Item 420	Concrete Structures
Item 421	Portland Cement Concrete
Section 421.2(5)	Fine Aggregate
Item 424	Precast Concrete Structures (Fabrication)
Item 440	Reinforcing Steel
Item 466	Headwalls and Wingwalls
Item 467	Safety End Treatment
Item 471	Frames, Grates, Rings and Covers
Item 529	Concrete Curb, Gutter and Combined Curb and Gutter

ITEM NO. 509
TRENCH SAFETY SYSTEMS

509.1 Description

This item shall govern the following:

- A. Designing, furnishing, and installing a Trench Safety System for trench excavation;
- B. Dewatering the area as specified on the Drawings and/or required; and
- C. Maintenance and removal of the trench safety systems as determined by Contractor's Trench Safety Engineer and/or Contractor's Competent Person(s).

This Item also includes special clearing, excavation and backfilling for safety systems. At a minimum, this work shall conform to 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.

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

509.2 Trench Safety System Plan Submittal

Prior to, or at the Pre-Construction Conference, the Contractor shall submit to the Owner/Developer a Trench Safety System Plan sealed by a registered Professional Engineer licensed in the State of Texas. Notice to Proceed with construction will not be issued by the Owner until the Contractor has submitted a Trench Safety System Plan to the Owner/Developer.

The Trench Safety System Plan at a minimum shall conform to OSHA standards for sloping of sides, utilization of trench boxes, and/or utilization of shoring, sheeting and bracing methods. The Contractor shall be responsible for obtaining the geotechnical information necessary for the design of the Trench Safety System Plan [normally acquired from borings taken at 500 foot (150 meter) intervals along the proposed centerline to a minimum depth of five feet (1.5 meters) below proposed flowline]. If the geotechnical information for the design of the improvements is acquired by the Owner/Developer or designated representative, it shall be provided to the Contractor for information purposes subject to the provisions of the Contract.

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 the length of trench to be opened, the length of time that the trench will remain open, the means of egress, the storage of materials, allowable loads on 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 describe 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. Sealed engineering calculations and/or equipment manufacturer's certifications, as applicable, that confirm that the system is designed to withstand the anticipated loadings and that it can be fully installed/implemented in the designated space easement provided.
- E. A Certificate of Insurance of the Trench Safety Engineer's Professional Liability Insurance coverage meeting the requirements of the Contract.
- F. Certificate of Completion of an OSHA-approved program indicating that the Contractor's Competent Person(s) has received training in "Excavation Safety".

509.3 Trench Safety System Plan Review

The review of the Trench Safety System Plan that will be conducted by the Owner/Developer or designated representative shall only relate to general conformance with OSHA standards and regulations. The Owner's/Developer's failure to note exception(s) to the submittal shall not relieve the Contractor of any or all responsibility or liability for the Trench Safety System Plan. The Contractor shall remain solely and completely responsible for all trench safety systems and for the associated means, methods, procedures, and materials.

509.4 Construction Methods

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 Drawings 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, personnel evacuated from hazardous area and the Owner/Developer notified. 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 replacement of damaged safety system shall be at the Contractor's sole expense.

509.5 Changed Conditions

When changed conditions require modifications to the Trench Safety System, the Contractor shall provide to the Owner/Developer or designated representative a new design or an alternate 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/Developer or designated representative in accordance with the requirements of section 509.2, "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, that could be reasonably anticipated, will not be cause for contract time extension or cost adjustment. When changes to the Trench Safety System Plan are necessitated by severe and uncharacteristic natural conditions or other conditions totally out of the control of the Contractor, the Contractor may make a written request to the Owner/Developer for a Change Order to address the anticipated work. The Contractor shall notify the Owner/Developer in writing within 24 hours of the occurrence of changed conditions that the Contractor anticipates the submittal of a claim for additional compensation. Under "Changed Conditions" the work deemed immediately necessary by the Contractor to protect the safety of workers and public, equipment or materials may only be accomplished until the Owner/Developer or designated representative has a reasonable opportunity to investigate the Contractor's written request for a Change Order and respond in writing to the request.

509.6 Measurement

Trench Safety Systems shall be measured by lineal foot (meter: 1 meter equals 3.281 feet) through manholes and other appurtenances along the centerline of trench conforming to the Drawings and specifications.

509.7 Payment

Payment for Trench Safety Systems, measured as prescribed above, will be made at unit bid price per centerline lineal foot of trench per the Drawings and specifications. The unit bid price shall include full compensation for designing, furnishing, installing the system; for dewatering, maintenance, replacement and removal of the Trench Safety Systems and for sloping, special clearing, and excavation necessary to safely implement the Trench Safety System Plan.

Payment will be made under the following:

Trench Safety Systems (all depths)	Per Lineal Foot.
------------------------------------	------------------

END

RELATED Cross Reference Materials

Standard Specification Item No. 509, "Trench Safety Systems

Texas Department of Transportation Standard Specifications
For Construction and Maintenance of Highways, Streets, and Bridges

<u>Designation</u>	<u>Description</u>
Item 104	Removing Concrete
Item 110	Excavation
Item 402	Trench Excavation Protection

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 101	Preparing Right of Way
Item No. 102	Clearing and Grubbing
Item No. 110	Street Excavation
Item No. 111	Excavation
Item No. 130	Borrow
Item No. 132	Embankment
Item No. 201	Subgrade Preparation
Item No. 402	Controlled Low Strength Material
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 503	Frames, Grates, Rings and Covers
Item No. 504	Adjusting Structures
Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 510	Pipe
Item No. 511	Water Valves
Item No. 593	Concrete Retards
Item No. 594	Gabions and Revet Mattresses

**ITEM NO. 510
PIPE**

510.1 Description

This item shall consist of furnishing and installing all pipe and/or materials for constructing pipe mains, sewers, laterals, stubs, inlet leads, service connections and culverts, including all applicable Work such as excavating, bedding, jointing, backfilling materials, tests, concrete trench cap, concrete cap and encasement, etc., prescribed under this item and in accordance with the provisions of the Edwards Aquifer Protection Ordinance, when applicable. The pipe shall be of the sizes, types, class and dimensions indicated or as designated by the Engineer or designated representative and shall include all joints or connections to new or existing mains, pipes, sewers, manholes, inlets, structures, etc., as may be required to complete the Work in accordance with specifications and published standard practices of the trade associations for the material specified and to the lines and grades indicated. This item shall include any pumping, bailing, drainage and Item No. 509, "Trench Safety Systems" for trench walls, when indicated or applicable. Unless otherwise provided, this item shall consist of the removal and disposition of trees, stumps and other obstructions, old structures or portions thereof such as house foundations, old sewers, masonry or concrete walls, the plugging of the ends of abandoned piped utilities cut and left in place and the restoration of existing utilities damaged in the process of excavation, cutting and restoration of pavement and base courses, the furnishing and placing of select bedding, backfilling and cement or lime stabilized backfill, the hauling and disposition of surplus materials, bridging of trenches and other provisions for maintenance of traffic or access as indicated.

510.2 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality.

(1) Concrete

Concrete shall conform to Item No. 403, "Concrete for Structures".

(2) Coarse Aggregate

Coarse aggregate shall conform to Item No. 403, "Concrete for Structures" or one of the following:

(a) Pipe Bedding Stone

Pipe bedding stone shall be clean gravel, crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C 33 for stone quality. Size gradation shall conform to ASTM C-33 No. 57 or No. 67 or the following Table:

SIEVE SIZE	% RETAINED BY WEIGHT
1-1/2"	0
1"	0-10
1/2"	40-85
#4	90-100
#8	95-100

(b) Foundation Rock
Foundation rock shall be well graded coarse aggregate ranging in size from 2 to 8 inches.

(c) Flexible Base
Flexible base shall conform to Item No. 210, "Flexible Base".

(3) Fine Aggregate

(a) Concrete and Mortar Sand
Fine aggregate shall conform to Item No. 403, "Concrete for Structures".

(b) Bedding Sand
Sand for use as pipe bedding shall be clean, granular and homogeneous material composed mainly of mineral matter, free of mud, silt, clay lumps or clods, vegetation or debris. The material removed by decantation TxDOT Test Method Tex-406-A, plus the weight of any clay lumps, shall not exceed 4.5 percent by weight.

The resistivity shall not be less than 3000 ohms-cm as determined by TxDOT Test Method Tex-129-E. Size gradation of sand for bedding shall be as follows:

GRADATION TABLE	
SIEVE SIZE	% RETAINED BY WEIGHT
1/4"	0
#60	75-100
#100	95-100

(c) Stone Screenings
Stone screenings shall be free of mud, clay, vegetation or other debris, and shall conform to the following Table:

SIEVE SIZE	% PASSING
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

All screenings shall be the result of a rock crushing operation.

(4) Controlled Low Strength Material

Controlled Low Strength Material (CLSM) shall conform to Item No. 402, "Controlled Low Strength Material.

(5) Pea Gravel

Pea gravel bedding shall be clean washed material, hard and insoluble in water, free of mud, clay, silt, vegetation or other debris. Stone quality shall meet ASTM C 33. Size gradation shall be as follows:

SIEVE SIZE	% RETAINED BY WEIGHT
3/4"	0
1/2"	0-25
1/4"	90-100

(6) Select Backfill or Borrow

This material shall consist of borrow or suitable material excavated from the trench. It shall be free of stones or rocks over 8 inches and shall have a plasticity index of less than 20. The moisture content at the time of compaction shall be within 2 percent of optimum as determined by TxDOT Test Method Tex-114-E. Sandy loam borrow will not be allowed unless shown on the Drawings or authorized by the Engineer or designated representative.

All suitable materials from excavation operations not required for backfilling the trench may be placed in embankments, if applicable. All unsuitable materials that cannot be made suitable shall be considered surplus excavated materials as described in 510.3(13). The Contractor may, if approved by the engineer, modify unsuitable materials to make them suitable for use. Modification may include drying, removal or crushing of over-size material, and lime or cement treatment.

(7) Cement Stabilized Backfill

When indicated or directed by the Engineer or designated representative, backfill shall be with cement-stabilized backfill rather than the usual materials. Unless otherwise indicated, cement stabilized backfill material shall consist of a mixture of the dry constituents described for Class J Concrete. The cement and aggregates shall be thoroughly dry mixed with no water added to the mixture except as may be directed by the Engineer or designated representative.

(8) Pipe

General

Fire line leads and fire hydrant leads shall be ductile iron. Domestic water services shall not be supplied from fire service leads, unless the domestic and fire connections are on separately valved branches with an approved backflow prevention device in the fire service branch. All wastewater force mains shall be constructed of ductile iron pipe Pressure Class 250 minimum for pipe greater than 12-inch size and Pressure Class 350 for pipe 12-inch size and smaller. Wastewater pipe shall have a corrosion resistant interior lining acceptable to the Owner/Developer.

For pipes 16" and larger all pipe manufacturers and suppliers shall be certified by the American National Standards Institute (ANSI) for ISO 9000 compliance. It is the intent of this certification that all appropriate tests be documented with sampling criteria, frequency of testing, date of testing and date in which every piece was manufactured. A copy of the testing data to include results shall be sent with the shipment with appropriate identification as it relates to the specific shipment.

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by the Engineer or designated representative at the pipe manufacturing plant and at the project site prior to and during installation. Plant inspections shall be conducted at the discretion of the Owner/Developer and shall require only 48 hours of advance notice to the manufacturer. Only manufacturers and suppliers meeting this certification will be considered as approved providers of products.

All water distribution pipe and fittings shall be listed in the Fire Protection Equipment Directory published by the Underwriter's Laboratories, Inc., or shall be Factory Mutual approved for fire service.

(a) Reserved

(b) Iron Pipe

Iron pipe shall be ductile iron pipe meeting all requirements of standards as follows:

-For push-on and mechanical joint pipe: AWWA C-151

-For flanged pipe: AWWA C-115

Barrels shall have a nominal thickness required by Table 1 of AWWA C-115, which thickness corresponds to Special Class 53 in sizes through 54 inch, and Class 350 in 60 and 64-inch sizes. Flanges shall be ductile iron (gray iron is not acceptable); they shall be as shown in ANSI/AWWA C115/A21.15 and shall conform to dimensions shown in Table 2 and Figure 1 of AWWA C115. These flanges are the same in all respects as flanges shown in ANSI/AWWA C110/A21.10 for fittings and are standard for all flanges used with pipe, valve, and equipment units in the City of Round Rock water distribution and wastewater force main systems. Flanges shall be fabricated and attached to the pipe barrels by U.S. fabricators using flanges and pipe barrels of U.S. manufacture. If fabrication is to be by other than the pipe barrel manufacturer, a complete product submittal and approval by the City of Round Rock will be required. Additionally, such fabricator shall furnish certification that each fabricated joint has been satisfactorily tested hydrostatically at a minimum pressure of 300 psi.

-Linings and Coating:

Interior surfaces of all iron water pipe shall be cement-mortar lined and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater line and force main pipe shall be coated with a non-corrosive lining material as approved by the City of Round Rock. Pipe exteriors shall be coated as required by the applicable pipe specification. The type and brand of interior lining shall be clearly marked on the outside of the pipe and fittings. Except as authorized by the Engineer or designated representative, only one type and brand of pipe lining shall be used on a given project.

Except as described above for flanged pipe (Thickness Class 53) and where not otherwise indicated, ductile iron pipe shall be minimum Class 250 as defined by ANSI/AWWA C150/A21.50-current; all ductile iron pipe and flanges shall meet the following minimum physical requirements:

Grade 60-42-10:

- Minimum tensile strength: 60,000 psi (414 mPa).
- Minimum yield strength: 42,000 psi (290 mPa).
- Minimum elongation: 10 percent.

The flanges for AWWA C115 pipe may be also be made from:

Grade 70-50-05:

- Minimum tensile strength: 70,000 psi (483 mPa).
- Minimum yield strength: 50,000 psi (345 mPa).
- Minimum elongation: 5 percent.

1. Ductile Iron Fittings:

Fittings shall be push-on, flanged or mechanical joint as indicated or approved and shall meet all requirements of standards as follows:

-Sizes 4 inch through 24 inch: AWWA C-110 or AWWA C-153

-Sizes larger than 24 inch: AWWA C-110.

-Lining and Coating:

Interior surfaces of all iron water pipe fittings shall be lined with cement-mortar and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater and force main fittings shall be coated with a non-corrosive lining material acceptable to the City of Round Rock. Fitting exteriors shall be coated as required by the applicable pipe specification.

2. Joint Materials

Gaskets for mechanical joints shall conform to ANSI/AWWA A21.11/C-111.

Joining of slip joint iron pipe shall, without exception, be accomplished with the natural or synthetic rubber gaskets of the manufacturer of that particular pipe being used. A joint lubricant shall be used and applicable recommendations of the manufacturer shall be followed.

Gaskets for flanged joints shall be continuous full face gaskets, of 1/8 inch minimum thickness of natural or synthetic rubber, cloth-reinforced rubber or neoprene material, preferably of deformed cross section design and shall meet all applicable requirements of ANSI/AWWA A21.11/C-111 for gaskets. They shall be manufactured by, or satisfy all recommendations of, the manufacturer of the pipe/fittings being used and be fabricated for use with Class 125 ANSI B16.1 flanges.

Tee-head bolts, nuts and washers for mechanical joints shall be high strength, low alloy, corrosion resistant steel stock equal to "COR-TEN A" having UNC Class 2 rolled threads or alloyed ductile iron conforming to ASTM A 536; either shall be fabricated in accordance with ANSI/AWWA A21.11/C-111.

Hex head bolts and nuts shall satisfy the chemical and mechanical requirements of ASTM A449 SAE Grade 5 plain, and shall be fabricated in accordance with ASTM B 18.2 with UNC Class 2 rolled threads.

Either Tee-Head or Hex-Head bolts, nuts and washers as required, shall be protected with bonded fluoro-polymer corrosion resistant coating where specifically required by the Engineer or designated representative.

All threaded fasteners shall be marked with a readily visible symbol cast, forged or stamped on each nut and bolt, which will identify the fastener material and grade. The producer and the supplier shall provide adequate literature to facilitate such identification; painted markings are not acceptable.

3 Polyethylene Film Wrap

All iron pipe, fittings and accessories shall be wrapped with standard 8 mil (minimum) low density polyethylene film or 4-mil (minimum) cross laminated high-density polyethylene conforming to AWWA C-105, with all edges overlapped and taped securely with duct tape to provide a continuous wrap to prevent contact between the piping and the surrounding backfill. All punctures of the polyethylene, including those caused by the placement of bedding aggregates, shall be repaired with duct tape to restore the continuous protective wrap before backfilling.

4. Marking

Each pipe joint and fitting shall be marked as required by the applicable AWWA specification. This includes in all cases: Manufacturer's identification, Country where cast, year of casting, and "DUCTILE" or "DI". Barrels of flanged pipe shall show thickness class; others shall show pressure class. The flanges of pipe sections shall be stamped with the fabricators identification; fittings shall show pressure rating, the nominal diameter of openings and the number of degrees for bends. Painted markings are not acceptable.

(c) Concrete

1. General

Pipe shall conform to ASTM C 76 for Circular Pipe. Concrete pipe smaller than 12 inches in diameter shall conform to ASTM C 14, Extra Strength. All pipe shall be machine made or cast by a process which will provide uniform placement of the concrete in the form and compaction by mechanical devices, which will assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete shall not be acceptable for use in precast pipe. The pipe shall be Class III or the class indicated. Storm sewer pipe shall be of the tongue and groove or O-ring joint design. Wastewater pipe shall be of the O-ring joint design; it shall be acceptably lined for corrosion protection.

2. Marking

Each joint of pipe shall be marked with the pipe class, the date of manufacture, the manufacturer's name or trade mark, diameter of pipe and orientation, if required.

Pipe marking shall be waterproof and conform to ASTM C 76.

3. Minimum Age for Shipment

Pipe shall be considered ready for shipment when it conforms to the tests specified in ASTM C 76.

4. Joint Materials

When constructing storm sewers, the Contractor shall have the option of making joints with either of the following materials:

a. Mortar

Mortar for joints shall meet the requirements set forth below in "Mortar".

b. Cold Applied Preformed Plastic Gaskets

Cold Applied Plastic Gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to obtain squeeze-out around the joint. The gasket joint sealer shall be protected by a suitable removable wrapper that may be removed longitudinally without disturbing the joint sealer to facilitate application.

The chemical composition of the gasket joint sealing compound as shipped shall meet the following requirements:

Composition (% by weight)	Test Method	Typical Analysis
Bitumen (petroleum plastic content)	ASTM D 4	50-70
Ash-inert Mineral Water	Tex-526-C	30-50
Volatile Matter (at 325° F)	Tex-506-C	2.0 Maximum

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5 percent solution of caustic potash, a mixture of 5 percent hydrochloric acid, a 5 percent solution of sulfuric acid and a saturated H₂S solution shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

Property	Test Method	Typical Analysis	
		Minimum	Maximum
Specific Gravity at 77° F	ASTM D 71	1.20	1.35
Ductility at 77° F (cm) Minimum	Tex-503-C	5.0	
Softening point	Tex-505-C	275° F	
Penetration:			
32° F (300 g) 60 sec	Tex-502-C	75	
77° F (150 g) 5 sec	Tex-502-C	50	120
115° F (150 g) 5 sec	Tex-502-C		150
Flashpoint C.O.C. F	Tex-504-C	600° F	
Fire Point C.O.C. F	Tex-504-C	625° F	

When constructing wastewater lines, the Contractor shall use O-ring gasket joints conforming to ASTM C 443. Just before making a joint, the ends of the pipe shall be clean, dry, free of blisters or foreign matter and shall be wire brushed. For O-ring joints, the gasket and the inside surface of the bell shall be lubricated with a light film of soft vegetable soap compound to facilitate assembly of the joint. The rubber O-ring gasket shall be stretched uniformly in the joint. Wedge seal type ("Forsheda" pre-lubricated) gaskets may be used if joint details submitted are approved; installation of such gaskets shall be in strict accordance with the manufacturer's recommendations, and shall be the sole element depended upon to make the joint flexible and watertight.

In wastewater lines no horizontal or vertical angles in the alignment of pipes shall be permitted unless indicated. The spigot shall be centered in the bell, the pipe pushed uniformly home and brought into true alignment. Bedding material shall be placed and tamped against pipe to secure the joint.

5. Bends

When horizontal or vertical angles in the alignment of storm sewers are indicated, the bend or angle shall be constructed by use of prefabricated bends meeting the specification requirements. All bends shall be watertight, have a smooth flow line and be equal or greater in strength to the adjacent pipe.

Horizontal or vertical changes in alignment in wastewater lines shall be accomplished by use of manholes. With the Engineer's or designated representative's approval, horizontal changes in alignment may be made

by the "Joint Deflection" method. Joint deflection is limited by regulations of the Texas Commission on Environmental Quality (TCEQ) to 80 percent of the maximum recommended by the manufacturer; such deflection may not exceed 5 degrees at any joint. Changes in alignment using pipe flexure shall not be allowed.

6. Sulfide and Corrosion Control

All concrete pipe used for wastewater installations shall be protected from sulfide and corrosion damage by using limestone aggregate.

(d) Concrete Steel Cylinder (CSC) Pipe

1. General Requirements

The Contractor shall submit to the Engineer or designated representative for approval along with other required data a tabulated layout schedule with reference to the stationing and grade lines to be used.

The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blow offs and connections to main line valves and other fittings as indicated.

Each pipe length, fitting and special joint shall have plainly marked on the bell end of the pipe the head condition for which it is designed. In addition, marking shall be required to indicate the location of each pipe length or special joint in the line and such markings will be referenced to the layout schedules and drawings submitted for approval.

Concrete steel cylinder fittings shall be tested as required by the applicable AWWA Standards.

2. Design and Inspection

Where not otherwise indicated, concrete steel cylinder pipe shall be Class 200, designed to withstand a vacuum of not less than 28 feet of water. Valve reducers, tees and outlets from a pipe run shall be designed and fabricated so that all stresses are carried by the steel forming the fitting or outlet.

Concrete steel cylinder pipe shall meet one of the following specifications:

AWWA C-301 - Any Size

AWWA C-303 - 24-inch maximum size

All pipe flanges shall conform to AWWA C-207, requirements for standard steel flanges of pressure classes corresponding to the pipe class.

Pipe to be installed in a tunnel or encasement shall be manufactured with 1 inch thick by 24-inch wide skid bands of mechanically impacted mortar in addition to the normal coating.

All concrete steel cylinder fittings shall be constructed of steel plate of adequate strength to withstand both internal pressure and external loading. Rod reinforcing shall not be used to figure the required steel area.

The fittings shall have a concrete lining and 1 inch minimum coating of cement mortar, except that centrifugally spun lining need not be reinforced.

Minimum lining thickness shall be 1/2 inch for 16-inch pipe and 3/4 inch for sizes larger than 16-inch pipe. Where it is impractical to place such concrete protection on interior surfaces of small outlets, 2 coats of "Bitumastic Tank Solution" shall be applied.

No fitting shall be made by cutting of standard pipe, except that outlets of less than 75 percent of the pipe diameter may be placed in a standard pipe. Beveled spigots may be placed on standard pipe.

3. Joint Materials

Joints shall be of the rubber gasket type conforming to the applicable standards. The inside and outside recesses between the bell and spigot shall be completely filled with Cement Grout in accordance with the pipe manufacturer's recommendations. Grout materials for jointing such pipe, unless otherwise indicated, shall be as described herein.

(e) In Place Pipe Rehabilitation

1. In Place Sliplining With or Without Pipe Destruction /Replacement.

This item shall consist of installing a high-density polyethylene pipe, by use of a pipe insertion machine into an existing line.

a. Material Requirements

The polyethylene pipe shall meet the following specifications:

ASTM F 714

Plastic Pipe Institute PE3408

Unless otherwise specified, the Contractor shall furnish the polyethylene pipe in accordance with the following table:

Depth of Cover in Feet	SDR of Pipe
0 – 16	17
Greater than 16	11

b. Functional Requirements

The polyethylene pipe shall be assembled and joined at the site using the thermal butt fusion method. All equipment and procedures shall be in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

The complete joint shall be in true alignment and have a uniform double roll back bead resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time

before removal of pressure. Joints shall be made smooth on the inside by removal of the projecting weld bead using appropriate equipment; maximum projection of the weld bead on the exterior of the pipe shall be approximately 3/16 inch. The fused joint shall be watertight and shall have a tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Engineer or his/her representative prior to placement. All defective joints shall be cut out and replaced.

Any section of the pipe with a gash, abrasion, nick or scar greater in depth than 10 percent of the wall thickness, or containing concentrated ridges, discolorization, excessive spot roughness, pitting, variable wall thickness, or any other defect of manufacturing or handling as determined by the Engineer or his/her representative, shall be discarded and removed from the site.

Terminal sections of pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp with a minimum length of one and one half times the nominal inside pipe diameter. The butt gap between pipe ends shall not exceed 1/10 of the nominal inside diameter of the pipe.

c. Installation Procedure

The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements.

The Contractor shall provide for the flow of water and wastewater around the section or sections of pipe designated for rehabilitation including active services in the rehabilitation section. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Contractor shall take all necessary steps to prevent flooding of any private property and shall be liable for damages incurred by the flooding. No sewage or water shall be allowed to drain into earthen sump pits.

New polyethylene pipe shall be inserted immediately behind the expansion and insertion equipment in accordance with the manufacturer's procedures. The expansion and insertion equipment shall be equipped with all controls necessary to place the pipe on proper line and grade according to the Drawings.

The Contractor shall install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes and to protect the pipe from damage during installation.

Lubrication may be used as recommended by the pipe manufacturer. Under no circumstances shall the pipe be stressed beyond its elastic limit.

All active service connections shall be identified by video inspection or other means and connected to the new main in accordance with the plan details.

Upon commencement, insertion, from manhole to manhole, shall be continuous without interruption except as approved by the Engineer or designated representative.

The installed pipe shall be allowed the manufacturer's recommended amount of time to provide for complete shrinkage or relaxation of the pipe prior to any connection of service lines, sealing of the annular space where the pipe enters the manhole, or backfilling of the insertion pit. Sufficient excess length of pipe shall be allowed to provide for this shrinkage.

The pipe bedding in the insertion pit shall be either pea gravel or pipe bedding stone. Bedding and backfill shall conform to the specification requirements of Section 510.3(14) contained herein. All street repairs and pavement replacement shall conform to City of Round Rock Criteria.

The relaxed pipe shall be cut so that it projects 4 inches inside of the manhole and any annular space shall be sealed. Sealing shall be with material approved by the Engineer or designated representative. The sealant shall completely fill the void between the pipe and the manhole wall and shall extend 3 inches beyond the annulus on the inside wall of the manhole. The sealant shall form a smooth transition from the pipe onto the manhole. The complete joint shall be uniform and watertight. A concrete invert shall be poured in place and shaped to form a smooth flow channel through the manhole.

2. Cured Resin Pipe Lining

This method of rehabilitation shall consist of the insertion of a resin-impregnated flexible tube into an existing pipe by the inversion method given in ASTM F 1216 or by a comparable approved method.

a. Material Requirements

Certified copies of all test reports on the properties of the selected resin and on the initial structural properties of the Cured in Place Pipe (CIPP) system—and later, on the field samples from designated inversion lengths as required by Section 8 of ASTM F 1216—shall be submitted to the Owner's/Developer's Engineer or designated representative. All testing costs are incidental to, and shall be included in, the unit price bid for CIPP.

The CIPP system shall have minimum initial structural properties as follows:

Flexural Strength (ASTM D 790)	4,500 psi
Tensile Strength (ASTM D 638)	2,500 psi
Flexural Modulus (ASTM D790)	250,000 psi

The results of tests by an independent laboratory of specimens taken by the Contractor as required by Section 8 of ASTM F 1216 and to demonstrate compliance with the above minimum values, shall be made available to the Owner's/Developer's Engineer or designated representative at the completion of testing.

b. Installation Procedure

Insertion of a resin-impregnated flexible tube into an existing pipe shall be by an inversion method as given in ASTM F 1216 and the manufacturer's recommendations.

The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements.

Measures shall be taken to reduce atmospheric styrene concentration to an acceptable level at all times during the CIPP installation procedure. The percent lower explosive limit, temperature and styrene concentration shall be measured and recorded for each inversion taken to ensure the following conditions are met:

Percent Lower Explosive Limit (LEL) shall not exceed 2% using an atmospheric monitor calibrated within at least six (6) months of the day reading is taken. The LEL shall be measured at the top of the downstream manhole adjacent to the section of pipe being lined.

No process water shall be discharged until cooled to below 100 degrees Fahrenheit in accordance with Section 7.1 of ASTM F 1216.

Atmospheric styrene levels shall not exceed 50 ppm as measured by a Drager Tube 67 23 301 Styrene 10/a five feet above and within 3 feet downwind of the downstream manhole adjacent to the section of pipe being lined.

Contractor shall be responsible for satisfactorily resolving customer complaints involving styrene odors.

Any necessary repairs to the pipeline shall be performed by the Contractor. Inspection of pipeline by the Contractor shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the pipe shall be carefully inspected to determine the location of any conditions which may prevent proper installation into the pipe and these conditions shall be corrected. A videotape and

log shall be made by the Contractor and provided to the Owner/Developer upon completion of the project.

The Contractor shall provide for the flow of water and wastewater around the section or sections of pipe designated for rehabilitation, including active services in the rehabilitation section. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Contractor shall take all necessary steps to prevent flooding of any private property and shall be liable for any damages incurred by the flooding. No sewage or water shall be allowed to drain into earthen sump pits.

The Contractor shall designate a location where the uncured resin in the original containers and the unimpregnated fiber-felt tube shall be vacuum impregnated prior to installation. The Contractor shall allow the Engineer or designated representative to inspect the materials and "wet out" procedure. The quantities of the liquid thermosetting materials shall be per manufacturer's standards to provide the wall thickness specified.

Water for the Work shall be metered and furnished by the Contractor in accordance with the Contract Documents. The wet out fiber-felt tube shall be inserted through an existing manhole or other approved access by means of an inversion process and the application of a hydrostatic head sufficient to fully extend it to the next designated manhole.

Any defect which will affect, in the foreseeable future, or warranty period, the integrity or strength of the pipe liner shall be repaired at the Contractor's expense, in a manner satisfactory to the Engineer or designated representative.

If, due to broken or misaligned pipe at a manhole wall, the pipe liner fails to make a tight seal, the Contractor shall apply a seal at that point. The seal shall be of a resin mixture compatible with pipe liner.

After the pipe liner has been cured in place, and allowed to cool down and normalize to ambient temperature, the Contractor shall connect new services or reconnect existing service piping as designated and identified in the proposal. After the Work is completed, the Contractor shall provide the Engineer or designated representative with a videotape showing both the before and after conditions including the restored connections.

(f) Polyethylene Tubing

1. General

All polyethylene (PE) tubing shall be high density, high molecular weight

plastic tubing meeting ASTM D2737; it shall be pressure rated at 200 psi working pressure and must bear the National Sanitation Foundation seal of approval for potable water service.

When tested for Environmental Stress Cracking, the PE tubing shall not show any loss of pressure in the 6 specimens tested for 3 hours in accordance with the requirements of ASTM D 2737 using the test pressure of 400 psi at 73.4° F.

The minimum burst pressure shall be 630 psi at 73.4° F determined in accordance with ASTM D 1599, latest revision. The time of testing of each specimen shall be between 60 and 70 seconds.

The tubing shall not fail, balloon, burst or weep as defined in ASTM D 1598, latest revision, when tested in accordance with the Sustained Pressure Test Method of ASTM D 2737 but under the following test conditions:

Temperature	Time	Pressure
73.4° F	1,000 hours	400 psi
100° F	1,000 hours	330 psi

2. Markings

Permanent marking on the tubing shall include the following at intervals of not more than 5 feet:

Nominal tubing size.

Type of plastic material, i.e., PE 3408.

Standard Dimension Ratio (SDR) and pressure rating in psi for water at 73.4° F (e.g., SDR-9, 200 psi).

ASTM D 2737 designation.

Manufacturer's name or trademark, code and seal of approval (NSF mark) of the National Sanitation Foundation.

3. Tube Size

PE tubing shall be standard copper tube size outside diameter, with Standard Dimension Ratio (SDR) of 9. Standard sizes, dimensions and tolerances shall be as follows:

Nominal Tube Size (inches)	Outside Diameter, inches		Wall Thickness, inches	
	Average	Tolerance	Minimum	Tolerance
3/4	0.875	±0.004	0.097	+0.010
1	1.125	±0.005	0.125	+0.012
1 1/4	1.375	±0.005	0.153	+0.015
1 1/2	1.625	±0.006	0.181	+0.018
2	2.125	±0.006	0.236	+0.024

(g) Copper Tubing

All copper service tubing shall be annealed seamless Type K water tube meeting ASTM B88 and rated at 150 psi working pressure. The tubing shall be homogenous throughout and free from cracks, holes, crimping, foreign inclusions or other defects. It shall be uniform in density and other physical properties.

Nominal Tube Size, inches	Outside Diameter, inches		Wall Thickness, inches	
	Average	Tolerance	Average	Tolerance
3/4	0.875	± 0.003	0.065	± 0.0045
1	1.125	± 0.0035	0.065	± 0.0045
1 1/4	1.375	± 0.004	0.065	± 0.0045
1 1/2	1.625	± 0.0045	0.072	± 0.005
2	2.125	± 0.005	0.083	± 0.007

(h) Service Connection Fittings

All fittings used in customer service connection - tapping mains, connecting meters, etc. - must be approved by the City of Round Rock.

(i) Brass Goods

All brass valves, couplings, bends, connections, nipples and miscellaneous brass pipe fittings and accessories used in meter connections, service lines, air release piping assemblies, and wherever needed in the water distribution system, shall conform to the City of Round Rock Standards Details, and AWWA C-800, and, shall be approved by the City of Round Rock

Unless otherwise noted, the goods described herein shall be fabricated of standard Red Brass (Waterworks Brass) meeting ASTM B62 or B584, alloy 83600, consisting of 85 percent copper and 5 percent each of tin, lead and zinc.

Exposed threads shall be covered with plastic caps or sheeting to protect the threads.

Brass goods of each type and class shall be compatible with other fittings in common usage for similar purposes. Where not otherwise indicated, all such materials shall meet the following requirements:

Inlet threads of corporation valves shall be AWWA iron pipe (IP) thread (male); outlets of service saddles shall be tapped with AWWA IP thread (female). AWWA IP threads shall conform to ANSI/ASME B1.20.1 as required by AWWA C800 for "General Purpose (Inch) Pipe Threads". For 3/4" and 1" sizes only, corporation valve inlet threads, and the internal threads of saddles may be the AWWA taper thread conforming to AWWA C800 Figure 1 and Table 6. External threads of corporation valve inlet must be compatible with internal threads of the service saddle.

Connections of all new tubing, and of tubing repairs wherever possible, shall be by flared fittings. Flare connections - and compression connections when permitted - shall be designed to provide a seal and to retain the tubing, without slippage, at a working water pressure of 150 psig.

Flanges shall conform to ANSI B16.1, Class 125, as to dimensions, drillings, etc. Copper tubing, when used, shall be Type K tubing having dimensions and weights given in Table A.1 of AWWA C800.

Brass pipe shall conform to the weights and dimensions for Extra Strong pipe given in Table A.2 of AWWA C800.

All fittings shall be suitable for use at hydrostatic working pressures up to 150 psig (hydrostatic testing of installed systems is at 200 psig).

(j) Reserved

(k) Polyvinyl Chloride Water Pipe

1. General

All polyvinyl chloride (PVC) water pipe shall be of the rigid (UNPLASTICIZED) type and must bear the National Sanitation Foundation seal of approval for potable water pipe. Each joint of pipe shall consist of single continuous extrusion; bells or other components attached by solvent welding are not acceptable. Pipe shall be pressure rated at 200 psi (SDR-14).

Pipe shall have push-on, rubber gasket joints of the bell and spigot type with thickened integral bells with rubber gasket joints. The wall thickness of each pipe bell and joint coupling must be greater than the standard pipe barrel thickness. Clearance must be provided in every gasket joint for both lateral pipe deflection and for linear expansion and contraction. Concrete thrust blocking shall be placed behind bends and tees. Concrete support cradles or blocking shall be required for support of all fire hydrants, valves and AWWA C110 fittings; such support shall be provided for AWWA C153 fittings when required by the Engineer or designated representative.

2. Applicable Specifications

Except as modified or supplemented herein, PVC pipe shall meet the following standards:

AWWA C-900, SDR 14 for PVC Pressure Pipe, in 4, 6, 8 and 12 inch nominal sizes, having Cast Iron Pipe size outside diameters.

Fittings used with PVC Pressure pipe shall be AWWA C-110 or AWWA C-153 compact ductile iron fittings.

Standard sizes, dimensions and tolerances shall be as follows:

			SDR-14	
Nominal Size (inches)	Outside Diameter, inches		Wall Thickness, inches	
	Avg.	Tolerance	Min.	Tolerance
4	4.800	+ 0.009	0.343	+ 0.041
6	6.900	+ 0.011	0.493	+ 0.059
8	9.050	+ 0.015	0.646	+ 0.078
12	13.200	+ 0.015	0.943	+ 0.113

All pipe 4 inches and larger must be approved by Underwriter's Laboratories for use in buried water supply and fire protection systems.

3. Material Requirements

All pipe and fittings shall be made from clean, virgin, NSF approved, Class 12454B PVC. Clean reworked materials generated from the manufacturer's own production may be used within the current limits of the referenced AWWA C-900.

4. Marking

Permanent marking on each joint of pipe shall include the following at intervals of not more than 5 feet:

Nominal pipe size and OD base (e.g., 4 CIPS).

Type of plastic material (e.g., PVC 12454B).

Standard Dimension Ratio and the pressure rating in psi for water at 73° F (e.g., SDR 14, 200 psi).

AWWA designation with which the pipe complies (e.g., AWWA C-900).

Manufacturer's name or code and the National Sanitation Foundation (NSF) mark.

5. Tracer Tape

For all non-metallic pipe, directly above the centerline of the pipe and a minimum of 12 inches below the subgrade, or a minimum of 18 inches below finished grade on areas outside the limits of pavement, shall be placed Inductive Tracer Detection Tape in accordance with the manufacturer's requirements. The tape shall be encased in a protective, inert, plastic jacket and color-coded in accordance with APWA Uniform Color Code.

(l) Polyvinyl Chloride (PVC) Pipe (Nonpressure) and Fittings

1. General

Where PVC sewer or wastewater pipe is indicated, it shall conform to ASTM D 3034. Cell Class shall be as required by applicable ASTM pipe specification; pipe stiffness shall be 115 psi minimum for pipe to 15" size, or 72 psi minimum for larger pipe.

2. Joint Material

PVC pipe and fitting shall have elastomeric gasket joints conforming to ASTM D 3212; gaskets to ASTM F 477.

3. Pipe Markings

Permanent marking on the pipe shall include the following at intervals of not more than 5 feet:

Manufacturer's name and/or trademark.

Nominal pipe size.

PVC cell classification per ASTM D 1784.

ASTM designation and legend:

For pipe 6 inch to 15-inch size: ASTM D 3034, type PSM, SDR-26 PVC Sewer Pipe.

For pipe 18 inches and larger: ASTM F 679. T-1 wall PVC sewer pipe.

4. Fitting Markings

Fittings shall be clearly marked as follows:

Manufacturer's name or trademark,

Nominal size,

The material designation "PVC",

PSM, and

The designation, "Specification D3034".

5. Tracer Tape

For all non-metallic pipe, directly above the centerline of the pipe and a minimum of 12 inches below the subgrade, or a minimum of 18 Inches below finished grade on areas outside the limits of pavement, shall be placed Inductive Tracer Detection Tape in accordance with the manufacturer's requirements. The tape shall be encased in a protective, inert, plastic jacket and color-coded in accordance with APWA Uniform Color Code.

(m) Steel Pipe

1. Standard Weight
ASTM A 53, Schedule 40.
2. Extra Heavy Weight
Seamless ASTM A 53, Schedule 80.
3. Encasement Pipe
Welded or Seamless pipepiles ASTM A-252, Grade 2.
4. Fittings
Nipples and fittings extra strong Federal Specification WW-N 351 or WW-P 521.
5. Coatings
Black or galvanized as indicated.

(n) Welded Steel Pipe and Fittings for Water Pipe

1. General Reference Standards Specification.
Specifications of the American Water Works Association (AWWA) listed below shall apply to this Section.
 - C-200 Steel Water Pipe 6 inches and larger.
 - C-205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 inches and larger, Shop Applied.
 - C-206 Field Welding of Steel Water Pipe.
 - C-207 Steel Pipe Flanges for Waterworks Services, Sizes 4 inches through 144 inches.
 - C-208 Dimensions for Steel Water Pipe Fittings.
 - C-602 Cement-Mortar Lining of Water Pipelines, 4 inches and larger in Place.
2. Submittals
Furnish Shop Drawings, product data, design calculations and test reports as described below:
 - a. Certified copies of mill tests confirming the type of materials used in steel plates, mill pipe flanges and bolts and nuts to show compliance with the requirements of the applicable standards.
 - b. Complete and dimensional working drawings of all pipe layouts. Shop Drawings shall include the grade of material, size, wall thickness of the pipe and fittings, type and location of fittings and the type and limits of the lining and coating systems of the pipe and fittings.

- c. Product data to show compliance of all couplings, supports, fittings, coatings and related items.
- 3. Job Conditions
 - a. The internal design pressure of all steel pipe and fittings shall be as indicated.
 - b. The interior of all steel pipe for potable water, 4 inches and larger, shall be cement-mortar lined.
- 4. Manufacturing
 - a. Description

Pipe shall comply with AWWA C-200.

 - (1) Circumferential deflection of all pipe in-place shall not exceed 2.0 percent of pipe diameter.
 - (2) Diameter

Nominal pipe diameter shall be the inside diameter of lining or pipe barrel, unless otherwise designated in Job Conditions.
 - b. Wall Thickness
 - (1) Steel pipe wall thickness shall be designed for the internal and external loads specified in this section. The cylinder thickness needed to resist internal pressure shall be based on an allowable stress in the steel equal to 1/2 the minimum yield stress of the material used.
- 5. Fittings
 - a. Welded

Fabricated steel fittings shall be of the same material as pipe and shall comply with AWWA C-208.
- 6. Flanges
 - a. Flanges shall comply with the requirements of AWWA C-207, Class D or Class E. The class shall be based on operating conditions and mating flanges of valves and equipment.
 - b. Gaskets shall be cloth-inserted rubber, 1/8 inch thick.
 - c. Flanges shall be flat faced with a serrated finish.
- 7. Pipe Joints
 - a. Lap Joints for Field Welding
 - (1) Lap joints for field welding shall conform to AWWA C-206. This item applies only to pipes 72 inches in diameter and larger.

- (2) The bell ends shall be formed by pressing on a hydraulic expander or a plug die. After forming, the minimum radius of curvature of the bell end at any point shall not be less than 15 times the thickness of the steel shell. Bell ends shall be formed in a manner to avoid impairment of the physical properties of the steel shell. Joints shall permit a lap at least 1 1/2 inches when assembled. The longitudinal or spiral weld on the inside of the bell end and the outside of the spigot end on each section of pipe shall be ground flush with the plate surface. The inside edge of the bell and the outside edge of the spigot shall be scarfed or lightly ground to remove the sharp edges or burrs.
 - b. Bell and Spigot Joints with O-Ring Gasket
 - (1) Bell and spigot joints with rubber gasket shall conform to AWWA C-200.
 - (2) The bell and spigot ends shall be so designed that when the joint is assembled, it will be self-centered and the gasket will be confined to an annular space in such manner that movement of the pipe or hydrostatic pressure cannot displace it. Compression of the gasket when the joint is completed shall not be dependent upon water pressure in the pipe and shall be adequate to ensure a watertight seal when subjected to the specified conditions of service. Bell and spigot ends shall be welded on preformed shapes. The bell and spigot ends shall conform to the reviewed Shop Drawings.
8. Interior and Exterior Protective Surface Coatings
- a. Exterior Surface to be mortar coated shall conform to AWWA C-205 for shop application and AWWA C-602 for field application. Pipe materials shall be the product of an organization, which has had not less than 5 years successful experience manufacturing pipe materials, and the design and manufacture of the pipe, including all materials, shall be the product of one company.
 - b. All surfaces except as noted in c and d below shall receive shop application of mortar lining and coating.
 - c. Field Welded Joints. After installation, clean, line and coat unlined or uncoated ends adjacent to welded field joints, including the weld proper, as specified for pipe adjacent to the weld.
 - d. Machined Surfaces. Shop coat machined surfaces with a rust preventative compound. After jointing surfaces, remaining exposed surfaces shall be coated per a) and b) above.

(o) Corrugated Metal Pipe

1. General

Pipe shall be corrugated continuous lock or welded seam helically corrugated pipe. Corrugated metal pipe may be galvanized steel, aluminized steel or aluminum conforming to the following:

Galvanized Steel	AASHTO M 218
Aluminized Steel	AASHTO M 274
Aluminum	AASHTO M 197

Where reference is made herein to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets. Tables in AASHTO M 218 and AASHTO M 274 list thickness for coated sheets in inches. The Tables in AASHTO M 197 list thickness in inches for clad aluminum sheets.

Sampling and testing of metal sheets and coils used for corrugated metal pipe shall be in accordance with TXDOT Test Method Tex-708-I.

Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld-burned spelter coating. The cleaned area shall be painted with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P 641b. Damaged pipe shall be rejected and removed from the project.

Damaged aluminized coating shall be repaired in accordance with the manufacturer's recommendations.

The following information shall be clearly marked on each section of pipe:

- Thickness and corrugations
- Trade Mark of the manufacturer
- Specification compliance

2. Fabrication

a. Steel Pipe

Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M 36, Type I or Type II as indicated.

It may be fabricated with circumferential corrugations; lap joint construction with riveted or spot welded seams or it may be fabricated with helical corrugations with continuous helical lock seam or ultra high frequency resistance butt-welded seams.

b. Aluminum Pipe

Pipe shall conform to AASHTO M 196, Type I, circular pipe or Type II, pipe arch as indicated. It may be fabricated with circumferential corrugations; lap joint construction with riveted or spot welded seams or it may be fabricated with helical corrugations with a continuous helical lock seam.

Portions of aluminum pipe that are to be in contact with high chloride concrete or metal other than aluminum, shall be insulated from these materials by a coating of bituminous material. The coating applied to the pipe or pipe arch to provide insulation between the aluminum and other material shall extend a minimum distance of 1 foot beyond the area of contact.

3. Selection of Gages

The pipe diameter, permissible corrugations and required gages for circular pipe shall be as indicated on the drawings.

For pipe arch, the span, rise, gage, corrugation size and coating thickness shall be as shown on the drawings. A tolerance of plus or minus 1 inch or 2 percent of equivalent circular diameter, whichever is greater, will be permissible in span and rise, with all dimensions measured from the inside crests of the corrugations.

4. Joint Material

Except as otherwise indicated, coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of soil material during the life of the installation.

Coupling bands shall be not more than 3 nominal sheet thickness lighter than the thickness of the pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.

Coupling bands shall be made of the same base metal and coating (metallic or otherwise) as the pipe.

Coupling bands shall lap equally on each of the pipes being connected to form a tightly closed joint after installation.

Pipes furnished with circumferential corrugations shall be field jointed with corrugated locking bands. This includes pipe with helical corrugations, which has reformed circumferential corrugations on the ends. The locking bands shall securely fit into at least one full circumferential corrugation on each of the pipe ends being coupled. The minimum width of the corrugated locking bands shall be as shown below for the corrugation which corresponds to the end circumferential corrugations on the pipes being joined:

10 1/2 inches wide for 2 2/3 inches x 1/2-inch corrugations.

12 inches wide for 3 inches x 1 inch or 5 inches x 1-inch corrugations.

Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join a new pipe to an existing pipe, which was

installed with no circumferential end corrugations. In this event, pipe furnished with helical corrugations at the ends shall be field jointed with either helically corrugated bands or with bands with projections or dimples. The minimum width of helically corrugated bands shall conform to the following:

12 inches wide for pipe diameters up to and including 72 inches.

14 inches wide for 1 inch deep helical end corrugations.

Bands with projections shall have circumferential rows of projections with one projection for each corrugation. The width of bands with projections shall be not less than the following:

12 inches wide for pipe diameters up to and including 72 inches.

The bands shall have 2 circumferential rows of projections.

16 1/4 inches wide for pipe diameters of 78 inches and greater.

The bands shall have 4 circumferential rows of projections.

Unless otherwise indicated, all bolts for coupling bands shall be 1/2-inch diameter. Bands 12 inches wide or less shall have a minimum of 2 bolts and bands greater than 12 inches wide shall have a minimum of 3 bolts.

Galvanized bolts may be hot dip galvanized conforming to AASHTO M 232, mechanically galvanized to provide the same requirements as AASHTO M 232 or electro-galvanized per ASTM A 164 Type RS.

5. Additional Coatings or Linings

a. Bituminous Coated

Bituminous Coated pipe or pipe arch shall be as indicated both as to base metal and fabrication and in addition shall be coated inside and out with a bituminous coating which shall meet the performance requirements set forth herein. The bituminous coating shall be 99.5 percent soluble in carbon bisulphide. The pipe shall be uniformly coated inside and out to a minimum thickness of 0.05 inch, measured on the crests of the corrugations.

The bituminous coating shall adhere to the metal tenaciously, shall not chip off in handling and shall protect the pipe from deterioration as evidenced by samples prepared from the coating material successfully meeting the Shock Test and Flow Test in accordance with Test Method Tex-522-C.

b. Paved Invert

Where a Paved Invert is indicated, the pipe or pipe arch, in addition to the fully coated treatment described above, shall receive additional bituminous material of the same specification as above, applied to the bottom quarter of the circumference to form a smooth pavement with a minimum thickness of 1/8 inch above the crests of the corrugations.

c. Cement Lined

(1) General

Except as modified herein, pipe shall conform to AASHTO M 36 for lock seam or welded helically corrugated steel pipe. Pipe shall be of full circle and shall be fabricated with two annular corrugations for purposes of joining pipes together with band couplers. Lock seams shall develop the seam strength as required in Table 3 of AASHTO M 36. Concrete lining shall conform to the following:

Composition

Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregated lining.

Cement

Portland Cement shall conform to AASHTO M 85.

Aggregate

Aggregates shall conform to AASHTO M 6 except that the requirements for gradation and uniformity of gradation shall not apply.

Mixture

The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogenous concrete mixture of such quality that the pipe will conform to the design requirements indicated. In no case, however, shall the proportions of Portland Cement, blended cement or Portland Cement plus pozzolanic admixture be less than 470 lb/cu. yd of concrete.

Thickness

The lining shall have a minimum thickness of 1/8 inch above the crest of the corrugations.

Lining Procedures

The lining shall be plant applied by a machine traveling through a stationary pipe. The rate of travel of the machine and the rate of concrete placement shall be mechanically regulated so as to produce a homogenous nonsegregated lining throughout.

Surface Finish

The lining machine shall also mechanically trowel the

concrete lining as the unit moves through the pipe.

Certification

Furnish manufacturer's standard certification of compliance upon request of the Owner/Developer.

Joints

Pipe shall be joined together with coupling bands made from steel sheets to an indicated thickness of 0.064 inch (12 ga.). Coupling bands shall be formed with two corrugations that are spaced to provide seating in the third corrugation of each pipe end without creating more than 1/2 inch \pm annular space between pipe ends when joined together.

Bands shall be drawn together by two 1/2 inch galvanized bolts through the use of a bar and strap suitably welded to the band.

When O-ring gaskets are indicated they shall be placed in the first corrugation of each pipe and shall be compressed by tightening the coupling band. Rubber O-ring gaskets shall conform to Section 5.9, ASTM C 361.

(2) Causes for Rejection

Pipe shall be subject to rejection on account of failure to conform to any of the requirements. Individual sections of pipe may be rejected because of any of the following:

Damaged ends, where such damage would prevent making satisfactory joint.

Defects that indicate poor workmanship and could not be easily repaired in the field.

Severe dents or bends in the metal itself.

If concrete lining is broken out, pipe may be rejected or at the discretion of the Engineer or designated representative, repaired in the field in accordance with the manufacturer's recommendation.

Hairline cracks or contraction cracks in the concrete lining are to be expected and does not constitute cause for rejection.

d. Fiber Bonded

Where fiber bonded pipe is indicated, the pipe or pipe arch shall be formed from sheets whose base metal shall be as indicated. In addition, the sheets shall have been coated with a layer of fibers, applied in sheet form by pressing them into a molten metallic

bonding. If a paved invert is indicated it shall be in accordance with the procedure outlined above. The test for spelter coating above is waived for fiber bonded pipe.

6. Slotted Drain Storm Sewers

The pipes for the slotted drain and slotted drain outfall shall be helically corrugated, lock seam or welded seam pipe. Materials and fabrication shall be in accordance with the above. The metal thickness shall be a minimum 16 gage.

The chimney assemblies shall be constructed of 3/16 inch welded plate or machine formed 14 gage galvanized steel sheets. The height of the chimney required shall be as indicated. Metal for the welded plate slot shall meet the requirements of ASTM A 36 and the completed plate slot shall be galvanized after fabrication in accordance with ASTM A 123.

Weld areas and the heat affected zones where the slot is welded to the corrugated pipe shall be thoroughly cleaned and painted with a good quality asphalt base aluminum paint.

7. Mortar

Mortar shall be composed of 1 part Type I Portland Cement and 2 parts clean, sharp mortar sand suitably graded for the purpose and conforming in other respects to the provisions for fine aggregate of Item No. 403, "Concrete for Structures". Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight of the total dry mix.

510.3 Construction Methods

(1) General

Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected. Clearing the site shall conform to Item No. 102, "Clearing and Grubbing". Maintenance of environmental quality protection shall comply with all requirements of the Contract and Item No. 601, "Salvaging and Placing Topsoil".

The Contractor shall conduct his Work such that a reasonable minimum of disturbance to existing utilities will result. Particular care shall be exercised to avoid the cutting or breakage of all existing utilities. If at any time the Contractor damages the utilities in place through his operations, the Contractor shall immediately notify the owner of the utility to make the necessary repairs. When active wastewater sewer lines are cut in the trenching operations, temporary flumes shall be provided across the trench while open and the lines shall be restored when the backfilling has progressed to the original bedding lines of the sewer so cut.

The Contractor shall inform utility owners sufficiently in advance of the Contractor's operations to enable such utility owners to reroute, provide temporary detours or to make other adjustments to utility lines in order that the

Contractor may proceed with his Work with a minimum of delay and expense. The Contractor shall cooperate with all utility owners concerned in effecting any utility adjustments necessary and shall not hold the Owner/Developer liable for any expense due to delay or additional Work because of conflicts arising from existing utilities.

The Contractor shall do all trenching in accordance with the provisions and the directions of the Engineer or designated representative as to the amount of trench left unfilled at any time. All excavation and backfilling shall be accomplished as indicated and in compliance with State Statutes.

Where excavation for a pipeline is required in an existing City street, a street cut permit is required and control of traffic shall be as indicated in accordance with the Texas Manual on Uniform Traffic Control Devices.

Wherever existing utility branch connections, sewers, drains, conduits, ducts, pipes or structures present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impractical, a deviation from line and grade will be ordered by the Engineer or designated representative and the change shall be made in the manner directed.

Adequate temporary support, protection and maintenance of all underground and surface utility structures, drains, sewers and other obstructions encountered in the progress of the Work shall be furnished by the Contractor, at his expense and as approved by the Engineer or designated representative.

Where traffic must cross open trenches, the Contractor shall provide suitable bridges. For trenches less than 2 feet in width, sheet steel plates having a minimum thickness of 1/2 inch shall be used. For trenches up to 4 feet in width, sheet steel plates having a minimum thickness of 3/4 inches shall be used. In all cases, the plates shall overlay the top of the trench a minimum of 18 inches on both sides and be secured by asphalt. Adequate provisions shall be made for the flow of sewers; drains and watercourses encountered during construction and any structures, which may have been disturbed, shall be satisfactorily restored upon completion of Work.

When rainfall or runoff is occurring or is forecast by the U.S. Weather Service, the Contractor shall not perform or attempt any excavation or other earth moving Work in or near the flood plain of any stream or watercourse or on slopes subject to erosion or runoff, unless given specific approval by the Engineer or designated representative. When such conditions delay the Work, an extension of time will be allowed in accordance with conditions contained in the Contract.

(2) Water Line/New Wastewater Line Separation

Installation of new water or wastewater lines shall conform to the following:

Where feasible, water and wastewater lines shall be no closer to each other than 9 feet between outside diameters in all directions and shall be in separate trenches.

If the 9 foot separation cannot be achieved, any portion of a new gravity wastewater line within 9 feet in any direction (between OD's) of a potable water line, shall be in a separate trench and constructed of material (pipe and joints) with a rating of 150 psi minimum.

If the lines are parallel, they shall not be closer than 4 feet horizontally or 2 feet vertically between OD's with the wastewater lower than the water line. If the lines cross, they may be no closer than 6 inches vertically between OD's with the sewer below the water line and one standard 20 foot joint of 150 psi rated wastewater pipe shall be centered at the point of crossing the water line.

Unless wastewater manholes and the connection to the sewer can be made completely watertight and tested for no leakage, they must be installed so as to provide a minimum of 9 feet of horizontal clearance from an existing or proposed water line.

(3) Utility and Storm Sewer Crossings

When the Contractor installs a pipe that crosses under a utility structure or storm sewer and the top of the pipe is within 18 inches of the bottom of the utility structure, the pipe shall be encased as specified in Item No. 505, "Concrete Encasement and Encasement Pipe", for a distance of at least 1 foot on either side of the ditch line of the utility structure or the storm sewer. Unless otherwise specified by the Engineer or designated representative, concrete encasement will not be required for ductile iron, AWWA C-900 (SDR-18) 150 psi rated PVC in sizes to 12 inch, or AWWA C-905 (SDR-25) 165 psi rated PVC in sizes larger than 12 inches. When the Contractor installs a pipe that crosses over a utility structure or storm sewer and the top of the utility structure or storm sewer is within 18 inches of the bottom of the pipe, the pipe shall be either ductile iron, AWWA C-900 (SDR-18) 150 psi rated PVC in sizes to 12 inch, or AWWA C-905 (SDR-25) 165 psi rated PVC in sizes larger than 12 inches, unless otherwise specified by the Engineer or designated representative..

Where trenches wider than 12 inches cross under existing wastewater lines, the sewer lines shall be replaced with one 20 foot joint of ductile iron, AWWA C-900 (SDR-18) 150 psi rated PVC in sizes to 12 inch, or AWWA C-905 (SDR-25) 165 psi rated PVC in sizes larger than 12 inches, centered over the trench.

(4) Trench Excavation

Underground piped utilities shall be constructed in an open cut in accordance with Federal regulations, applicable State Statutes and conforming to Item No. 509, "Trench Safety Systems" and with a trench width and depth described below. When pipe is to be constructed in fill above the natural ground, Contractor shall construct embankment to an elevation not less than one foot above the top of the pipe, after which trench is to be excavated. Required vertical sides shall be sheeted and braced as indicated to maintain the sides of the required vertical excavation throughout the construction period. Adequacy of the design of sheeting and bracing shall be the responsibility of the Contractor's design professional. The Contractor shall be responsible for installation as indicated.

After the pipe has been laid and the backfill placed and compacted to 12 inches above the top of the pipe, any sheeting, shoring and bracing required may be removed with special care to insure that the pipe is not disturbed. As each piece of sheeting is removed, the space left by its removal must be thoroughly filled and compacted with suitable material and provisions made to prevent the sides of the trench from caving until the backfill has been completed. Any sheeting left in place will not be paid for and shall be considered subsidiary to the pipe item bid.

(5) Trench Width

Trenches for water and wastewater lines shall have a clear width on each side beyond the outside surfaces of the pipe bell or coupling of not less than 6 inches nor more than 12 inches.

Trenches for Storm Sewers up to 42 inches shall have a width of 1 foot on each side beyond the outside surfaces of the pipe. Pipes more than 42 inches shall have a trench width of 18 inches on each side beyond the outside surfaces of the pipe.

If the trench width within the pipe zone exceeds widths above, the entire pipe zone shall be refilled with approved backfill material, thoroughly compacted to a minimum of 95 percent of maximum density as determined by TxDOT Test Method Tex-114-E and then re-excavated to the proper grade and dimensions. Excavation along curves and bends shall be so oriented that the trench and pipe are approximately centered on the centerline of the curve, using short lengths of pipe and/or bend fittings if necessary.

For all utilities to be constructed in areas to be filled above natural ground, the embankment shall first be constructed to an elevation not less than 1 foot above the top of the utility after which excavation for the utility shall be made.

(6) Trench Depth and Depth of Cover

All pipe and in-line appurtenances shall be laid to the grades indicated. The depth of cover shall be measured from the established finish grade, natural ground surface (if natural grade is to remain), subgrade for staged construction, street or other permanent surface to the top or uppermost projection of the pipe.

(a) Where not otherwise indicated, all water piping shall be laid to the following minimum depths:

1. Water piping installed in unpaved areas shall be laid with at least 42 inches of cover.
2. Water piping installed in existing streets, roads or other traffic areas shall be laid with at least 48 inches of cover below finish grade.
3. Unless approved by the Engineer or designated representative, installation of water piping in proposed new streets or traffic areas will not be permitted until paving and drainage plans have been approved and the roadway traffic areas excavated to the specified or standard paving subgrade, with all parkways and sidewalk areas

graded according to any applicable provisions of the drainage plans or sloped upward from the curb line to the right of way line at a minimum slope of 1/4 inch per foot. Piping and appurtenances installed in such proposed streets shall be laid with at least 30 inches of cover below the actual subgrade.

- (b) Where not otherwise indicated, all wastewater piping shall be laid to the following minimum depths:
1. Wastewater piping installed in unpaved areas shall be laid with at least 48 inches of cover.
 2. Wastewater piping installed in existing streets, roads or other traffic areas shall be laid with at least 66 inches of cover.
 3. Wastewater piping installed in proposed streets or traffic areas shall be laid with at least 48 inches of cover below the actual subgrade.

(7) Classification of Excavation

Excavation will not be considered or paid for as a separate item of Work, therefore excavated material will not be classified as to type or measured as to quantity. Full payment for all excavation required for the construction shall be included in the various unit or lump sum Contract prices for the various items of Work installed, complete in place. No extra compensation, special treatment or other consideration will be allowed due to rock, pavement, caving, sheeting and bracing, falling or rising water, working under and in the proximity of trees or any other handicaps to excavation.

(8) Dewatering Excavation

Underground piped utilities shall not be constructed or the pipe laid in the presence of water. All water shall be removed from the excavation prior to the pipe placing operation to insure a dry firm granular bed on which to place the underground piped utilities and shall be maintained in such unwatered condition until all concrete and mortar is set. Removal of water may be accomplished by bailing, pumping or by a well-point installation as conditions warrant.

In the event that the excavation cannot be dewatered to the point where the pipe bedding is free of mud, a seal shall be used in the bottom of the excavation. Such seal shall consist of Class B concrete, conforming to Item No. 403, "Concrete for Structures", with a minimum depth of 3 inches.

(9) Trench Conditions

Before attempting to lay pipe, all water, slush, debris, loose material, etc., encountered in the trench must be pumped or bailed out and the trench must be kept clean and dry while the pipe is laid and backfilled. Where needed, sump pits shall be dug adjoining the trench and pumped as necessary to keep the excavation dewatered.

Backfilling shall closely follow pipe laying so that no pipe is left exposed and unattended after initial assembly. All open ends, outlets or other openings in the

pipe shall be protected from damage and shall be properly plugged and blocked watertight to prevent the entrance of trench water, dirt, etc. The interior of the pipeline shall at all times be kept clean, dry and unobstructed.

Where the soil encountered at established footing grade is a quicksand, saturated or unstable material, the following procedure shall be used unless other methods are indicated:

All unstable soils shall be removed to a depth of a minimum 2 feet below bottom of piped utility or as required to stabilize the trench foundation. Such excavation shall be carried out for the entire trench width.

All unstable soil so removed shall be replaced with a concrete seal, foundation rock or coarse aggregate materials placed across the entire trench width in uniform layers not to exceed 6 inches, loose measure and compacted by mechanical tamping or other means which shall provide a stable foundation for the utility.

Forms, sheathing and bracing, pumping, additional excavation and backfill required in unstable trench conditions shall be subsidiary to pipe bid.

(10) Blasting

All blasting shall conform to the provisions of the Contract and applicable local and state codes.

(11) Removing Old Structures

When out of service masonry structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the trench and to a depth of 1 foot below the bottom of the trench. When abandoned inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new sewers, such manholes and inlets within the construction limits shall be removed completely to a depth 1 foot below the bottom of the trench. In each instance, the bottom of the trench shall be restored to grade by backfilling and compacting by the methods provided above. Where the trench cuts through storm or wastewater sewers which are known to be abandoned, these sewers shall be cut flush with the sides of the trench and blocked with a concrete plug in a manner satisfactory to the Engineer or designated representative. When old structures are encountered, which are not visible from the existing surface and are still in service, they shall be protected and adjusted as required to the finished grade.

(12) Lines and Grades

Grades, lines and levels shall conform to the Drawings. Any damage to the above by the Contractor shall be re-established at the Contractor's expense. The Contractor shall furnish copies of all field notes and "cut sheets" to the City.

The location of the lines and grades indicated may be changed only by direction of the Engineer or designated representative and it is understood that the Contractor will be paid on the basis of his unit Contract prices bid for such Work

actually performed and shall make no claim for damages or loss of anticipated profits due to the change of location or grade.

The Contractor shall furnish, at his expense, all necessary batter boards or electronic devices for controlling the Work. Batter boards shall be of adequate size and material and shall be supported substantially. The boards and all location stakes must be protected from possible damage or change of location. The Contractor shall furnish good, sound twilled lines for use in achieving lines and grades and the necessary plummets and graduated poles.

The Contractor shall submit to the Engineer or designated representative at least 6 copies of any layout Drawings from the pipe manufacturer for review and approval. The Contractor shall submit the layout Drawings at least 30 days in advance of any actual construction of the project. The Engineer or designated representative will forward all comments of the review to the Contractor for revision. Revisions shall be made and forwarded to the Engineer or designated representative for his acceptance. Prior to commencement of the Project, reviewed layout Drawings will be sent to the Contractor marked for construction.

Should the Contractor's procedures not produce a finished pipe placed to grade and alignment, the pipe shall be removed and relayed and the Contractor's procedures modified to the satisfaction of the Engineer or designated representative. No additional compensation shall be paid for the removal and relaying of pipe required above.

(13) Surplus Excavated Materials

Excess material or material which cannot be made suitable for use in embankments will be declared surplus by the Engineer or designated representative and shall become the property of the Contractor to dispose of off site at a permitted fill site, without liability to the City or any individual. Such surplus material shall be removed from the Work site promptly following the completion of the portion of the utility involved.

(14) Pipe Bedding Envelope

Pipe shall be installed in a continuous bedding envelope of the type shown on the drawings or as described herein. The envelope shall extend the full trench width, to a depth of 6 inches below the pipe and shall rise at least to the top of storm water pipe and to 12 inches above water and wastewater pipe.

(a) Standard Bedding Materials

USE / PIPE MATERIAL	Cement Stabilized Backfill	Natural or Mf'd Sand	Pea Gravel	PIPE BEDDING STONE			
				Uncrushed Gravel	Crushed Gravel	Crushed Stone	Stone Screenings
WATER							
Welded Steel	X					X	
Service Tubing 3/4" to 2-1/2"		X	X				X
WATER and WASTEWATER							
Up to 15 Inch ID		X	X	X	X	X	X
Larger Than 15 Inch ID			X	X	X	X	
STORMWATER							
Concrete		X	X	X	X	X	X
Metal		X	X	X			X

- (b) General requirements and limitations governing bedding selection.
- (1) Crushed gravel or crushed stone shall not be used with polyethylene tubing or polyethylene film wrap.
 - (2) Uncrushed gravel may be used with polyethylene film wrap in trenches up to 6 feet deep and in deeper trenches where ample trench width, a tremmie, or conditions will allow controlled placement of the gravel without damaging the polyethylene wrap.
 - (3) Bedding shall be placed in lifts not exceeding 8 inches loose thickness and compacted thoroughly to provide uniform support for the pipe barrel and to fill all voids around the pipe.
 - (4) Pea Gravel or bedding stone shall be used in blasted trenches.

- (c) Requirements to prevent particle migration.

Bedding material shall be compatible with the materials in the trench bottom, walls and backfill so that particle migration from, into or through the bedding is minimized. The Engineer or Designated representative may require one or more of the following measures to minimize particle migration: use of impervious cut-off collars; selected bedding materials, such as pea gravel or bedding stone mixed with sand; filter fabric envelopment of the bedding; cement stabilized backfill; or other approved materials or methods. Measures to minimize particle migration will be shown on the Drawings or designated by the Engineer or designated representative, and, unless provisions for payment are provided in the contract documents, the cost of these measures shall be agreed by change order. The following limitations shall apply.

- (1) Sand, alone, shall not be used in watercourses, in trenches where groundwater is present, or in trenches with grades greater than 5 percent.
- (2) Pea gravel or bedding stone, alone, shall not be used in the street right-of-way within 5 feet of subgrade elevation in trenches that are 3 feet or wider.
- (3) Pea gravel or bedding stone, alone, shall not be used where the trench bottom, sides, or backfill is composed of non-cementitious, silty or sandy soils having plasticity indices less than 20, as determined by the Engineer or designated representative.

(15) Laying Pipe

No pipe shall be installed in the trench until excavation has been completed, the bottom of the trench graded and the trench completed as indicated.

Laying of corrugated metal pipes on the prepared foundation shall be started at the outlet end with the separate sections firmly joined together, with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints, which is not protected by galvanizing, shall be coated with suitable asphaltum paint. Proper facilities shall be provided for hoisting and lowering the sections of pipe into the trench without damaging the pipe or disturbing the prepared foundation and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying or damage, shall be taken up and re-laid without extra compensation.

Multiple installations of corrugated pipe or arches shall be laid with the centerlines of individual barrels parallel. When not otherwise indicated, clear distances of 2 feet between outer surfaces of adjacent pipes shall be maintained.

No debris shall remain in the drainways or drainage structures.

All recommendations of the manufacturer shall be carefully observed during handling and installation of each material. Unless otherwise indicated, all materials shall be delivered to the project by the manufacturer or agent and unloaded as directed by the Contractor. Each piece shall be placed facing the proper direction near to where it will be installed.

The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times and stored in a manner that will protect them from damage. Stockpiled materials shall be stacked so as to minimize entrance of foreign matter.

The interior of all pipeline components shall be clean, dry and unobstructed when installed.

Piping materials shall not be skidded or rolled against other pipe, etc. and under no circumstances shall pipe, fittings or other accessories be dropped or jolted.

During handling and placement, materials shall be carefully observed and inspected and any damaged, defective or unsound materials shall be marked,

rejected and removed from the job site. Minor damage shall be marked and repaired in a manner satisfactory to the Engineering or designated representative. Joints, which have been placed, but not joined, backfilled, etc., shall be protected in a manner satisfactory to the Engineer or designated representative.

(16) Assembling of Pipe

Angular spacing of all joints shall meet the manufacturer's recommendations for the pipe and accessories being used. Side outlets shall be rotated so that the operating stems of valves shall be vertical when the valves are installed. Pressure pipe shall be laid with bell ends facing the direction of pipe installation. Pipe end bells shall be placed upgrade for all wastewater lines.

Orientation marks, when applicable, shall be in their proper position before pipe is seated.

Before joining any pipe, all foreign matter, lumps, blisters, excess coal tar coating, oil or grease shall be removed from the ends of each pipe and the pipe ends shall then be wire brushed and wiped clean and dry. Pipe ends shall be kept clean until joints are made.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing or other materials shall be placed in the pipe.

(17) Joints

(a) Mortar (Storm Drain joints only)

Pipe ends shall be clean, free of asphalt or other contaminants, which will inhibit the bond of the mortar to the pipe. The pipe ends shall be moistened immediately prior to placing the mortar in the joint.

b) Cold Applied Preformed Plastic Gaskets (Storm Drain joints only)

The pipe ends shall be clean and the joint material applied to the dry pipe. In cold weather, the joint material shall be heated to facilitate the seal of the joint.

(c) O-Ring and Push-on Joints

Just before making a joint the ends of the pipe shall be clean, dry, free of any foreign matter, lump blisters, excessive coal tar coating and grease or oil and shall be wire brushed. The gasket and the inside surface of the bell shall be lubricated with a light film of soft vegetable soap compound (Flax Soap) to facilitate telescoping the joints. The rubber gasket if not factory installed shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the groove. The spigot shall be centered in the bell, the pipe pushed home uniformly and brought into true alignment. Bedding material shall be placed and tamped against pipe to secure the joint. Care should be taken to prevent dirt or foreign matter from entering the joint space.

(d) Bolted Joints

All flanged, mechanical or other bolted joints shall be joined with nuts and bolts and be coated as indicated above in Iron Pipe.

(18) Pressure Pipe Laying

(a) Grout for Concrete Steel Cylinder Pipe (CSC) and Welded Steel Pipe

Aggregate, cement, etc., shall be as indicated in "Mortar" herein.

Grout shall be poured into the recess between the bell and spigot on the outside of the pipe and contained by a joint wrapper ("diaper") recommended by the pipe manufacturer. The wrapper shall have a minimum width of 7 inches for 30 inch and smaller and 9 inches for larger pipe, secured to the pipe by "Band Iron" steel straps. The grout shall be poured in one continuous operation in such manner that after shrinkage and curing the joint recess shall be completely filled.

Mortar for the inside recess shall be of the consistency of plaster. The inside recess between the bell and spigot shall be filled with mortar after the pipe joint on either side of the recess has been backfilled and well tamped with no less than one pipe joint installed ahead of the pipe forming the recess. The mortar shall completely fill the recess and shall be trowelled and packed into place and finished off smooth with the inside of the pipe.

The Contractor shall inspect the joint after the mortar has set and make repairs of any pockets, cracks or other defects caused by shrinkage to the satisfaction of the Engineer or designated representative. The inside surface shall be cleared of any mortar droppings, cement, water, slurry, etc., before they have become set and shall be cleared of any other foreign matter. The inside surface of the pipe shall be left clean and smooth.

Pipe shall be handled at all times with wide non abrasive slings, belts or other equipment designed to prevent damage to the coating and all such equipment shall be kept in such repair that its continued use is not injurious to the coating. The use of tongs, bare pinch-bars, chain slings, rope slings without canvas covers, canvas or composition belt slings with protruding rivets, pipe hooks without proper padding or any other handling equipment, which the Engineer or designated representative deems to be injurious to the coating, shall not be permitted. The spacing of pipe supports required to handle the pipe shall be adequate to prevent cracking or damage to the cement mortar lining.

(19) Placing Pipe in Tunnels and Encasements

Piping installed as a carrier pipe in a tunnel, encasement pipe, etc., shall have uniform alignment, grade, bearing and conform to the reviewed Shop Drawings. All necessary casing spacers, bedding material, grout cradle or paving, bracing, blocking, etc., as stipulated by the Contract or as may be required to provide and

maintain the required pipe alignment and grade, shall be provided by the Contractor at no cost except as provided by the Bid Items. This shall include casing spacers acceptable to the City Round Rock attached to the carrier pipe in accordance with the manufacturer's recommendations. The insertion pushing forces shall not exceed the pipe manufacturer's recommendation. Such carrier piping shall have flexible bolted or gasketed push-on joints or Concrete Steel Cylinder pipe installed as follows:

(a) 21 Inch Pipe and Smaller

Prior to placing the pipe in the tunnel, the inside joint recess at the bell shall be buttered with cement mortar.

After the joint is engaged, the excess mortar shall be smoothed by pulling a tight fitting swab through the joint. Cement mortar protection shall then be placed in the normal manner to the exterior of the joint and allowed to harden sufficiently to avoid dislodgment during installation. If time is of the essence, a quick setting compound may be used.

(b) 24 Inch Pipe and Larger

Each length of pipe shall be pushed into the tunnel as single units. A flexible mastic sealer shall be applied to the exterior of the joint prior to joint engagement. The surfaces receiving the mastic sealer shall be cleaned and primed in accordance with the manufacturer's recommendation. Sufficient quantities of the mastic sealer shall be applied to assure complete protection of all steel in the joint area. The interior of the joint shall be filled with cement mortar in the normal manner after the pipe is in its final position within the tunnel.

(20) Temporary Pipe Plugs, Caps, Bulkheads and Trench Caps

Temporary plugs, caps or plywood bulkheads shall be installed to close all openings of the pipe and fittings when pipeline construction is not in progress.

All temporary end plugs or caps shall be secured to the pipe as provided under Item No. 507, "Bulkheads".

Trench caps shall be reinforced Class D concrete as indicated.

(21) Corrosion Control

(a) Protective Covering

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other iron or steel components buried and in contact with earth or backfill shall be wrapped with 8-mil (minimum) polyethylene film meeting ANSI/AWWA C-105 to provide a continuous wrap.

(22) Pipe Anchorage, Support and Protection

Pressure pipeline tees, plugs, caps and bends 22-1/2 degrees and more and other bends as directed shall be securely anchored by suitable concrete thrust blocking or by approved metal harness. Unless otherwise indicated, on 24 inch or

larger piping, all bends greater than 11 1/4 degrees shall be anchored as described herein.

Storm sewers on steep grades shall be lugged as indicated.

(a) Concrete Thrust Blocking

Concrete for use as reaction or thrust blocking shall be Class B conforming to Item No. 403, "Concrete for Structures".

Concrete blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as indicated or directed by the Engineer or designated representative. The blocking shall, unless otherwise indicated, be so placed that the pipe, fittings and joints will be accessible for repair.

The trench shall be excavated at least 6 inches outside the outermost projections of the pipe or appurtenance and the trench walls shaped or undercut according to the detail Drawings or as required to provide adequate space and bearing area for the concrete.

The pipe and fittings shall be adequately weighted and laterally braced to prevent floating, shifting or straining of the pipeline while the concrete is being placed and taking initial set. The Contractor shall be solely responsible for the sufficiency of such restraints.

(b) Metal Thrust Restraint

Fabricated thrust restraint systems such as those described below may be approved for use instead of concrete blocking. To obtain approval, the project Drawings must include sufficient drawings, notes, schedules, etc., to assure that the proposed restraints as installed will be adequate to prevent undesirable movement of the piping components. Such restraint systems may only be used where and as specifically detailed and scheduled on approved Project Drawings.

1. Thrust Harness

A metal thrust harness of tie rods, pipe clamps or lugs, turnbuckles, etc., may be approved. All carbon steel components of such systems, including nuts and washers, shall be hot-dip galvanized; all other members shall be cast ductile iron. After installation, the entire assembly shall be wrapped with 8-mil polyethylene film, overlapped and taped in place with duct tape to form a continuous protective wrap.

2. Restrained Joints

Piping or fitting systems utilizing integral mechanically restrained joints may be approved. All components of such systems shall be standard manufactured products fabricated from cast ductile iron, hot-dip galvanized steel, brass or other corrosion resistant materials and the entire assembly shall be protected with a continuous film wrap as described for 1. above.

Location, configuration and description of such products shall be specifically detailed on the Drawings. (Add-on attachments such as retainer glands, all-thread rods, etc., are not acceptable.)

(c) Concrete Encasement, Cradles, Caps and Seals

When trench foundation is excessively wet or unstable or installation of water or wastewater pipe will result in less than 30 inches of cover, Contractor shall notify the Engineer or designated representative. The Engineer or designated representative may require Contractor to install a concrete seal, cradle, cap, encasement or other appropriate action.

All concrete cap, etc., shall be continuous and begin and end as specified. Concrete cap, cradle and encasement shall conform to the Drawings. The pipe shall be well secured to prevent shifting or flotation while the concrete is being placed.

(d) Anchorage Bulkheads

Concrete bulkheads keyed into the undisturbed earth shall be placed as indicated to support and anchor the pipe and/or backfill against end thrust, slippage on slopes, etc. Concrete material and placement shall be Class A, Item No. 403, "Concrete for Structures".

(e) Trench Caps, Concrete Rip-Rap and Shaped Retards

Where called for by the Contract or as directed by the Engineer or designated representative, concrete trench caps, concrete rip-rap and/or shaped retards shall be placed as detailed by the Drawings as protection against erosion. Concrete material and placement shall be Class B, Item No. 403, "Concrete for Structures".

(23) Wastewater Connections

(a) Connections to Mains 12 Inches and Smaller

All branch connections of new main lines shall be made by use of manholes.

Service stubs shall be installed as indicated. Minimum grade shall be 1 percent downward to main and minimum cover shall be 4 1/2 feet at the curb. Standard plugs shall be installed in the dead end before backfilling.

Where a service connection to a main 12 inches or smaller is indicated, a sanitary tee or double wye shall be installed.

Where a service connection to a main 15 inches or larger is indicated, a field tap may be made with the pipes installed crown to crown. The tap should be made conforming to the pipe manufacturer's recommendations with the Engineer or designated representative's approval.

Where not otherwise indicated, (wastewater) service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

(b) Connections to the Existing System

Unless otherwise specified by the Engineer or designated representative, all connections made to existing mains shall be made at manholes with the crown of the inlet pipe installed at the same elevation as the crown of the existing pipe. Service stubs installed on the existing system shall be installed by use of tapping saddles unless otherwise approved by the Engineer or designated representative. Extreme care shall be exercised to prevent material from depositing in the existing pipe as the taps are being made.

When connections to existing mains are made, a temporary plug approved by the Engineer or designated representative must be installed downstream in the manhole to prevent water and debris from entering the existing system before Final Completion. These plugs shall be removed after the castings are adjusted to finish grade or prior to Final Completion.

(24) Water System Connections

The Contractor shall, at his expense, make all necessary connections of new piping or accessories to the existing water system. To minimize any inconvenience from outages, the Contractor shall schedule all such connections in advance and such schedule must be approved by the Engineer or designated representative before beginning any Work.

(a) Shutoffs

The City will make all shutoffs on existing water mains. The Contractor shall be required to notify the Engineer or designated representative on the job at least 72 hours prior to the desired time for any shutoff. The Engineer or designated representative will notify any affected utility customers at least 24 hours prior to the shutoff. The Water Utility will make the shutoff after ensuring that all appropriate measures have been taken to protect the water system, customers and employees.

The City will operate all valves to fill existing mains. Where a newly constructed main has not been placed in service and has only one connection to the public water supply, the Contractor may operate one valve to fill the main after approval has been obtained from the Water Utility. The operation of the valve is to be conducted under the immediate supervision of the Engineer or designated representative.

Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

(b) Wet Connections to Existing Water System

The Contractor shall make all wet connections called for by the Contract or required to complete the Work. Two connections to an existing line performed during the same shutout, at the same time and at a distance less than 50 linear feet apart, will be considered one wet connection. Two connections to an existing line performed during the same shutout, at the

same time and at a distance equal to, or greater than 50 linear feet will be considered two wet connections. A wet connection shall include draining and cutting into existing piping and connecting a new pipeline or other extension into the existing pressure piping, forming an addition to the water transmission and distribution network.

The Contract price for wet connections shall be full payment for all necessary shutoffs, excavation, removing plugs and fittings, pumping water to drain the lines, cutting in new fittings, blocking and anchoring piping, bedding and backfilling, placing the lines and service and all site cleanup.

No water containing detectable amounts of chlorine may be drained, released or discharged until specific planning and appropriate preparations to handle, dilute and dispose of such chlorinated water are approved in advance by the City and the disposal operations will be witnessed by an authorized representative from the City.

(c) Pressure Taps to Existing Water System

The Contractor shall make all pressure taps called for by the Contract Documents or required to complete the Work. A pressure tap shall consist of connecting new piping to the existing water system by drilling into the existing pipe while it is carrying water under normal pressure without taking the existing piping out of service.

Unless otherwise provided by the Contract, the Contractor shall, at his expense, perform all necessary excavation, furnish and install the tapping sleeve, valve and accessories, provide the tapping machine, drill the tap and shall block, anchor and backfill the piping, valve and all accessories, place the new piping in service and perform all site cleanup. When the City makes the tap, City forces are not obligated or expected to perform any Work except to provide tapping machine and drill the actual hole. If City crews are to make the tap, fiscal arrangements must be made in advance at the Taps Office, Waller Creek Center, 625 East 10th Street.

If a private Contractor makes the tap, a W-WW Inspector must be present. "Size on size" taps will not be permitted, unless made by use of an approved full circle gasket tapping sleeve. Concrete blocking shall be placed behind and under all tap sleeves 24 hours prior to making the wet tap.

(d) Service Connections

Service connection taps into PVC or AC pipe or into CI or DI pipe 12 inches or smaller shall be made using either a service clamp or saddle or a tapping sleeve as recommended by the pipe manufacturer and as approved by the Engineer or designated representative. Direct tapping of these pipes will not be permitted.

All water service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

Precautions should be taken to ensure that the tapping saddle or sleeve is placed on the pipe straight to prevent any binding or deformation of the PVC pipe. The mounting chain or U-bolt strap must be tight.

Tapping shall be performed with a sharp shell type cutter so designed that it will smoothly penetrate heavy walled PVC DR14 and 200 psi AC and will retain and extract the coupon from the pipe.

(25) Backfilling

(a) General

Special emphasis is placed upon the need to obtain uniform density throughout the backfill material. The maximum lift of backfill shall be determined by the compaction equipment selected and in no case shall it exceed 18 inches, loose measurement.

No heavy equipment, which might damage pipe, will be allowed over the pipe until sufficient cover has been placed and compacted. All internal pipe bracing installed or recommended by the manufacturer shall be kept in place until the pipe bedding and trench backfill have been completed over the braced pipe section. Testing of the completed backfill in streets and under and around structures shall meet the specified density requirements. Initial testing shall not be at Contractor's expense and shall conform to the "General Conditions."

(b) General Corrugated Metal Pipe

After the corrugated metal pipe structure has been completely assembled on the proper line and grade and headwalls constructed where indicated; selected material free from rocks over 8 inches in size from excavation or borrow, as approved by the Engineer or designated representative, shall be placed along both sides of the completed structures equally, in uniform layers not exceeding 6 inches in depth (loose measurement), sprinkled if required and thoroughly compacted between adjacent structures and between the structures and the sides of the trench.

Backfill material shall be compacted to the same density requirements as indicated for the adjoining sections of embankment in accordance with the governing specifications thereof. Above the 3/4 point of the structure, the fill shall be placed uniformly on each side of the pipe in layers not to exceed 12 inches, loose measure.

Prior to adding each new layer of loose backfill material, until a minimum of 12 inches of cover is obtained over the crown of the pipe, an inspection will be made of the inside periphery of the corrugated metal structure to determine if any floating, local or unequal deformation has occurred as a result of improper construction methods.

(c) Backfill Materials

The Engineer or designated representative may approve any of the following well graded materials:

1. Select trench material
2. Sand
3. Crushed rock cuttings
4. Rock cuttings
5. Foundation Rock
6. Blasted material with fines and rock
7. Cement stabilized material
8. Borrow

Within the 100-year flood plain, sand will not be permitted for backfilling. The Engineer or designated representative will approve the topsoil for areas to be seeded or sodded.

(d) Backfill in Street Right of Way

Placement of backfill under existing or future pavement structures and within 2 feet of any structures shall be compacted to the required density using any method, type and size of equipment, which will give the required compaction without damaging the pipe or bedding. Placement of backfill greater than 2 feet beyond structures in Right of Way shall be conform to (g) below. The depth of layers, prior to compaction, shall depend upon the type of sprinkling and compacting equipment used and the test results thereby obtained. Prior to and in conjunction with the compaction operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept level to insure uniform compaction over the entire layer. Testing for density shall be in accordance with Test Method Tex-114-E and Test Method Tex-115-E.

Each layer of backfill must provide the density as required herein. Swelling soils (soils with plasticity index of 20 or more) shall be sprinkled as required to provide not less than optimum moisture nor more than 2 percent over optimum moisture content and compacted to the extent necessary to provide not less than 95 percent nor more than 102 percent of the density as determined in accordance with Test Method Tex-114-E. Non-swelling soils (soils with plasticity index less than 20) shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the density as determined in accordance with Test Method Tex-114-E.

After each layer of backfill is complete, tests may be made by the Engineer or designated representative. If the material fails to meet the density indicated, the course shall be reworked as necessary to obtain the indicated compaction and the compaction method shall be altered on subsequent Work to obtain indicated density.

At any time, the Engineer or designated representative may order proof rolling to test the uniformity of compaction of the backfill layers. All irregularities, depressions, weak or soft spots that develop shall be corrected immediately by the Contractor.

Should the backfill, due to any reason, lose the required stability, density or finish before the pavement structure is placed, it shall be recompacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent backfill layer or granular material. Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is more than 4 percent below the optimum of compaction ratio density. Backfill shall be placed from the top of the bedding material to the existing grade, base course, subgrade or as indicated. The remainder of the street backfill shall be Flexible Base, Concrete or Hot Mix Asphalt Concrete as indicated or to be replaced in kind to the surface removed to construct the pipe.

(e) Backfill in County Street or State Highway Right of Way

All Work within the right of way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the County when their requirements are more stringent. Prior to the start of construction, the Contractor shall be responsible for contacting the appropriate TxDOT office or County Commissioner's Precinct Office and for coordinating his activities with the operating procedures in effect for utility cut permits and pavement repair under their jurisdiction. Approval for all completed Work in the State or County right of way shall be obtained from the appropriate Official prior to final payment by the Owner.

(f) Backfill in Railroad Right of Way

All Work within the railroad right of way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the Railroad Owner when their requirements are more stringent. Approval for all completed Work in the railroad right of way shall be obtained from the Railroad prior to Final Completion.

(g) Backfill in Easements

Where not otherwise indicated, Contractor may select whatever methods and procedures may be necessary to restore entire Work area to a safe, useful and geologically stable condition with a minimum density of 85 percent or a density superior to that prior to construction.

In and near flood plain of all streams and watercourses, under or adjacent to utilities, structures, etc. all backfill shall be compacted to a density of not less than 95 percent conforming to TxDOT Test Method Tex-114-E, unless otherwise directed by Engineer or designated representative.

All soil areas disturbed by construction shall be covered with top soil and seeded conforming to Item No. 604, "Seeding for Erosion Control". All turf, drainways and drainage structures shall be constructed or replaced to their original condition or better. No debris shall remain in the drainways or drainage structures.

(26) Quality Testing for Installed Pipe

(a) Wastewater Pipe Acceptance Testing

After construction is complete, Engineer or designated representative will determine whether the pipeline is to be tested for infiltration, exfiltration or by the low-pressure air test method. In addition, plastic pipe 18 inches and larger in diameter shall be deflection tested.

Wastewater pipe installed in the City of Round Rock and its ETJ areas shall be tested for exfiltration or infiltration as described below in "Exfiltration Test" and "Infiltration Test" or by acceptable low pressure air test, as described below. At the conclusion of either test series, the Work shall be further tested for pipeline settlement and also for deflection as described below. The Contractor shall be solely responsible for making proper repairs to those elements, which do not pass these test requirements.

(b) Exfiltration Test

Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

The pipeline shall be completely filled with water for its complete length or by sections as determined by the Engineer or designated representative. If tested for its complete length, the maximum head at any point shall not exceed 25 feet unless otherwise indicated. If tested in sections, the manholes in the test section shall be completely filled with water. After the pipeline has been filled and allowed to stand for 24 hours, the amount of exfiltration shall be calculated. Any amount in excess of 200 gallons per inch of inside pipe diameter per mile per day shall be cause for rejection.

For portions of lines located within the Edwards Aquifer Recharge Zone or within any recharge area or recharge feature within the Edwards Aquifer Transition Zone, the minimum head during testing shall not be less than 2 feet and the leakage rate shall not exceed 50 gallons per inch of inside pipe diameter per mile per day. This rate shall apply for the entire portion of the line extending up to the first manhole located outside the recharge zone, recharge area, or recharge features indicated on Drawings and shall also be applicable for any recharge areas or recharge features which may be identified during construction. For construction within the 25-year flood plain, the exfiltration rate shall not exceed 10 gallons per inch diameter per mile of pipe per 24 hours at the same minimum test head.

(c) Infiltration Test

When the pipe placed in easements is completed, the upper portion of the trench backfill shall be removed to a depth of not less than 18 inches below the finished surface and width equal to the original trench width. The trench shall then be flooded with water until it is completely saturated and water stands in the ditch a minimum of 12 inches deep. In cases of steep terrain, earthen dikes shall be used to assure that water will stand

over the trench. After it is apparent that the trench is completely saturated, the main shall then be inspected with closed-circuit television for infiltration. Any section of the main or any service stub that indicates infiltration above the maximum quantity specified shall be cause for rejection.

This procedure shall not be used for pipes installed in areas where the Plasticity Index (P.I.) of the surrounding material is 20 or higher or where the backfill material has a P.I. of 20 or more.

For portions of lines located within the Edwards Aquifer Recharge Zone or within any recharge area or recharge feature within the Edwards Aquifer Transition Zone, the total infiltration as determined by water test, must be at a rate not greater than 50 gallons per inch of pipe diameter per mile of pipe per 24 hours at a minimum test head of two feet. This rate shall apply for the entire portion of the line extending up to the first manhole located outside the recharge zone, recharge area, or recharge features indicated on Drawings and shall also be applicable for any recharge areas or recharge features which may be identified during construction. For construction within the 25-year flood plain, the infiltration rate shall not exceed 10 gallons per inch diameter per mile of pipe per 24 hours at the same minimum test head.

If the quantity of infiltration exceeds the maximum quantity specified, remedial action must be undertaken in order to reduce the infiltration to an amount within the limits specified.

(d) Pipeline Settlement Test

During the infiltration test or after the exfiltration test, the pipe will be TV inspected for possible settlement. When air testing has been used, water shall be flowed into the pipe to permit meaningful observations. Any pipe settlement which causes excessive ponding of water in the pipe shall be cause for rejection. Excessive ponding shall be defined as a golf ball (1-5/8" dia.) submerged at any point along the line.

(e) Low Pressure Air Test of Plastic Gravity Flow Wastewater Lines

(1) General

Wastewater lines, at the discretion of the Engineer or designated representative, shall be air tested between manholes. Backfilling to grade shall be completed before the test and all laterals and stubs shall be capped or plugged by the Contractor so as not to allow air losses, which could cause an erroneous, test result. Manholes shall be plugged so they are isolated from the pipe and cannot be included in the test.

All plugs used to close the sewer for the air test shall be capable of resisting the internal pressures and must be securely braced. Place all air testing equipment above ground and allow no one to enter a manhole or trench where a plugged sewer is under pressure.

Release all pressure before the plugs are removed. The testing equipment used must include a pressure relief device designed to relieve pressure in the sewer under test at 10 psi or less and must allow continuous monitoring of the test pressures in order to avoid excessive pressure. Use care to avoid the flooding of the air inlet by infiltrated ground water. (Inject the air at the upper plug if possible.) Use only qualified personnel to conduct the test.

(2) Ground Water

Since the presence of ground water will affect the test results, test holes shall be dug to the pipe zone at intervals of not more than 100 feet and the average height of ground water above the pipe (if any) shall be determined before starting the test.

(3) Test Procedure

The Engineer or designated representative may, at any time, require a calibration check of the instrumentation used. Use a pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.0625 psi. (One ounce per square inch.) All air used shall pass through a single control panel. Clean the sewer to be tested and remove all debris where indicated. Wet the sewer prior to testing. The average back pressure of any groundwater shall be determined (0.433 psi) for each foot of average water depth (if any) above the sewer.

Add air slowly to the section of sewer being tested until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any ground water that may submerge the pipe. After the internal test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure. After the temperature stabilization period, disconnect the air supply. Determine and record the time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig greater than the average backpressure of any ground water that may submerge the pipe. Compare the time recorded with the specification time for the size and length of pipe as given in the following table:

Table For Low Pressure Air Testing of Plastic Pipe:

Minimum Specified Time Required For 1.0 psig Pressure Drop For Size and Length of Pipe Indicated								
Diameter of Pipe, (in.)	Specification Time (min: sec) for length shown							
	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

- NOTES:**
1. Specification times are as given in UNI-B-6 RECOMMENDED PRACTICE FOR LOW-PRESSURE TESTING OF INSTALLED PIPE -- by Uni-Bell PVC Pipe Association, 2655 Villa Creek Dr., Ste. 155, Dallas Texas 75234.
 2. Pipe Sizes acceptable by City of Round Rock are as given in the Water and Wastewater Utility's Standard Products List (SPL's) WW-227 and WW-227A.

Any drop in pressure, from 3.5 psig to 2.5 psig (adjusted for groundwater level), in a time less than that required by the above table shall be cause for rejection. When the line tested includes more than one size pipe, the minimum time shall be that given for the largest size pipe included.

Test procedure for wastewater pipe located in the Edwards Aquifer Recharge Zone or identified recharge areas or recharge features within the Edwards Aquifer Transition Zone:

Low-pressure air tests must conform to the procedure described in ASTM C-924 or other equivalent procedures. For safety reasons, air testing of pipe sections will be limited to line sizes of 36 inches inside diameter or less. Lines that are 36 inches or larger inside diameter may be air tested at each joint. The minimum time allowable for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch gauge during a joint test, regardless of pipe size, shall be twenty (20) seconds.

For sections of pipe less than 36-inch inside diameter, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge must be computed by the following equation:

$T = 0.0850 (D)(K)/(Q)$, where

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

K = $0.000419(D)(L)$, but not less than 1.0

D = nominal inside diameter in inches;

L = length of line of same pipe size in feet; and

Q = rate of loss, assume 0.0015 cubic feet per minute per square foot ($\text{ft}^3/\text{min}/\text{ft sq}$) of internal surface area.

Any drop in pressure, from 3.5 psig to 2.5 psig, in a time less than that required by the above formula shall be cause for rejection. When the line tested includes more than one size of pipe, the minimum time shall be that calculated for the largest size pipe included.

Manholes must be tested separately and independently. All manholes must be hydrostatically tested with a maximum loss allowance of 0.025 gallon per foot diameter per foot of head per hour.

When lines are air tested, manholes are to be tested separately by exfiltration or vacuum method (see Standard Specification Item No. 506, "Manholes").

(f) Deflection Test

Deflection tests shall be performed by the Contractor on all flexible and semi-rigid wastewater pipes. The tests shall be conducted after the final backfill has been in place at least 30 days. Testing for in-place deflection shall be with a pipe mandrel or rigid ball sized at 95% of the inside diameter of the pipe. A second test of flexible and semi-rigid wastewater pipes 18 inch size and larger, also with a pipe mandrel or ball sized at 95% of the inside diameter of the pipe, shall be conducted by the Contractor 30 days prior to expiration of his warranty on the Work.

Contractor shall submit his proposed pipe mandrels or testing balls to the Engineer or his designated representative for concurrence prior to testing the line.

Test(s) must be performed without mechanical pulling devices and must be witnessed by the Engineer or his designated representative.

Any deficiencies noted shall be corrected by the Contractor and the test(s) shall be redone.

(27) Pressure Pipe Hydrostatic Testing

After the pipe has been installed and backfilled and all service laterals, fire hydrants and other appurtenances installed and connected, a pressure test, followed by a leakage test, will be conducted by the City. The City will furnish the pump and gauges for the tests. The Contractor shall be present and shall furnish all necessary assistance for conducting the tests. The specified test pressures will be based on the elevation of the lowest point of the line or section under test. Before applying the specified test pressure, all air shall be expelled from the pipe.

If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points.

All drain hydrant and fire hydrant leads, with the main 6-inch gate valve open, the hydrant valve seats closed and nozzle caps open, shall be included in the test.

(a) Pressure Test

The entire project or each valved section shall be tested, at a pressure of 200 psi for a sufficient period (approximately 10 minutes) to discover all leaking or defective materials. Repairs shall be made by the Contractor to correct any leaking or defective materials.

(b) Pressure Pipe Leakage Test

A leakage test will follow the pressure test and be conducted on the entire project or each valved section. The leakage test shall be at 150 psi for at least 1 hour.

(1) Allowable Leakage

Leakage shall be defined as the quantity of water that must be supplied into any test section of pipe to maintain the specified leakage test pressure (see above, "Pressure Pipe Leakage Test") after the air in the pipeline has been expelled and the pipe has been filled with water.

No pipe installation will be accepted if the leakage exceeds 25 gallons/24 hours/mile of pipe/inch nominal pipe diameter.

$$\frac{(25 \text{ gpd})}{(\text{in.} \cdot \text{mi.})}$$

(2) Location and Correction of Leakage

If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the indicated allowance.

All visible leakage in pipe shall also be corrected by Contractor at his own expense.

(28) Service Charges for Testing

Initial testing performed by City forces for the Contractor will be at the City's expense. Retesting, by City forces, of Contractor's work that fails initial testing will be at the Contractor's expense. The City's charge for retests will be \$265.00, plus \$50.00 for each hour over four hours. On City-funded projects, the charges incurred by the City for retesting will be deducted from funds due the Contractor. On non-City-funded projects, the charges incurred by the City for retesting will be billed to the Contractor. The City will withhold acceptance of the Contractor's work until the Contractor has paid the City for the retesting costs.

(29) Disinfection of Potable Water Lines

(a) Preventing Contamination

The Contractor shall protect all piping materials from contamination during storage, handling and installation. Prior to disinfection, the pipeline interior shall be clean, dry and unobstructed. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work.

(b) Cleaning

Prior to disinfection the Contractor shall clean the pipeline to remove foreign matter. For pipelines 16" in diameter or smaller, cleaning shall consist of flushing the pipeline. For pipelines greater than 16" in diameter, cleaning shall be performed by operating hydrants and blow-offs located at low points in the pipeline, or by mechanical means (sweeping or pigging). Water for the Work shall be metered and furnished by the Contractor in accordance with Section 01500 of the Standard Contract Documents.

(c) Procedure and Dosage

The Contractor, at its expense, will supply the test gauges and the Sodium Hypochlorite conforming to ANSI/AWWA B300, which contains approximately 5 percent to fifteen percent available chlorine, and will submit for approval a written plan for the disinfection process. Calcium Hypochlorite conforming to ANSI/AWWA B300, which contains approximately 65 percent available chlorine by weight, may be used in granular form or in 5 g tablets for 16" diameter or smaller lines, if it is included as part of the written plan of disinfection that is approved by the City of Round Rock. The Contractor, at its expense, shall provide all other equipment, supplies and the necessary labor to perform the disinfection under the general supervision of the City.

One connection to the existing system will be allowed with a valve arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The valve shall be kept closed and locked in a valve box with the lid painted red. No other connection shall be made until the disinfection of the new line is complete and the water samples have met the established criteria. The valve shall remain closed at all times except when filling or flushing the line and must be manned during these operations. Backflow prevention in the form of a reduced pressure backflow assembly must be provided if the valve is left unattended. The new pipeline shall be filled completely with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of 50 mg/liter available chlorine.

The disinfecting solution shall be retained in the piping for at least 24 hours and all valves, hydrants, services, stubs, etc. shall be operated so

as to disinfect all their parts. After this retention period, the water shall contain no less than 25 mg/liter chlorine throughout the treated section of the pipeline.

For pipelines larger than 16" in diameter, the Contractor may use the AWWA C-651 "Slug Method" for disinfecting the pipeline. Chlorine shall be fed at a constant rate and at a sufficient concentration at one end of the pipeline to develop a slug of chlorinated water having not less than 100 mg/liter of free chlorine. The Contractor shall move the slug through the main so that all interior surfaces are exposed to the slug for at least three (3) hours. The chlorine concentration in the slug shall be measured as it moves through the pipeline. If the chlorine concentration drops below 50 mg/liter, the Contractor shall stop the slug and feed additional chlorine to the head of the slug to restore the chlorine concentration to at least 100 mg/liter before proceeding. As the slug flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches.

Unless otherwise indicated, all quantities specified herein refer to measurements required by the testing procedures included in the current edition of "Standard Methods". The chlorine concentration at each step in the disinfection procedure shall be verified by chlorine residual determinations.

(d) Final Flushing

The heavily chlorinated water shall then be carefully flushed from the potable water line until the chlorine concentration is no higher than the residual generally prevailing in the existing distribution system. Proper planning and appropriate preparations in handling, diluting, if necessary, and disposing of this strong chlorine solution is necessary to insure that there is no injury or damage to the public, the water system or the environment. The plans and preparations of the Contractor must be approved by the City before flushing of the line may begin. Additionally the flushing must be witnessed by an authorized representative of the City.

Approval for discharge of the diluted chlorine water or heavily chlorinated water into the wastewater system must be obtained from the Water and Wastewater Utility Department. The line flushing operations shall be regulated by the Contractor so as not to overload the wastewater system or cause damage to the odor feed systems at the lift stations. The City shall designate its own representative to oversee the work.

Daily notice of line discharging must be reported to the Water and Wastewater Utility Dispatch office.

(e) Bacteriological Testing

After final flushing of the strong disinfecting solution, two (2) sets of water samples from the line, that are taken at least twenty-four (24) hours apart, will be tested for bacteriological quality by the City and must be found free

of coliform organisms before the pipeline may be placed in service. Each set shall consist of one (1) sample that is drawn from the end of the main and additional samples that are collected at intervals of not more than 1000 feet along the pipeline. All stubs shall be tested before connections are made to existing systems.

The Contractor, at its expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

Samples for bacteriological analysis will only be collected from suitable sampling taps in sterile bottles treated with sodium thiosulfate. Samples shall not be drawn from hoses or unregulated sources. The City, at its expense, will furnish the sterile sample bottles and may, at its discretion, collect the test samples with City personnel.

If the initial disinfection fails to produce acceptable sample test results, the disinfection procedure shall be repeated at the Contractor's expense. Before the piping may be placed in service, two (2) consecutive sets of acceptable test results must be obtained.

An acceptable test sample is one in which: (1) the chlorine level is similar to the level of the existing distribution system; (2) there is no free chlorine and (3) total coliform organisms are absent. An invalid sample is one, which has excessive free chlorine, silt or non-coliform growth as defined in the current issue of the "Standards Methods." If unacceptable sample results are obtained for any pipe, the Contractor may, with the concurrence of the Inspector, for one time only flush the lines and then collect a second series of test samples for testing by the City. After this flushing sequence is completed, any pipe with one or more failed samples must be disinfected again in accordance with the approved disinfection procedure followed by appropriate sampling and testing of the water.

The City of Round Rock Water Quality Laboratory will notify the assigned City of Round Rock Inspector in writing of all test results. The Inspector will subsequently notify the Contractor of all test results. The Water Quality Laboratory will not release test results directly to the Contractor.

(30) Cleanup and Restoration

It shall be the Contractor's responsibility to keep the construction site neat, clean and orderly at all times. Cleanup shall be vigorous and continuous to minimize traffic hazards or obstructions along the streets and to driveways. Trenching, backfill, pavement repair (as necessary), and cleanup shall be coordinated as directed by the City. The Engineer or designated representative will regulate the amount of open ditch and may halt additional trenching if cleanup is not adequate to allow for orderly traffic flow and access.

Materials at the site shall be stored in a neat and orderly manner so as not to

obstruct pedestrian or vehicular traffic. All damaged material shall be removed from the construction site immediately and disposed of in a proper manner. All surplus excavated materials become the property of the Contractor for disposal at his expense. After trenching, the Contractor shall immediately remove all excavated materials unsuitable for or in excess of, backfill requirements. Immediately following the pipe laying Work as it progresses, the Contractor shall backfill, grade and compact all excavations as provided elsewhere and shall immediately clean up and remove all unused soil, waste and debris and restore all surfaces and improvements to a condition equal or superior to that before construction began and to an appearance which complements the surroundings. The Contractor shall grade and dress the top 6 inches of earth surfaces with soil or other material similar and equal to the surrounding, fill and smooth any visible tracks or ruts, replace and re-establish all damaged or disturbed turf or other vegetation and otherwise make every effort to encourage the return of the entire surface and all improvements to a pleasant appearance and useful condition appropriate and complementary to the surroundings and equal or similar to that before construction began.

Permanent pavement replacement, if necessary, shall begin immediately after all testing of each segment of piping is satisfactorily completed.

510.4 Measurement

Pipe will be measured by the linear foot for the various types, sizes and classes. Parallel lines will be measured individually.

Where a line ties into an existing system, the length of the new line will be measured from the visible end of the existing system at the completed joint. Unless otherwise indicated, the length of water and wastewater lines will be measured along pipe horizontal centerline stationing through fittings, valves, manholes, and other appurtenances.

Unless otherwise provided, ductile fitting 24-inch and smaller will be measured by the ton and paid for in accordance with the schedule in Standard Product List WW-27C. Unless otherwise provided, fittings larger than 24 inch sizes will be subsidiary to the pipe. Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be measured separately. These will be subsidiary to the bid item Pipe.

Stormwater pipe will be measured along the slope of the pipe. Where drainage pipe ties into inlets, headwalls, catch basins, manholes, junction boxes or other structures that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

Excavation and backfill, when included as pipe installation will not be measured as such but shall be included in the unit price bid for constructing pipe and measured as pipe complete in place including excavation and backfill.

When pay items are provided for the other components of the system, measurement will be made as addressed hereunder.

510.5 Payment

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot for the various sizes of pipe, of the materials and type indicated, unless unstable material is encountered or trench excavation and backfill is bid as a separate item.

The concrete seal, foundation rock or coarse aggregate when used as directed in unstable material will be paid for at the unit price bid per cubic yard, which shall be full payment for all excavation and removal of unsuitable material and furnishing, placing and compacting the foundation rock, coarse aggregate or other approved material all complete in place.

Excavation and backfill, when included as a separate pay item, will be paid for by Pay Item No. 510-E or 510-F.

(1) Pipe

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot complete-in-place as designed and represented in the Drawings and other Contract documents. Unless otherwise provided herein, as separate pay item(s), subsidiary items to the bid price per linear foot of pipe shall include the following:

- a. clearing
- b. constructing any necessary embankment
- c. excavation
- d. disposal of surplus or unusable excavated material
- e. furnishing, hauling and placing pipe
- f. fittings larger than 24 inch
- g. field constructed joints, collars, temporary plugs, caps or bulkheads
- h. all necessary lugs, rods or braces
- i. pipe coatings and protection
- j. connections to existing systems or structures, concrete blocking and thrust blocks and restrained joints
- k. preparing, shaping, pumping for dewatering, and shoring of trenches
- l. bedding materials
- m. backfill materials
- n. hauling, placing and preparing bedding materials
- o. particle migration measures
- p. hauling, moving, placing and compacting backfill materials
- q. temporary and permanent pavement repairs and maintenance
- r. temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction
- s. cleanup
- t. vertical stack on deep wastewater services
- u. all other incidentals necessary to complete the pipe installation as indicated.

No separate payment will be made for thrust restraint measures.

Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be paid for separately. These will be subsidiary to the bid item Pipe.

(2) Concrete Cradles and Seals

When called for in the Bid, concrete cradles and seals will be paid for at the unit Contract price bid per linear foot for the size of pipe specified, complete in place.

(3) Concrete Retards

When called for in the Bid, Concrete retards will be paid under Item No. 593, Concrete Retards."

(4) Boring, Jacking and Tunneling

When called for in the Bid, boring, jacking and tunneling will be paid under Item 501, "Jacking or Boring Pipe" or Item 502, "Tunneling".

(5) Wet Connections to Water Mains

When called for in the bid, wet connections will be paid at the unit price bid per each, complete in place, according to the size of the main that is in service and shall be full compensation for all Work required to make the connection and place the pipe in service. (See subsection 510.3 'Construction Methods part (24) (b) 'Wet Connections to Existing Water System').

(6) Fittings

Cast iron and ductile iron fittings of the class indicated, furnished in accordance with these specifications will be paid for at the unit price bid per ton, complete in place, according to scheduled weights for mechanical joint fittings furnished, including glands, bolts and gaskets, as published in the following standards:

AWWA C-153 for all fittings 4-inch through-24 inch sizes, regardless of whether AWWA C-110 or

AWWA C-153 fittings are furnished or the type of end connections supplied.

AWWA C-110 for all fittings larger than 24-inch size.

Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be paid for separately. The Contractor shall include these in his bid for pipe.

(7) Concrete Trench Cap and Encasement

Where the distance between the top of the concrete encasement and the top of the trench cap is less than 36 inches, the concrete cap and encasement shall be poured as one unit and paid for under this bid item at the Contract price bid per linear foot. When the distance above is greater than 36 inches or when the trench cap is placed separately, the trench cap shall be paid for as a separate item, per linear foot, complete in place.

(8) Cement-Stabilized Backfill

Cement-stabilized backfill will be paid for at the unit price bid per linear foot and shall be full payment to the Contractor for furnishing and installing the required material, mixed, placed and cured complete in place.

(9) Concrete Encasement

When called for in the Bid, Concrete Pipe Encasement will be paid under Item No. 505, "Encasement and Encasement Pipe".

(10) Pressure Taps

Pressure taps will be paid for at the unit price bid, complete in place, according to the size tap made and the size main tapped and shall be full payment for furnishing all necessary materials, including tapping sleeve and valve, making the tap, testing and placing the connection in service.

(11) Trench Safety Systems

When called for in Bid, Trench Safety Systems shall conform to Item No. 509, "Trench Safety Systems".

(12) In-Place Slip lining with or without In-Place Pipe Destruction/Replacement

As called for in the corresponding bid items, pipe slip lining with or without in-place pipe destruction/replacement will be paid for at the Contract price per linear foot for the specified liner and pipe size and type pipe, at all depths, complete in place.

Installation of new services, or reconnection of existing services, to the liner will be paid for at the Contract price per each for the specified size and type of service, at all depths, complete in place.

(13) Cured Resin Pipe Lining

When called for in the bid, cured resin pipe lining will be paid for per linear foot, for the size and type of pipe lined, at all depths, complete in place including all equipment set-ups, video inspection and cleaning of existing pipe. Installation of new services or reconnection of existing services to the relined pipe will be paid for per each, for the specified size and type of service, at all depths, complete in place.

Payment, when included as a Contract pay item, will be made under one of the following:

Pipe, ___Dia. ___(all depths), including Excavation and Backfill
Per Linear Foot.

In-Place Sliplining without In-Place Pipe Destruction/Replacement

(___ Dia. ___ Pipe Lining ___ in. Dia. Existing Pipe) Per Linear Foot.

In-Place Sliplining with Pipe Destruction/Replacement

(___ Dia. ___Replacement Pipe ___in. Dia. Existing Pipe) Per Linear Foot.

Installing or Reconnecting Lateral Service to Existing, Relined or Replaced Pipe (____ Dia. ____ Service) in. (____ Dia. ____ Pipe)	Per Each.
Pipe Excavation, ____ Ft. Width	Per Linear Foot.
Pipe Trench Backfill, ____ Ft. Width	Per Linear Foot.
Concrete Seal or Cradle, ____ Dia. Pipe	Per Linear Foot.
Concrete Trench Cap, ____ Ft. Width	Per Linear Foot.
Concrete Cap and Encasement, ____ Dia. Pipe	Per Linear Foot.
Cement Stabilized Backfill, ____ Dia. Pipe	Per Linear Foot.
Cured Resin Pipe Lining (for ____ Dia. Pipe)	Per Linear Foot.
Installing or Reconnecting Lateral Service to Cured Resin Lined Pipe, (____ Dia. ____ Service (for ____ Dia. Main)	Per Each.
Pressure Taps, ____ Dia. X ____ Dia.	Per Each.
Wet Connections, ____ Dia. x ____ Dia.	Per Each.
Ductile Iron Fittings 4 inch through 24 inch	Per Ton.

A "W" after the pay item indicates the use for water.

A "WW" after the pay item indicates the use for wastewater.

End

Applicable References:

Standard Specifications Manual: Item Nos. Ref: 102, 210, 402, 403, 501, 502, 505, 506, 507, 509, 593, 601, 604

Standards Manual: Standard Detail Nos. 510-1, (520 - series).

Design Criteria Manuals: Utilities Criteria Manual, Section 5.

ITEM NO. 511 WATER VALVES

511.1 Description

This item shall govern the valves furnished and installed as indicated on the Drawings. Unless otherwise indicated on the Drawings, all valves 4 inches (102 mm) and larger shall be AWWA-type valves of suitable design and fully equipped for service buried in the earth, without need for further modification and shall be wrapped with 8-mil (0.2 mm) polyethylene film with all edges and laps securely taped to provide a continuous wrap. Where not indicated, the Contractor may use valves with any type end-joint allowed for fittings of the pipe class being used. Unless otherwise indicated on the Drawings, all valve stems shall be adjusted to situate the operating nut not more than 24 inches (0.6 meters) below the proposed ground or paving surface of the finished project.

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

511.2 Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is of the kind and quality that satisfies the specified functions and quality. The City of Round Rock Water and Wastewater Utility Standard Products Lists (SPL) are considered to form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the Engineer/Architect (E/A) is still required. If the Contractor elects to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal. This will expedite the review process in which the E/A, and, if necessary, the Water and Wastewater Utility Standard Products Committee, decide whether the products meet the Contract requirements and the specific use foreseen by the E/A in the design of this engineered Project.

The SPL's should not be interpreted as being a pre-approved list of products necessarily meeting the requirements for a given construction Project. Items contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the Engineer or designated representative in conjunction with the Water and Wastewater Utility Standard Products Committee. The Standard Product List current at the time of plan approval will govern.

(A) Samples, Inspection and Testing Requirements:

All tests and inspections called for by the applicable standards shall be performed by the manufacturer. Upon request, results of these tests shall be made available to the purchaser.

(B) Other Requirements:

Each submittal shall be accompanied by:

- (1) Complete data covering:
 - a) the operator, including type and size, model number, etc.,
 - b) the manufacturer's name and address of his nearest service facility,
 - c) the number of turns to fully open or close the valve.
- (2) detailed instructions for calibrating the limit stops for open and closed positions, and
- (3) any other information, that may be necessary to operate and maintain the operator.
- (4) Complete dimensional data and installation instructions for the valve assembly as it is to be installed, including the operator.
- (5) Complete replacement parts lists and drawings, identifying every part for both the valve and operator.

511.3 Valves

(A) Iron-Body Gate Valves

Unless otherwise indicated, Iron Body Gate Valves, 4" to 12" (102 mm to 305 mm), including Tapping Valves, shall conform to AWWA C509, "Resilient Seated Gate Valves for Water and Sewerage Systems".

Iron Body Gate Valves larger than 12" (305 mm), including Tapping Valves, shall be double disc, parallel seat valves meeting the requirements of AWWA C500.

16 (406 mm) Iron Body Resilient Seated Gate valves may be used if called for in the design and if indicated in the Standard Product List WW-282.

- (1) Stem Seals: All valves shall have approved O-ring type stem seals. At least two O-rings shall be in contact with the valve stem where it penetrates the valve body.
- (2) Operation: All valves shall have non-rising stems with a 2" (50 mm) square operating nut, or with a spoke type handwheel when so ordered, turning clockwise to close.
- (3) Gearing: Double disc gate valves in 16 inch (406 mm) and larger sizes shall be geared and, when necessary for proper bury depth and cover, shall be the horizontal bevel-geared type enclosed in a lubricated gear case.
- (4) Bypass: Unless otherwise indicated, 16 inch (406 mm) and larger gate valves shall be equipped with a bypass of the non-rising stem type which meets the same AWWA standard required for the main valve.
- (5) Valve Ends: Valve ends shall be push-on, flanged or mechanical joint, as indicated or approved.

Tapping valves shall have inlet flanges conforming to MSS SP-60, with boltholes drilled per ANSI B16.1 Class 125. Seat rings and body casting

shall be over-sized as required to accommodate full size cutters; the outlet end shall be constructed and drilled to allow the drilling machine adapter to be attached directly to the valve.

- (6) Gear Case: All geared valves shall have enclosed gear cases of the extended type, attached to the valve bonnet in a manner that makes it possible to replace the stem seal without disassembly and without disturbing the gears, bearing or gear lubricant. Gear cases shall be designed and fabricated with an opening to atmosphere so that water leakage past the stem seal does not enter the gear case.
- (7) Valve Body: Double disc gate valves in 16 inch (406 mm) and larger sizes installed in the horizontal position shall have bronze rollers, tracks, scrapers, etc.

(B) Butterfly Valves:

Unless otherwise indicated, all valves shall conform to the current "AWWA" Standard C-504, "Rubber-Seated Butterfly Valves", Class 150B, except as modified or supplemented herein.

(1) Functional Requirements

- a) Valves shall be the short body design and shall have flanged connections on both ends unless otherwise called for.
- b) Valves shall be of such design that the valve discs will not vibrate or flutter when operated in a throttled position. Valve discs shall be secured to the shafts by means of keys or pins so arranged that the valve discs can be readily removed without damage thereto. All keys and pins used in securing valve discs to shafts shall be stainless steel or monel. Valve discs shall be stainless steel or ductile iron, ASTM A 536, Grade 65-45-12 (448-310-12); seating edge shall be stainless steel or other corrosion resistant material.
- c) Valve shafts shall be constructed of wrought stainless steel or monel. The ends of the shaft shall be permanently marked to indicate the position of the disc on the shaft.
- d) All buried valves shall have approved manufacturer's O-ring type or split V type "Chevron" shaft seals. When O-ring seals are used, there shall be at least two O-rings in contact with the valve shaft where it penetrates the valve body.

On 24 inch (635 mm) and larger valves, the seat shall be completely replaceable and/or adjustable with common hand tools without disassembling the valve from the pipeline.

Rubber seats located on the valve disc shall be mechanically secured with stainless steel retainer rings and fasteners.

- e) Unless otherwise indicated, valves shall be provided with manual operators with vertical stems and 2 inches (50 mm) square

operating nut turning clockwise to close and equipped with a valve disc position indicator. All keys or pins shall be stainless steel or monel. Buried valves shall have the valve stems extended or adjusted to locate the top of the operating nut no more than 24 inches (0.6 meter) below finish grade.

- f) Unless otherwise indicated, motorized butterfly valves shall be equipped with 230/460 volt, 3-phase reversing motor operators, extended as required to locate the center line of the operator shaft approximately 4 feet to 4 feet, 6 inches (1.2 to 1.4 meters) above finish grade. Operators shall be equipped with cast iron or malleable iron manual override hand wheel with a valve position indicator, local push button controls, lighted status/position indicator, torque and travel limit switches and all switches, relays and controls (except external power and signal wiring) necessary for both local and remote operation.

(2) Performance Requirements

- a) Unless otherwise indicated, valve operators shall be sized to seat, unseat, open and close the valve with 150 psi (1 megapascal) shutoff pressure differential across the disk and allow a flow velocity of 16 feet (4.9 meters) per second past the disc in either direction.
- b) Motorized valve motors shall be capable of producing at least 140 percent of the torque required to operate the valves under conditions of maximum non-shock shutoff pressure without exceeding a permissible temperature rise of 131°F over 104°F ambient (55 degrees Celsius over 40 degrees Celsius ambient); they shall have a duty rating of not less than 15 minutes and shall be capable of operating the valve through 4 1/2 cycles against full unbalanced pressure without exceeding the permissible temperature rise. Motors shall be suitable for operating the valve under maximum differential pressure when voltage to motor terminals is 80 percent of nominal voltage. Motor bearings shall be permanently lubricated and sealed.

(C) Ball Valves:

Ball valves shall be brass, bronze, stainless steel or PVC as indicated on the Drawings or Details or as approved by the Engineer or designated representative.

(D) Air-Vacuum Release Valves

- (1) Valves shall be combination air-release, air-vacuum units having small and large orifice units contained and operating within a single body or assembled unit.

The small orifice system shall automatically release small volumes of air while the pipe is operating under normal conditions. The large air-vacuum

orifice system shall automatically exhaust large volumes of air while the pipe is being filled and shall permit immediate re-entry of air while being drained.

Valves shall be rated for at least 150 psi (1 megapascal) {maximum} normal service pressure.

(2) Material Requirements

Valve exterior bodies and covers shall be cast iron.

Internal bushings, hinge pins, float guide and retaining screws, pins, etc., shall be stainless steel or bronze.

Orifice seats shall be Buna-N rubber.

Floats shall be stainless steel, rated at 1000 psi (6.9 megapascals).

Unless otherwise indicated, these valves shall be as included in the Standard Products List (SPL WW-367 for water, WW-462 for wastewater force mains).

E) Fire Hydrants

All fire hydrants shall be Dry Barrel, Traffic Model (break-away), Post Type having Compression Type Main Valves with 5 1/4" (133 mm) opening, closing with line pressure. Approved models are listed on SPL WW-3 of the Water and Wastewater Utility Standard Products List.

(1) Applicable Specifications

AWWA C-502 current: "AWWA Standard for Dry-Barrel Fire Hydrants".

NFPA 1963: "National (American) Standard Fire Hose Coupling Screw Thread" and City of Round Rock 4 inch (102 mm) Fire Hose Connection Standard (Available upon request from Standards Committee Secretary at 322-2806).

ANSI A-21.11 current: "American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings".

(2) Functional Requirements

Design Working Pressure shall be 200 psi (1.38 megapascals) and a test pressure of 400 psi (2.76 megapascals).

Inlet shall be side connection hub end for mechanical joint (ANSI A-21.11-current). Shoe shall be rigidly designed to prevent breakage.

Lower Barrel shall be rigid to assure above ground break at traffic feature. Bury length of hydrant shall be four (4) feet (1.2 meters) minimum, five (5) feet (1.5 meters) maximum (hydrant lead pipe may be elbowed up from main using restrained joints; flanged joints in lead pipes are not allowed). Flange type connections between hydrant shoe, barrel sections and bonnet shall have minimum of 6 corrosion resistant bolts.

Hydrant Main Valve shall be 5 1/4 inch (133 mm) I.D. Valve stem design shall meet requirements of AWWA C502, with Operating Nut turning clockwise to close. Operating Nut shall be pentagonal, 1 1/2 inch (38 mm) point to flat at base, and 1 7/16 inches (36.5 mm) at top and 1 inch (25 mm) minimum height. Seat ring shall be bronze (bronze to bronze threading), and shall be removable with light weight stem wrench. Valve mechanisms shall be flushed with each operation of valve; there shall be a minimum of two (2) drain ports.

Traffic Feature shall have replaceable breakaway ferrous metal stem coupling held to stem by readily removable type 302 or 304 stainless steel fastenings. Breakaway flange or frangible lugs shall be designed to assure aboveground break. Breakaway or frangible bolts will not be acceptable.

Outlet Nozzles shall be located approximately 18 inches (450 mm) above ground. Each hydrant shall have two (2) 2 1/2 inch (63.5 mm) nozzles 180 degrees apart with National (American) Standard Fire Hose Coupling Screw Thread NFPA 1963 and one (1) 4 inch (102 mm) pumper nozzle with City of Round Rock standard thread—six (6) threads per inch (25 mm) "Higbee" cut, 4.8590 inch (123.4 mm) O.D., 4.6425 inch (117.9 mm) root diameter. Nozzles shall be threaded or cam-locked, O-ring sealed, and shall have type 302 or 304 stainless steel locking devices. Nozzle caps (without chains) and cap gaskets shall be furnished on the hydrant. The cap nut shall have the same configuration as the operating nut.

Hydrants shall be Dry-Top Construction, factory lubricated oil or grease with the lubricant plug readily accessible. The system shall be described for City approval.

A blue reflective delineator of a type approved by the Engineer shall be placed 2 to 3 feet (0.6 to 0.9 meters) offset from the centerline of paved streets, on the side of and in line with, all newly installed fire hydrants.

Hydrant shall have double O-ring seals in a bronze stem sheath housing to assure separation of lubricant from water and shall have a weather cap or seal, or both, as approved by the Owner, to provide complete weather protection.

(3) Material Requirements

All below ground bolts shall be corrosion resistant. The hydrant valve shall be Neoprene, 90 durometer minimum. The seat ring, drain ring, operating nut and nozzles shall be bronze, AWWA C-502 current, containing not over 16 percent zinc. Break-away stem coupling shall be of ferrous material; its retaining pins, bolts, nuts, etc. of type 302 or 304 stainless steel.

Coatings shall be durable and applied to clean surfaces. Exterior surfaces above ground shall receive a coating of the type and color specified in the applicable version of City of Round Rock SPL WW-3. The coating shall

be applied according to coating manufacturer's specifications. Other exposed ferrous metal shall receive asphalt-based varnish, or approved equal, applied according to the coating manufacturer's specifications.

(F) Pressure/Flow Control Valves:

All control valves to regulate pressure, flow, etc., in City lines shall be models listed in the City of Round Rock Water and Wastewater Standard Products List (SPL).

(G) Drain Valves:

Drain valve materials and installation shall conform to City of Round Rock Standard Detail No. 511-9.

511.4 Construction Methods

(A) Setting Valves, Drains and Air Releases

Unless otherwise indicated, main line valves, drain valves and piping, air and vacuum release assemblies and other miscellaneous accessories shall be set and jointed in the manner described for cleaning, laying, and jointing pipe.

Unless otherwise indicated, valves shall be set at the locations shown on the Drawings and such that their location does not conflict with other appurtenances such as curb ramps. Valves shall be installed so that the tops of operating stems will be at the proper elevation required for the piping at the location indicated above. Valve boxes and valve stem casings shall be firmly supported and maintained, centered and aligned plumb over the valve or operating stem, with the top of the box or casing installed flush with the finished ground or pavement in existing streets, and installed with the top of the box or casing approximately 6 inches (150 mm) below the standard street subgrade in streets which are excavated for paving construction or where such excavation is scheduled or elsewhere as directed by the Engineer or designated representative.

Drainage branches or air blowoffs shall not be connected to any sanitary sewer or submerged in any stream or be installed in any other manner that will permit back siphonage into the distribution system (see City of Round Rock "Standard Detail Drawings- Series 500/500"). Every drain line and every air release line shall have a full sized independent gate valve flanged directly to the main. Flap-valves, shear gates, etc., will not be accepted.

(B) Setting Fire Hydrants:

Fire hydrants shall be located in a manner to provide accessibility and in such a manner that the possibility of damage from vehicles or conflict with pedestrian travel will be minimized. Unless otherwise directed, the setting of any hydrant shall conform to the following:

Hydrants between curb and sidewalk on public streets, shall be installed as shown on Standard 511-17, with outermost point of large nozzle cap 6" to 18" (150 mm to 450 mm) behind back of curb. Where walk abuts curb, and in other public areas or in commercial areas, dimension from gutter face of curb to

outermost part of any nozzle cap shall be not less than 3 feet (0.9 meters), nor more than 6 feet (1.8 meters), except that no part of a hydrant or its nozzle caps shall be within 6 inches (150 mm) of any sidewalk or pedestrian ramp. Any fire hydrant placed near a street corner shall be no less than 20 feet (6 meters) from the curb line point of tangency. Fire hydrants shall not be installed within nine feet (2.75 meters) vertically or horizontally of any sanitary sewer line regardless of construction.

All hydrants shall stand plumb; those near curbs shall have the 4 inch (102 mm) nozzle facing the curb and perpendicular to it. The hydrant bury mark shall be located at ground or other finish grade; nozzles of all new hydrants shall be approximately 18 inches (450 mm) above grade. Lower barrel length shall not exceed 5 feet (1.5 meters). Barrel extensions are not permitted unless approved by the Engineer or designated representative. Each hydrant shall be connected to the main by 6 inch (152 mm) ductile iron pipe; a 6 inch (152 mm) gate valve shall be installed in the line for individual shutoff of each new hydrant.

Below each hydrant, a drainage pit 2 feet (0.6 meter) in diameter and 2 feet (0.6 meter) deep shall be excavated and filled with compacted coarse gravel or broken stone mixed with coarse sand under and around the bowl of the hydrant, except where thrust blocking is located (City of Round Rock Specification Item 510 and Standard Detail 510-6 and to a level 6 inches (150 mm) above the hydrant drain opening.

The hydrant drainage pit shall not be connected to a sanitary sewer. The drain gravel shall be covered with filter fabric to prevent blockage of voids in the gravel by migration of backfill material. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with concrete thrust blocking (taking care not to obstruct the hydrant drain holes), or the hydrant shall be tied to the pipe with approved metal harness rods and clamps. The fire line shall be provided with joint restraint from the main line to the fire hydrant. Hydrants shall be thoroughly cleaned of dirt or foreign matter before setting.

Fire hydrants on mains under construction shall be securely wrapped with a poly wrap bag or envelope taped into place. When the mains are accepted and placed in service the bag shall be removed.

(C) Pressure Taps: Refer to Section 510.3 (24) of Standard Specification Item Number 510, "Pipe".

(D) Plugging Dead Ends:

Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses and spigot ends shall be capped. All end plugs or caps shall be secured to the pipe conforming to Section 510.3 (22) of Standard Specification Item Number 510, "Pipe".

(E) Protective Covering:

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other steel component shall be coal tar coated and shall be wrapped with standard minimum 8-mil (0.2 mm) low density polyethylene film or a minimum 4-mil (0.1

mm) cross laminated high-density polyethylene meeting ANSI/AWWA Specification C-105-current, with all edges and laps taped securely to provide a continuous and watertight wrap. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling.

(F) Valve Box, Casing and Cover:

Stems of all buried valves shall be protected by valve box assemblies. Valve box castings shall conform to ASTM A 48, Class 30B. Testing shall be verified by the manufacturer at the time of shipment. Each casting shall have cast upon it a distinct mark identifying the manufacturer and the country of origin.

(G) Drain Valve Installations:

Refer to City of Round Rock Standards 511-9.

(H) Air Release Assemblies:

Refer to City of Round Rock Standards Details.

(I) Pressure/Flow Control Valves:

Assemblies shall be installed as indicated.

(J) Connections to Existing System:

Refer to Item No. 510, "Pipe" for connections to the existing system.

(K) Shutoffs:

Refer to Item No. 510, "Pipe" for shutoffs.

511.5 Measurement

All types of valves will be measured per each. Fire hydrants and drain valves will be measured per each. Fire Hydrant and Drain Valve barrel extensions will be measured per vertical foot (meter: 1 meter equals 3.28 feet). Pressure/Flow control valve assemblies and both manual and automatic air release assemblies will be measured per each. The blue reflective delineator for identifying the location of newly installed fire hydrants shall be measured per each.

Unless indicated otherwise in the Drawings, bury depths that exceed 5.5 feet (1.68 meters) shall be considered subsidiary to the completed unit.

511.6 Payment

Payment shall include full compensation, in accordance with the pay item established in the bid, for excavation, furnishing, hauling and placing valves and barrel extensions including anchorage and all incidental and subsidiary materials and work; preparing, shaping, dewatering, shoring of trenches, bedding, placing and compacting backfill materials and for all other incidentals necessary to complete the installation, as indicated in the Drawings, complete in place. The blue reflective delineator for identifying the location of newly installed fire hydrants shall be measured per each.

When indicated in the Drawings, bury depths that exceed 5.5 feet (1.68 meters) payment shall be made at the unit bid price for additional bury depth.

Payment for iron fittings and for wet connections are covered in Section 510.6 of Standard Specification Item 510, "Pipe".

- (A) Valves: Valves will be paid for at the unit bid price for the size and type valve installed, including valve stem casing and cover, excavation and backfill, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation.
- (B) Fire Hydrants: Fire Hydrants installation shall be paid for at the unit bid price, including fittings, between the main line and the fire hydrant, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and fire hydrant.
- (C) Pressure/Flow Control Assemblies: Pressure control and flow control valve assemblies will be paid for at the unit bid price, including box or vault, setting, adjusting to grade, anchoring in place, adjusting the control device to the required conditions, providing other appurtenances necessary for proper operation, and placing in operation.
- (D) Drain Valve Assemblies: Drain valve installation shall be paid for at the unit bid price, including fittings between the main line and the drain valve, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and drain hydrant.
- (E) Manual Air Release: Manual air release installations will be paid for at the unit bid price and shall include valves, fittings, pipe, tapping the main, box and cover, and other appurtenances necessary for proper operation.
- (F) Automatic Air-Vacuum Valves: Automatic air-vacuum release assemblies will be paid for at the unit bid price and will include the main line tap or outlet, all pipe, valves, fittings, box or vault and cover, and other appurtenances necessary for proper operation.

Payment, when included as a contract pay item, will be made under one of the following:

Valves, _____ Type, _____ Diameter	Per Each.
Fire Hydrants	Per Each.
Reflectorized Pavement Markers (Type II-B-B)	Per Each.
Pressure or Flow Control Valve Assemblies	Per Each.
Drain Valve Assemblies	Per Each.
Manual Air Release Assemblies, _____ Diameter	Per Each.
Automatic Combination Air/Vacuum Release Valve Assembly, _____ Diameter	Per Each.
Iron Body Resilient Seated Gate Valve, 16" (406 mm) Diameter	Per Each.
Additional Bury depth	Per Vertical Foot.

END

<u>SPECIFIC</u> CROSS REFERENCE MATERIALS
--

Specification 511, "Water Valves"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 510	Pipe
<u>Section</u> 510.3 (22)	Pipe Anchorage, Support and Protection
<u>Section</u> 510.3(24)	Water System Connections

ANSI/AWWA Standards

<u>Designation</u>	<u>Description</u>
A-21.11	American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings
C-105	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe
C-500	Metal-Seated Gate Valves for Water Supply Service
C-502	Dry-Barrel Fire Hydrants
C-504	Rubber-Seated Butterfly Valves
C509	Resilient Seated Gate Valves for Water and Sewerage Systems

ASTM Standards

<u>Designation</u>	<u>Description</u>
ASTM A48/A48M	Specification for Gray Iron Castings
ASTM A 536	Specification for Ductile Iron Castings

National Fire Protection Association (NFPA)

National (American) Standard Fire Hose Coupling Screw Thread

<u>RELATED</u> CROSS REFERENCE MATERIALS

Specification 511, "Water Valves"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 503	Frames, Grates, Rings and Covers
Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 508	Miscellaneous Structures and Appurtenances
Item No. 509	Trench Safety Systems

ITEM NO. 551
PIPE UNDERDRAINS

551.1 Description

This item shall consist of pipe underdrains embedded in filter material, constructed at such places as indicated and in accordance with lines and grades established by Engineer. This item shall also consist of any pumping, bailing, drainage and Item No. 509, "Trench Safety Systems" for trench walls, when indicated.

551.2 Materials

(1) **Pipe**

The following materials will be permitted as alternates unless type is indicated. Size indicated shall be inside diameter. Pipe shall meet the following requirements:

Type 1 Vitrified Clay or Concrete Pipe

Pipe may be either thoroughly and perfectly burned or glazed vitrified clay or nonreinforced concrete conforming to ASTM C 14. Vitrified clay pipe shall be of first quality hub and spigot style, sound, without warps or cracks or other imperfections and shall be sufficiently tough so that it may be cut with a chisel and hammer.

Type 2 Clay Drain Tile

Standard clay drain tile shall conform to specifications of AASHTO M 179.

Type 3 Concrete Drain Tile

Butt end concrete drain tile shall conform to ASTM C 412. Tongue and groove concrete drain tile shall conform to ASTM C 118.

Type 4 Porous Concrete Pipe

Porous concrete pipe shall conform to AASHTO M 176.

Type 5 Perforated Clay Pipe

Perforated clay pipe shall conform to specifications for standard strength perforated clay pipe of AASHTO M 65 except that extra strength clay pipe may be substituted for standard strength clay pipe.

Type 6 Perforated Corrugated Metal Pipe

Perforated helically corrugated metal pipe shall be fabricated from corrugated galvanized sheets and shall conform to AASHTO M 36 or corrugated aluminum alloy sheets and shall comply with AASHTO M 196.

Type 7 Perforated Corrugated Metal Pipe (Bituminous Coated)

Pipe shall conform in all particulars to requirements specified above for perforated corrugated metal pipe. Steel pipe shall be uniformly coated inside and out with a bituminous coating to a minimum thickness of 0.05 inch.

Bituminous material used to coat pipe shall meet the following requirements when tested in accordance with TxDOT Test Method Tex-522-C:

Solubility, % by wt. in	
Trichloroethylene	99.5 minimum
Brittleness Test	Pass
Flow, inches	0.25 maximum

Type 8 Perforated Concrete Pipe

Perforated concrete pipe shall conform to ASTM C 444, “Standard Strength Perforated Nonreinforced Concrete Underdrain Pipe”, except that “Extra Strength Perforated Nonreinforced Concrete Underdrain Pipe” may be substituted for standard strength pipe.

Type 9 ABS Perforated Pipe

ABS pipe shall be extruded and fittings molded from virgin ABS plastic material conforming to ASTM D 1788, Type 4, except that minimum heat deflection temperature is 180°F. Contractor shall furnish certified test reports as evidence that material used for project meets ASTM requirements. Dimensions of ABS pipe shall be as shown in Table I. Fittings shall conform to manufacturer's standard for particular size of pipe required.

TABLE I		
Nominal Size, Inches	Inside Diameter Inches, Minimum	Thickness of Barrel Inches, Minimum
4	3.82	0.19
6	5.70	0.28

Perforations shall conform to requirements for Type 5 pipe underdrains. Crushing strength of ASB pipe shall meet or exceed minimum values in Table II when tested in accordance with flat-plate loading method as outlined in ASTM Designation: D 2412.

TABLE II	
Nominal Size, Inch	Minimum Strength lb. Inch
4	179
6	604

Pipe shall withstand at least 35 percent vertical deflection without rupture of pipe wall and stiffness shall equal or exceed valves at 5 percent deflection. Vertical deflection shall be computed as follows:

$$\text{Percent Deflection} = \frac{\text{Reduction Vert. I.D.}}{\text{Nominal I.D.}} \times 100$$

Ends of ABS pipe, couplings and fittings shall be perpendicular or square to longitudinal axis of main body within a maximum angle of 3 degrees. Outer and inner surface of pipe shall be free from blisters, voids and discontinuities.

Type 10 Preformed Corrugated Polyethylene Plastic Tubing

Tubing shall comply with AASHTO M 252.

Type 11 Perforated Polyvinyl Chloride Pipe

Pipe shall be Schedule 40 and conform to ASTM D 1785. Unless otherwise specified, the perforated pipe shall have two rows of holes 13 mm (½ in.) in diameter on 125-mm (5 in.) centers, with allowable tolerances of ±1 mm (1/16 in.) on the diameter and + 6, -0 mm (+¼, -0 in.) on the spacing, and the rows shall be parallel to the axis of the pipe and 120 ±5° apart.

(2) Filter Material

(a) Aggregate

Filter material for use in backfilling trenches under, around and over underdrains shall consist of hard, durable, clean, washed gravel or crushed stone, ranging in size from 5/8 to 1 inch and shall be free from organic matter, clay balls or other deleterious matter.

(b) Geotextile

Geotextile shall conform to Item No. 620, "Filter Fabric".

551.3 Construction Methods

Excavation of each trench shall begin at its outlet and proceed toward its upper end. Trench must not be excavated below proposed grade line and shall be located as indicated or as directed by Engineer and true to line and grade. Trench shall be dressed with a tile hoe or shovel in such manner that will facilitate placement of underdrain. Closed joints shall be coupled with bands, solvent weld couplings or integral joints. Perforated ABS pipe shall be jointed by couplers or solvent welding according to manufacturer's recommendation. No tar paper strips shall be used.

Approved plugs shall be placed in upper ends of pipes and exposed ends of underdrains shall be covered with ½ inch galvanized hardware cloth and filter fabric.

When indicated, concrete riprap or headwalls of dimensions indicated shall be constructed at outlet ends of pipe underdrains. Concrete materials and proportions shall conform to requirements specified for Class B Concrete conforming to Item No. 403, "Concrete for Structures".

When perforated metal pipe is used and trench is founded in pervious material, a thin layer of tamped impervious material shall be placed on bottom of trench as indicated or as directed by Engineer. Sections shall be jointed with band couplers.

When clay or concrete pipe is used and trench is founded in pervious material, a bottom course of specified filter material shall be placed and tamped to a uniform depth of 2 inches. Pipe shall then be firmly embedded in filter material, hub upgrade and spigot firmly centered into adjacent hub end or in the case of butt end type drains with an open

joint of approximately 3/8 inch. Open joints shall then be covered with approved 2 ply tar paper strips not less than 6 inches in width and of sufficient length to permit ends being turned outward and laid flat on bottom course of filter material of each side for a distance of 3 inches. When trench is founded in impervious material, the 2 inch bottom course of filter material shall be omitted, pipe laid directly in trench and filter material placed in trench to a depth of 2 inches on each side of pipe. Two ply tar paper strips shall then be placed as specified above.

551.4 Measurement

Work and accepted materials for "Pipe Underdrains" shall be measured by the linear foot of pipe measured along slope and shall include clearing, excavation, filter material, filter fabric, pipe, length of elbows, wyes, tees and other branches and backfill.

551.5 Payment

Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid per linear foot of "Pipe Underdrains" of type and size specified, which price shall be full compensation for furnishing and placing materials, for underdrain excavation and backfill, for filter materials, for plugs and screens and for labor, tools, equipment and incidentals necessary to complete the work.

Any riprap, headwalls or Trench Safety System indicated will be measured and paid for in accordance with provisions of Item No. 403, "Concrete for Structures", Item No. 410, "Concrete Structures", Item No. 509, "Trench Safety Systems" and Item No. 591, "Riprap for Slope Protection".

Payment will be made under:

Pipe Underdrains, In. - Per Linear Foot.

End

Ref: 403, 410, 509, 591, 620

ITEM NO. 558
STRUCTURAL PLATE STRUCTURES

558.1 Description

This item shall consist of furnishing and installing structural plate pipes, pipe arches, arches and special shapes conforming to these specifications, of the sizes, out dimensions and materials indicated at locations indicated or as directed by the Engineer, in conformity with established lines and grades. Structural plate pipes shall be furnished round or elongated, as indicated.

558.2 Materials and Manufacture

(1) Plates

The plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes shall conform to AASHTO M 167 for galvanized corrugated steel structures and to AASHTO M 219 for aluminum alloy structures.

Steel fasteners may be mechanically galvanized or hot-dip galvanized.

Steel plates shall consist of structural units of corrugated galvanized metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. Plates will have approximately a 2 inch lip beyond each end crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled. Footings for arches shall be designed and constructed to accommodate this additional length.

Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 1 foot.

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as indicated. Joints shall be staggered so that not more than 3 plates are jointed at any one point. Unless otherwise indicated, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be (a) staggered in rows 2 inches apart, with 1 row in the valley and 1 in the crest of the corrugations and not less than 4 bolts per foot for galvanized steel structures or (b) in rows 1 ¾ inches apart with 2 bolts in each valley and on each crest and not less than 16 bolts per 3 feet for aluminum alloy structures. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall be not less than 1 ¾ times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch. Plates for forming skewed or sloped ends shall be cut so as to give the

angle of skew or slope specified. Burned edges shall be free from oxide and burrs, shall present a workmanlike finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

(2) **Metal Headwalls**

The material for metal headwalls shall comply with details indicated.

When required, aluminum alloy inverts, toe walls, footings and closure plates shall conform to the material requirements for the aluminum structural plate structure. Extruded aluminum transverse stiffeners shall conform to ASTM B 221, Alloy 6061-T6.

(3) **Concrete**

Concrete and reinforcing steel shall conform to Item No. 403, "Concrete for Structures" and Item No. 406, "Reinforcing Steel". Unless otherwise indicated, concrete for footings and headwalls shall be Class A. Riprap for slope protection and for invert paving, when required, shall be Class B concrete, with reinforcement as indicated and shall conform to Item No. 591, "Riprap for Slope Protection".

Material for membrane curing shall conform to Item No. 409, "Membrane Curing".

558.3 Visual Inspection

The Contractor shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified and any evidence of poor workmanship as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

558.4 Mill and Factory Inspection

If the Engineer so elects, he may have the material inspected and sampled in the rolling mill or in the shop where fabricated. He may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the direction of the Engineer. The Engineer or his representative shall have free access to the mill or shop for inspection and every facility shall be extended to him for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

558.5 Workmanship

Structural plates on which the spelter coating has been damaged or which show defective workmanship, shall be rejected, except that damaged areas of spelter coating deemed by the Engineer to be of a minor nature may be repaired by painting with a zinc dust-zinc oxide paint conforming to individual plates but to the shipment as a whole. The following defects are considered to be poor workmanship. The presence of any or all of them in any individual structure plate will be cause for rejection:

- (a) Uneven laps
- (b) Elliptical shaping (unless specified)
- (c) Variation from a straight center line
- (d) Ragged edges
- (e) Loose, uneven lined or spaced bolts
- (f) Illegible brand
- (g) Bruised, scaled or broken spelter coating
- (h) Dents or bends in the metal itself

558.6 Design

(1) **Gage or Minimum Thickness and Corrugations for Structural Plate**

The gage or minimum thickness and permissible corrugations of metal plates to be furnished for each structure will be as indicated.

(2) **Skewed Structures**

The end skew shall not exceed 45 degrees. When the skew of arches is more than 15 degrees, the length of the structure shall be such that no portion of the live load will be carried by the cut portion of the arch end. Where right of way or other conditions do not permit the required length, the cut end shall be supported by a rigid headwall designed to meet the conditions. When the skew angle of pipes exceeds 20 degrees and the structure has the ends cut to fit a slope, the ends shall be reinforced with concrete riprap or other suitable end treatment as indicated on the plans or as directed by the Engineer. If headwalls are required, the plates shall be anchored to the headwall with not less than $\frac{3}{4}$ inch diameter by 6 inch minilength bolts, at not over 19 inch centers. If structures are to have skewed ends, bevels, step-bevels or other special end treatment, this information will be indicated.

(3) **Multiple Structures Installed in Parallel Lines**

Where multiple lines of pipes, pipe arches or box culverts greater than 48 inches in diameter or span are used, they shall be spaced so that adjacent sides of the pipe shall be at least $\frac{1}{2}$ diameter or 3 feet apart, whichever is less, to permit adequate compaction of backfill material. For diameters up to and including 48 inches, the minimum spacing shall be not less than 24 inches.

(4) **Substructure for Arches**

The substructure for structural plate arches shall be as indicated.

558.7 Designation of Type

The type(s) of structure will be indicated by one of the following descriptions:

- Structural Plate Pipe (Galv. Steel)
- Structural Plate Pipe (Alum.)
- Structural Plate Pipe Arch (Galv. Steel)
- Structural Plate Pipe Arch (Alum.)
- Structural Plate Arch (Galv. Steel)
- Structural Plate Underpass (Galv. Steel)
- Structural Plate Underpass (Alum.)
- Structural Plate Long Span Structures (Galv. Steel)
- Structural Plate Long Span Structures (Alum.)

When designated as one of the above types without the material being shown, Contractor may furnish the structure in either galvanized steel or aluminum.

558.8 Construction Methods

(1) Excavation

All excavation shall conform to Item No. 401, "Structural Excavation". Trenches for pipes, pipe arches, underpasses or box culverts shall be of sufficient width to provide free working space for erection and thorough tamping of the backfill and bedding material under and around the structure. If the quality of the native soil is less than that of the proposed backfill material, the excavation shall extend, to each side of the barrel, a minimum horizontal distance of half the span or 2/3 of the total rise, whichever is greater. The Contractor shall make such temporary provisions as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.

(2) Foundations, Structural Plate Structures with Metal Inverts

These structures shall be bedded in a foundation of sandy earth material carefully and accurately shaped to fit the lower part of the pipe for at least 10 percent of its overall height, except that the length of bedding arc need not exceed the width of the bottom plate. The sandy material shall be at least 3 inches in thickness so as to obtain uniform seating of the corrugations on the pipe bed. For culverts the bedding specified herein shall be the full width of the invert.

Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with a compacted earth cushion having a thickness of not less than ½ inch per foot height of fill over the top of the pipe, with the minimum allowable thickness of 12 inches and a maximum of 24 inches under the pipe. Where the soil encountered at the established grade is a quicksand, muck or similar unstable material, it shall be removed and replaced in conformance with Item No. 401, "Structural Excavation". Special bedding, when required, shall be as indicated.

(3) **Foundations, Structural Plate Structures with Reinforced Concrete Footings**

Footings for these structures shall be formed and finished to true lines and grades as established by the Engineer. Anchors or slots (for box culverts) shall be set to true line and grade when placing concrete for each substructure unit. The work of placing substructure units shall conform to Item No. 403, "Concrete for Structures", Item No. 406, "Reinforcing Steel" and Item No. 410, "Concrete Structures".

Footing shall be placed entirely on (a) rock, shale or similarly hard material or (b) firm soil or compacted soil cushion. When part of the founding area is rock, it shall be undercut and replaced with a minimum 12 inch thick compacted soil cushion. When a thin layer of soil is partially covering rock within the bearing area and when practical to do so, the soil may removed and the footings place directly on rock as indicated.

(4) **Erection**

Structural plate structures shall be installed as indicated and in accordance with this item.

Any steel in joints which is not protected by galvanizing shall be coated with suitable asphaltum paint.

Pipes and/or plates shall be handled carefully to avoid damage to any protective coating. Damaged coatings shall be repaired.

Anchor bolts used for anchoring plates to headwalls or other concrete end treatment shall be $\frac{3}{4}$ inch diameter by 6 inch minimum length on not more than 19 inch centers.

No plates for arch structures shall be placed until the substructure has cured for a minimum of 3 days.

When all plates are in position, all bolts not already in place shall be inserted and all nuts tightened progressively and uniformly, beginning at one end of the structure. All nuts shall be tightened a second time to a torque of not less than 150 ft-lbs nor more than 300 ft-lbs for steel bolts and not less than 100 ft-lbs nor more than 150 ft-lbs if using aluminum bolts. It is essential that bolts be well If an impact wrench is used, a sufficient number of bolts should be checked with a long-handled, structural or socket wrench or a torque wrench to insure that they are properly tightened. All service bolts used in drawing the plates together shall be replaced with standard high strength bolts.

(5) **Shape Control**

The Contractor shall furnish acceptable shape control devices for monitoring the horizontal and vertical shape of the structure(s). The shape shall be kept within 2 percent of design measurements (span or rise, whichever is greater) or 5 inches whichever is less during erection and backfilling.

(6) **Backfilling**

Backfilling and/or construction of the embankment around and over the pipe is a critical phase of the construction and strict adherence to these construction methods is required. Backfilling and/or embankment construction around the pipe shall conform to Item No. 401, "Structural Excavation", except as modified herein.

Within vertical planes 2 feet beyond the horizontal limits of the structure and until a minimum of 2 feet of cover has been compacted over the structure, only hand operated, mechanical tamping equipment will be permitted.

Unless otherwise indicated or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 4 feet of permanent or temporary, compacted fill has been placed thereon. Plates or structures damaged by the Contractor's equipment during backfilling operation shall be removed and replaced by the Contractor at his expense.

During the backfilling operations, extreme care shall be taken to avoid unequal pressures and to obtain uniformly compacted backfill material of uniform density throughout the length of the structure and to insure proper backfill under the structure.

Prior to adding each new layer of loose backfill material, until a minimum 2 feet of cover is obtained, an inspection will be made of the inside periphery of the structure to determine any local or unequal deformation caused by improper construction methods.

The structure shall be backfilled so that when backfill is complete the inside dimensions shall be within tolerances set forth in shape control above. In the case of arches (does not apply to pipe arches) when backfilling is completed before headwalls are placed, the first material shall be placed midway between the ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. The ramp shall be constructed evenly from both sides and the backfilling material shall be thoroughly compacted as it is placed. After the 2 ramps have been constructed to the top of the arch, the remainder of the backfill shall be deposited from the top of the arch both ways from the center, to the ends and as evenly as possible on both sides of the arch. If the headwalls are built before the arch is backfilled, the fill material shall be placed first adjacent to one headwall until the top of the arch as been reached, after which the fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch.

For multiple structures the same backfill phases will be performed for all structures more or less simultaneously. Backfilling between the barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Backfill material shall not be dropped over the top arc so that damage to the flexible structure will result. Compaction of this backfill shall be with hand operated tampers or other acceptable equipment.

558.9 Measurement

Structural plate pipes, pipe arches, arches or special shapes of the gage or minimum thickness and corrugation indicated will be measured by the linear foot of each structure along its flow line between the ends of the structure.

For multiple structures, the measured length will be the sum of the lengths of barrels as prescribed above.

Aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required, will be considered a part of the requirements of the structure and will not be measured for payment.

558.10 Payment

Payment for "Structural Plate Pipes, Pipe Arches, Arches or Special Shapes", measured as prescribed above, will be made at the unit price bid for the various sizes, gage or minimum thickness and of the required material, if specified, of the various items required by the plans, complete in place.

This payment shall be full compensation for furnishing, transporting and erecting; for handling and placing of select fill material; for all bolts, nuts, washers, anchor bolts and anchor channels or angles; for furnishing all aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required; and for all other items of material, labor, equipment, tools and incidentals necessary to complete the various installations in accordance with these specifications.

Payment will be made under one of the following:

- Structural Plate Pipe, _____, _____ - Per Linear Foot.
- Structural Plate Pipe Arch, _____, _____ - Per Linear Foot.
- Structural Plate Arch, _____, _____ - Per Linear Foot.
- Structural Plate Underpass, _____, _____ - Per Linear Foot.
- Structural Plate Box Culvert, _____, _____ - Per Linear Foot.

End

ITEM NO. 559

PORTLAND CEMENT CONCRETE BOX CULVERTS

559.1 Description

This item governs the materials used and the constructing, furnishing and placing of Portland cement concrete box culverts and wing walls on a prepared grade at the location shown on the Drawings and in accordance with Standard Detail 559-1, "Fabrication Tolerances for Precast Box Culverts". Unless indicated otherwise on the Drawings, the Contractor shall have the option of furnishing cast-in-place, precast (formed) or precast (machine made) Portland cement concrete box culverts.

When cast-in-place box culverts are used, they shall conform to the details indicated on the Drawings and Standard Detail 559-1, "Fabrication Tolerances for Precast Box Culverts" along with the requirements for Standard Specification Item No. 403, "Concrete for Structures" and Standard Specification Item No. 410, "Concrete Structures". When precast box culverts are used under traffic, the design loads shall consist of the impact load, dead load and live load [HS 20- per AASHTO Standard Specifications for Highway Bridges; design wheel load, 16 Kips (71.2 kN)] and to the requirements of ASTM C 789 and/or ASTM C 850.

This item to also consist of any pumping, bailing, drainage and requirements of Standard Specification Item No. 509, "Trench Safety Systems" for trench walls, when indicated on the Drawings.

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

559.2 Submittals

The submittal requirements of this specification item include:

- A. The foundation plan and drilling/excavation details;
- B. Class A Portland cement concrete mix design;
- C. Anchor bolt plan and details;
- D. Reinforcing Steel details and placement drawings and
- E. Casing plan and details (if required).

559.3 Materials

- A. Concrete

Class A Concrete shall be used for cast-in-place and precast (formed) box culverts conforming to the requirements of Standard Specification Item No. 403, "Concrete Structures" and Standard Specification Item No. 410, "Concrete for Structures", except that Class S Portland cement Concrete will be required for direct traffic boxes.

Portland cement concrete for precast (machine made) boxes shall conform to ASTM C 789 or C 850 and shall have a minimum 28-day compressive strength of 5,000 psi (34.475 mPa).

B. Reinforcement

Reinforcing steel shall conform to Standard Specification Item No. 406, "Reinforcing Steel".

C. Jointing Material

Materials for jointing precast box culverts shall conform to Standard Specification Item No. 510, "Pipe".

D. Membrane Curing

Materials for membrane curing shall conform to Standard Specification Item No. 409, "Membrane Curing".

E. Admixtures

Admixtures shall conform to Standard Specification Item No. 405, "Concrete Admixtures". Air entraining admixtures shall be added to the mixture to produce concrete with not less than 4 nor more than 7 percent air content by volume.

F. Granular Backfill

Materials for Granular Backfill shall conform to Standard Specification Item No. 210, "Flexible Base".

G. Foundation Rock

Foundation Rock shall be well graded, coarse aggregate ranging in size from 2 to 8 inches (50 to 200-mm) and capped with 5/8 inch (16-mm) rock.

559.4 Fabrication

Forms for precast (machine made) boxes shall be made of steel. Forms for precast (formed) boxes may be either wood or steel. Forms shall be mortar-tight and of sufficient strength to prevent bulging or misalignment of adjacent boxes. They shall be constructed to permit their removal without damage to the concrete. Offsets at form joints shall not exceed 1/8 inch (3.2-mm). Forms shall be clean and free of extraneous matter when Portland cement concrete is placed.

Positive means of supporting steel cages in place throughout forming and Portland cement concrete placement will be required and subject to the approval of the Engineer or designated representative. Welding of reinforcing steel will be permitted only where shown on the Drawings. Welding shall be done by a qualified welder.

Precast (machine made) boxes shall be cast by a process, which will provide for uniform placement of the Portland cement concrete in the forms and compaction by mechanical devices, that will assure dense concrete. Portland cement concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the Portland cement concrete can be assured. Transit-mixed concrete will not be acceptable for use in precast (machine made) boxes.

Curing of precast boxes made in a commercial plant shall be by any one or by a combination of the following methods, which are compatible with the joint materials selected or as directed by the Engineer or designated representative.

A. Steam Curing

Boxes will be placed in a curing chamber, free from outside drafts and cured in a moist atmosphere maintained by the injection of steam for such time and temperature as necessary for proper curing. The curing chamber shall be constructed to allow full circulation of steam around the entire box. Steam outlets shall be positioned so that live steam is not applied directly to the Portland cement concrete.

B. Water Curing

Boxes may be water cured by covering with water saturated cotton mats, polyethylene sheeting or polyethylene burlap blankets, by a system of perforated pipe or mechanical sprinklers, by porous hose or by other methods that will keep the boxes moist during the curing period. Water for curing shall conform to Standard Specification Item No. 403, "Concrete for Structures".

C. Membrane Curing

Type 1 membrane curing compound may be used for interim curing or for complete curing. All surfaces shall be kept moist prior to the application of the curing compound and shall be damp when the compound is applied.

When used for interim curing, the curing compound shall be applied to the outside surface of the box upon removal of forms. It shall also be applied to the inside surface or a suitable covering may be placed over the box opening to protect the inside of the box against rapid drying.

When used for complete curing, curing compound shall be applied to the inside surface of the box when interim curing is applied or when handling strength has been attained, but not later than 24 hours after casting.

Curing shall not be delayed longer than 1 hour after the Portland cement concrete has been placed in the forms or more than 1/2 hour after removal of forms, unless interim curing is applied.

Precast boxes made in a commercial plant shall be continuously cured for a period of 3 days after reaching handling strength or until the design strength has been attained. Curing may be interrupted for no more than 30 minutes for form removal and no more than 4 hours for removal to a storage area and resumption of curing. All precast boxes shall be protected from freezing during the curing period.

A curing day is a calendar day when the air temperature, taken in the shade away from artificial heat, is above 50°F (10°C) for at least 19 hours or for colder days if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above 50°F (10°C) for the entire 24 hours.

Test cylinders shall be cured at the same time and in the same manner as the boxes.

Not more than 4 lifting holes may be provided in each box to facilitate handling. They may be cast-in, cut into the fresh Portland cement concrete after form

removal or drilled and shall not be more than 2 inches (50-mm) in diameter or 2 inches (50-mm) square. Cutting or displacement of reinforcement will not be permitted. Spalled areas around the holes shall be repaired. Concrete boxes shall be given an ordinary finish conforming to Standard Specification Item No. 410, "Concrete Structures".

Precast boxes of either type, made in a plant, shall bear the following marking:

The name or trademark of the manufacturer;

The date of manufacture;

The box size and height of fill.

When fitting holes are not provided, one end of each box section shall be clearly marked on the inside and outside walls to indicate the top and/or bottom as it will be installed.

Marking shall be indented into the box or may be painted thereon with waterproof paint.

559.5 Testing

Precast box culverts made in a commercial plant, shall have a minimum of 4 test cylinders for design strength made for each day's production run of each size and class of box culverts. Strength tests for each production run will be based on the average strength of 2 cylinders, which may be tested anytime after completion of the specified curing period.

When design strength is attained on the initial test, further tests on that run will not be required. Should the initial test fail to meet the design strength, a subsequent test shall be made at 28 days unless additional test cylinders were made during production of that run. Failure to attain design strength by the 28-day test will result in rejection of the run represented by the test. Tests for handling strength will be based on the average of 2 cylinders. These test cylinders are in addition to those required for design strength. Cylinders for compressive strength tests shall be made in accordance with TxDOT Test Method Tex-704-I. Testing of precast (formed) culvert sections or cast-in-place culverts shall conform to Standard Specification Item No. 403, "Concrete for Structures".

559.6 Fabricating Tolerances

Tolerances for precast boxes of either type shall conform to the following:

- A. The inside vertical and horizontal dimensions shall not vary from plan requirements more than + 1/2 inch (12.5-mm).
- B. The horizontal or vertical plane at each end shall not vary from being perpendicular to the top and bottom by more than 1/2 inch (12.5-mm) when measured diagonally between opposite interior corners of the end section.
- C. The sides of a section at each end shall not vary from being perpendicular to the top and bottom by more than 1/2 inch (12.5-mm) when measured diagonally between opposite interior corners of the end section.
- D. The thickness of walls and slabs shall not be less than that required by the

Drawings, except that an occasional deficiency not greater than 1/4 inch (6.3-mm), will be acceptable. If proper jointing is not affected, thick nesses in excess of Drawing requirements are acceptable.

- E. The straightness of the tongue and groove at the mating surface shall not vary by more than 1/4 inch (6.3-mm).

Deviations from the above tolerances will be acceptable if the box sections can be fitted at the plant or job site and it is determined that an acceptable joint can be made. For this condition, an acceptable joint is:

When 2 box sections are fitted together on a flat surface in proper alignment and in the position they will be installed, the longitudinal opening at any point shall not exceed 1 inch (50-mm). Box sections accepted in this manner shall be match-marked for installation.

559.7 Defects and Repair

Fine cracks or checks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless they are numerous and extensive. Cracks, which extend into the plane of the reinforcing steel, but are acceptable otherwise, shall be repaired in an approved manner.

Small damaged or honeycombed areas, which are purely surface in nature, may be repaired. Excessive damage, honeycomb or cracking will be subject to structural review. Repairs shall be sound, properly finished and cured in conformance with the pertinent specifications.

When fine cracks or hairchecks on the surface indicate poor curing practices, further production of precast boxes shall be discontinued until corrections are made and proper curing provided.

559.8 Storage and Shipment

Precast boxes shall be stored on level blocking in a manner acceptable to the Engineer or designated representative. No load shall be placed upon them until design strength is reached and curing completed. Shipment of boxes may be made when the design strength and curing requirements have been met.

559.9 Construction Methods

Excavation and backfill shall conform to Standard Specification Item No. 401, "Structural Excavation and Backfill" and Standard Specification Item No. 510, "Pipe", except where tunneling or jacking methods are required or indicated on the Drawings.

Precast concrete boxes shall be bedded on a foundation of firm stable material accurately shaped to conform to their base. When indicated on the Drawings, special bedding materials shall be provided.

Unless otherwise indicated on the Drawings, the Contractor may use any of the jointing materials, except rubber gaskets, and shall conform to the jointing requirements in Standard Specification Item No. 510, "Pipe".

When precast boxes are used to form multiple barrel structures, they shall be placed in conformance with the details indicated on the Drawings. Materials to be used between barrels shall be as indicated on the Drawings.

Connections of precast boxes to cast-in-place boxes or to any required headwalls, wingwalls, riprap or other structures shall conform to the details indicated on the Drawings.

Lifting holes shall be filled with mortar or concrete and cured to the satisfaction of the Engineer or designated representative.

559.10 Measurement

A. Cast in Place Box Culverts

The quantities of Portland cement concrete of the various classifications, which will constitute the completed and accepted "Box Culverts" in place will be measured by the cubic yard (cubic meter: 1 cubic meter equals 1.308 cubic yards) , based on the dimensions indicated on the Drawings.

B. Precast

Portland cement Concrete box culverts of each size and type shall be measured by the lineal foot (lineal meter: 1 lineal meter equals 3.28 lineal feet). The measurement will be made between the ends of the box along the central axis. For concrete boxes used in multiple barrel structures, the measured length will be the sum of the lengths of all barrels measured as described above.

559.11 Payment

The unit price bid, per lineal foot for the various sizes and types of precast "Concrete Box Culverts" or the unit price bid, per cubic yard for the various sizes and types of cast in place

"Concrete Box Culverts" shall be full compensation for constructing, furnishing and transporting boxes; the preparation and shaping of bed; jointing of boxes; for connections to existing structures; concrete, reinforcing steel and all other items of material, labor, equipment, tools and incidentals necessary to complete the work in accordance with the Drawings and specifications, except excavation and backfill, which shall be in accordance with Standard Specification Item No. 401, "Structural Excavation and Backfill". When precast boxes are laid on a skew, full compensation for cutting the ends when required by the Drawings, shall be included in the unit bid price per lineal foot, measured in accordance with "Measurement" above.

Payment will be made under one of the following:

Concrete Box Culverts, ____Ft. x ____Ft.	Per Lineal Foot.
Concrete Box Culverts	Per Cubic Yard.

End

SPECIFIC Cross Reference Materials

Standard Specification Item No. 559, "Concrete Box Culverts"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 210	Flexible Base
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures
Item No. 406	Reinforcing Steel
Item No. 409	Membrane Curing
Item No. 410	Concrete Structures
Item No. 509	Trench Safety Systems
Item No. 510	Pipe

American Society for Testing and Materials,

<u>ASTM Designation</u>	<u>Description</u>
C 789/789M	Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
C 850/850M.	Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 0.6 m (2 ft) of Cover Subjected to Highway Loadings

Texas Department of Transportation, Manual of Testing Procedures

<u>Test Method</u>	<u>Description</u>
Tex 704-1	Making, Curing, and Testing Compression Test Specimens in Precast Concrete

RELATED Cross Reference Materials

Standard Specification Item No. 559, "Concrete Box Culverts)

Texas Department of Transportation: Standard Specifications for Construction, Maintenance Of Highways, Streets and Bridges

<u>Designation</u>	<u>Description</u>
Item No. 420	Concrete Structures
Item No. 421	Portland Cement Concrete
Item No. 440	Reinforcing Steel

ITEM NO. 591
RIPRAP FOR SLOPE PROTECTION

591.1 Description

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

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

591.2 Submittals

The submittal requirements for this specification item shall include:

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

591.3 Materials

- A. Rock

Rock for riprap shall consist of field rock or rough, unhewn quarry rock as nearly uniform in section as is practicable. The rock shall be dense, resistant to the action of air and water and suitable in all respects for the purpose intended.

- B. Broken Concrete

The rock used for mortar riprap may consist of broken concrete removed under the contract or obtained from other approved sources. Broken concrete shall be as nearly uniform in section as practicable and of the sizes indicated in Section 591.5, "Dry Riprap".

- C. Concrete

Cast in place concrete shall be Class A Concrete and shall conform to Standard Specification Item No. 403, "Concrete for Structures".

- D. Grout and Mortar

Grout and mortar shall consist of 1 part Portland Cement and 3 parts sand, thoroughly mixed with water. Mortar shall have a consistency such that it can be easily handled and spread by trowel. Grout shall have a consistency such that it

will flow into and completely fill all joints.

E. Reinforcement

Reinforcement shall conform to Standard Specification Item No. 406, "Reinforcing Steel".

F. Joints

Premolded expansion joint material shall conform to Standard Specification Item No. 408, "Concrete Joint Material".

G. Tie Backs and Anchors

Galvanized tie backs and anchors shall be as indicated on the Drawings.

H. Filter Fabric

Filter Fabric shall conform to Standard Specification Item No. 620, "Filter Fabric".

591.4 Construction Methods

Prior to commencement of this work, all required erosion control and tree protection measures (Standard Specification Item No. 610, "Preservation of Trees and Other Vegetation") shall be in place and utilities located and protected as set forth in the "General Conditions". Construction equipment shall not be operated within the drip line of trees unless indicated on the Drawings. Construction materials shall not be placed under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees until tree wells are constructed. Spalls and small stones used to fill open joints and voids in rock riprap shall be rocked and wedged to provide a tight fit.

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

All blasting shall conform to 01550, "Public Safety and Convenience". The Contractor shall comply with all laws, ordinances, applicable safety code requirements, uniform Fire Code Articles 77, "Explosive Materials" and 80, "Hazardous Materials" and any other regulations relative to handling, storage and use of explosives. In all cases, a Blasting Permit must be obtained in advance from the appropriate City agency.

591.5 Dry Riprap

Unless otherwise indicated on the Drawings, all rocks used in these types of riprap shall weigh between 50 and 150 pounds (22 and 69 kilograms) each and at least 60 percent of the rocks shall weigh more than 100 pounds (45 kilograms) each. When the riprap will be placed on an erodible soil, as determined by the Engineer or designated representative, a layer of filter fabric shall be placed, prior to placement of the Riprap material.

The rocks shall be placed in a single layer with close joints. The upright axis of the rocks shall make an angle of approximately 90 degrees with the embankment slope. The courses shall be placed from the bottom of the embankment upward, with the larger rocks being placed on the lower courses. Open joints shall be filled with spalls. Rocks

shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches (75 mm). Rocks that project more than the allowable amount in the finished work shall be replaced or chipped. Dry Riprap may have a toe wall of concrete with dimensions and reinforcement indicated on the Drawings.

591.6 Mortared Rock Riprap

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

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

591.7 Concrete Riprap

Concrete for riprap shall be placed as indicated on the Drawings or as directed by the Engineer or designated representative. Unless otherwise indicated on the Drawings, concrete riprap shall be reinforced using wire or bar reinforcement.

Concrete shall be Class A or as indicated otherwise on the Drawings and shall conform to Standard Specification Item No. 403, "Concrete for Structures".

When welded wire reinforcement is indicated, it shall be a minimum of 6 x 6 W1.4 x W1.4 (150 x 150 MW9 x MW9) with a minimum lap of 6 inches (150 mm) at all splices. At the edge of the riprap, the wire fabric shall not be less than 1 inch (25 mm) nor more than 3 inches (75 mm) from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.

When bar reinforcement is used, the sectional area of steel in each direction shall not be less than the sectional area of the wire fabric described above. The spacing of bar reinforcement shall not exceed 18 inches (450 mm) in each direction and the distance from the edge of concrete to the first parallel bar shall not exceed 6 inches (150 mm).

Reinforcement shall be supported properly throughout the placement to maintain its position approximately equidistant from the top and bottom surface of the slab.

Unless otherwise noted, expansion joints of the size and type indicated on the Drawings shall be provided at intervals not to exceed 40 feet (12.2 meters) and shall extend the full width and depth of the concrete. Marked joints shall be made 3/8 inch (9.5 mm) deep at 10 foot (3 meter) intervals. All joints shall be perpendicular and at right angles to the forms unless otherwise indicated on the Drawings.

Slopes and bottom of the trench for toe walls shall be compacted and the entire area sprinkled before the concrete is placed.

After the concrete has been placed, consolidated and shaped to conform to the dimensions indicated on the Drawings and has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface.

Immediately following the finishing operation, the riprap shall be cured conforming to Standard Specification Item No. 410, "Concrete Structures".

591.8 Pneumatically Placed Concrete Riprap, Type I and Type II

Pneumatically placed concrete for riprap shall be placed as indicated on the Drawings or as established by the Engineer or designated representative. Pneumatically placed concrete shall conform to Standard Specification Item No. 404, "Pneumatically Placed Concrete". Reinforcement shall conform to the details indicated on the Drawings and Standard Specification Item No. 406, "Reinforcing Steel". Reinforcement shall be supported properly throughout placement of concrete. All subgrade surfaces shall be moist when concrete is placed.

The surface shall be given a wood float finish or a gun finish as indicated on the Drawings.

The strength and design of Pneumatically Placed Concrete Riprap shall be either Type I or if indicated, Type II conforming to Standard Specification Item No. 404, "Pneumatically Placed Concrete".

Immediately following the finishing operation, the riprap shall be cured conforming to Standard Specification Item No. 410, "Concrete Structures".

591.9 Measurement

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

Concrete toe walls will not be measured separately but shall be subsidiary to the riprap of the type with which it is placed.

591.10 Payment

The riprap quantities, measured as provided above, will be paid for at the unit bid prices per square foot or per cubic yard as indicated for riprap of the various classifications.

The Unit Bid Price shall include full compensation for furnishing, hauling and placing all materials, including toe walls, reinforcement and premolded expansion joint material and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment for excavation of toe wall trenches and for all necessary excavation below natural ground or bottom of excavated channel will be included in the unit bid price for riprap.

Payment for excavation required for shaping of slopes for riprap shall be included in the unit bid price for riprap, except for the situation when the header banks upon which the riprap is to be placed are built by prior contract. In this specific case the excavation for shaping of slopes, will be paid for conforming to Standard Specification Item No. 401, "Structural Excavation and Backfill".

Payment will be made under one of the following:

Dry Riprap -	Per Square Yard.
Mortared Rock Riprap -	Per Square Yard.
Concrete Riprap, ___ In. -	Per Square Yard.
Concrete Riprap	Per Cubic Yard.
Pneumatically Placed Concrete Riprap, ___In.	Per Square Yard.

End

<u>SPECIFIC</u> CROSS REFERENCE MATERIALS
--

Specification 591, "Riprap for Slope Protection"
--

City of Round Rock Specifications

<u>Designation</u>	<u>Description</u>
Item No. 403	Concrete for Structures
Item No. 404	Pneumatically Placed Concrete
Item No. 406	Reinforcing Steel
Item No. 408	Concrete Joint Material
Item No. 410	Concrete Structures
Item No. 610	Preservation of Trees and Other Vegetation
Item No. 620	Filter Fabric

<u>RELATED</u> CROSS REFERENCE MATERIALS

Specification 591, "Riprap for Slope Protection"
--

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 623	Dry Stack Rock Wall

ITEM NO. 593
P.C. CONCRETE RETARDS

593.1 Description

This item governs Portland Cement concrete retards used to anchor underground pipe. Retards shall be constructed as indicated on the Drawings, presented in City of Round Rock Standard Detail 593-1 or as directed by the Engineer or designated representative in accordance with these specifications. This item shall also govern any pumping, bailing and dewatering or drainage necessary to complete the work, including Standard Specification Item No. 509, "Trench Safety Systems" for trench walls, when Concrete Retards are indicated on the Drawings or required by the Engineer or designated representative.

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

593.2 Submittals

The submittal requirements of this specification item include:

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

593.3 Materials

- A. Portland Cement Concrete
The concrete materials used in construction under this item shall conform to Class D, Standard Specification Item No. 403, "Concrete for Structures".
- B. Reinforcement
Reinforcement shall conform to Standard Specification Item No. 406, "Reinforcing Steel".

593.4 Construction Methods

Prior to placement of Portland cement concrete, excavation for retards shall be made to proper section and depth. If considered necessary by Engineer or designated representative, the bottom of the excavation shall be hand tamped and sprinkled. The excavated area for concrete retards shall be moist when the Portland cement concrete is placed.

After the Portland cement concrete has been placed, consolidated and shaped to conform to the dimensions indicated on the Drawings and after sufficiently set, it shall be given a moderately rough finish by floating with a wood float (Standard Specification Item No. 411, "Surface Finishes for Concrete").

No mortar or concrete work shall be undertaken, when the ambient temperature is below 35⁰F (1⁰C) and Work shall be protected from freezing. After completion of the concrete retard, exposed surfaces shall be covered with burlap, cotton mats or other approved covering and kept moist for a minimum period of 3 days. White pigmented curing compound conforming to Item No. 409, "Membrane Curing", Type 2, will be permitted when applied to exposed surfaces.

Unless directed otherwise by the Engineer or designated representative, the material excavated during trenching shall be disposed of at a permitted site.

593.5 Measurement

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

593.6 Payment

Work performed and materials furnished as prescribed by this Standard Specification item, measured as provided under the "Measurement" section will be paid for by the cubic yard or the unit price bid for "Concrete Retards", as indicated in the Contract Documents. The bid pay item price shall include full compensation for excavation, reinforcing, furnishing, hauling and placing all materials required in the construction, the disposal of excavated material and any manipulation, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Portland Cement Concrete Retards	Per Cubic Yard.
Portland Cement Concrete Retards	Per Each.

End

<u>SPECIFIC</u> CROSS REFERENCE MATERIALS
--

Specification Item No. 593, "P.C. Concrete Retards"

City of Round Rock Standard Specification Items

<u>Designation</u>	<u>Description</u>
Item No. 403	Concrete for Structures".
Item No. 406	Reinforcing Steel".
Item No. 409	Membrane Curing",
Item No. 411	Surface Finishes for Concrete
Item No. 507	Trench Safety Systems"

<u>RELATED</u> CROSS REFERENCE MATERIALS

Specification Item No. 593, "P.C. Concrete Retards"

City of Round Rock Standard Specifications

<u>Designation</u>	<u>Description</u>
Item No. 402	Controlled Low Strength Material
Item No. 405	Concrete Admixtures
Item No. 407	Fibrous Concrete
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 504	Adjusting Structures
Item No. 505	Concrete Encasement and Encasement Pipe
Item No. 506	Manholes
Item No. 507	Bulkheads
Item No. 510	Pipe
Item No. 511	Water Valves

TxDOT Specifications

<u>Designation</u>	<u>Description</u>
Item 421	Portland Cement Concrete
Item 440	Reinforcing Steel
Item 526	Membrane Curing
Item 532	Concrete Erosion Retards

ITEM NO. 594 GABIONS AND REVET MATTRESSES

594.1 Description

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

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

594.2 Materials

Gabions and revet mattresses shall be constructed of galvanized steel wire with polyvinylchloride (PVC) flexible coating. The gabions and revet mattresses shall be of the construction and sizes specified in the Drawings and shall meet the specifications presented herein. Unless otherwise specified in the Drawings or approved by the Engineer or designated representative, the gabions and revet mattresses may be constructed of either double twist woven mesh or welded wire mesh.

Gabions shall be furnished in the specified dimensions within a tolerance of ± 5 percent. Revet mattresses shall be furnished in the specified dimensions within a tolerance of (5 percent for the length and width and (10 percent for the height. For each individual gabion or revet mattress, the same mesh style shall be used for the base, front, ends, back, diaphragms and lid panels. Each gabion or revet mattress shall be manufactured and divided into cells of equal length, no greater than 3 feet (0.9 meter), by diaphragm panels.

(1) Gabion and Revet Mattress Wire

Gabion wire shall be galvanized steel, Class 3 or A coating, soft temper conforming to ASTM A 641, and shall specifically meet the requirements given below for gabions (12 gage wire) and/or revet mattresses (13.5 wire gage) as called for in the Drawings. PVC coating of the wire may be fusebonded or extruded onto the wire. Galvanization of welded wire shall be performed either before or after welding.

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

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

(2) **Gabion Mesh**

(A) Woven Mesh

Woven mesh shall be of a uniform nonraveling, double twist hexagonal pattern nominally of dimensions 3.25 inches by 4.5 inches (83 mm by 114 mm). Selvedge wire shall be 10 gage (nominal diameter of 3.4 mm).

(B) Welded Mesh

Mesh opening shall be nominally 3 inches by 3 inches (75 mm by 75 mm). Strength of welds shall meet the following requirements when tested in accordance with section 13.4 of ASTM A-974:

Table 2: Minimum Weld Strength Requirements

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

(C) Manufacturing

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

(3) **Revet Mattresses**

(A) Woven Mesh

Woven mesh shall be of a uniform nonraveling, double twist hexagonal

pattern, nominally of dimensions 2.5" x 3.25" (64 mm by 83 mm). Selvedge wire shall be 12 gage (nominal diameter of 2.7 mm).

(B) Welded Mesh

Mesh opening shall be nominally 1.5" x 3.0" (38 mm by 76 mm). Strength of welds shall meet the requirements listed in Table 2 for 13.5 gage (2.2 mm) wire, when tested in accordance with section 13.4 of ASTM A-974:

(C) Manufacturing

Twisted wire mesh revet mattresses shall be manufactured in conformance with ASTM A-975, while welded wire mesh revet mattresses shall be manufactured in conformance with ASTM A-974.

(4) **PVC Coating**

All wire used in fabrication of the gabions, revet mattresses and wiring operations during construction shall, after zinc coating, have a fusebonded or extruded coating of PVC. The coating shall be gray in color. The thickness shall be nominally 0.020 inch (0.5 mm), and shall not be less than 0.015 inch (0.38 mm) in thickness. It shall be capable of resisting deleterious effects of natural weather exposure, and immersion in salt water.

For PVC-coated welded wire fabric panel, cutting of the panels shall not be allowed closer than 1/4 inch (1/8 inch (6 mm (3.18 mm) after fabrication in order to prevent exposure near the welds.

(A) Initial Properties:

1) Woven Mesh:

The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-975:

a) Specific Gravity:

The specific gravity as determined in accordance with ASTM D-792 shall be between 1.3 to 1.35.

b) Durometer Hardness:

The hardness as determined in accordance with ASTM D-2240 shall be between 50 to 60, Shore D.

c) Tensile Strength:

The tensile strength when tested in accordance with ASTM D-412 shall not be less than 2985 psi (20.6 mPa).

d) Modulus of Elasticity at 100% Elongation:

The Modulus of Elasticity when determined in accordance with ASTM D-412 shall not be less than 2700 psi (18.6 mPa).

- e) Resistance to Abrasion:
The percentage loss in weight (mass) during abrasion testing in accordance with ASTM D-1242 shall be less than 12%.
- f) Brittleness Temperature:
The brittleness temperature shall not be higher than 15°F (-9.0°C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 15°F (8°C) below the minimum temperature at which the gabion will be handled or filled.

2) Welded Mesh:

The initial properties of the PVC coating material shall have a demonstrated ability to conform to the following requirements specified in ASTM A-974:

- a) Specific Gravity:
The specific gravity as determined in accordance with ASTM D-792 shall be between 1.20 and 1.40.
- b) Durometer Hardness:
The hardness as determined in accordance with ASTM D-2240 shall not be less than 75, Shore A.
- c) Tensile Strength:
The tensile strength when tested in accordance with ASTM D-638 shall not be less than 2275 psi (15.7 mPa).
- d) Modulus of Elasticity:
The Modulus of Elasticity when determined in accordance with ASTM D-638 shall not be less than 1980 psi (13.7 mPa).
- e) Resistance to Abrasion:
The percentage loss in weight (mass) shall be less than 12 % during abrasion testing in accordance with ASTM D-1242, Method B, at 200 cycles, CSI-A abrader tape, 80 grit.
- f) Brittleness Temperature:
The brittleness temperature shall not be higher than 15°F (-9.0°C) or a lower temperature specified by the Engineer, when tested in accordance with ASTM D-746. The maximum brittleness temperature should be at least 15°F (8°C) below the minimum temperature at which the gabion will be handled or filled.

g) Adhesion:

The PVC coating on the wire shall adhere to the wire such that the coating breaks rather than separates from the wire, when tested in accordance with the PVC Adhesion Test described in Section 13.3 of ASTM A-974.

h) Mandrel Bend:

The PVC-coated wire, when subjected to a single 360° bend at 0°F (-18°C) around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating.

(B) Performance Tests:

The PVC coating shall have the demonstrated ability to withstand the specified exposure testing.

1) Exposure to Salt Spray: The PVC shall show no effect after 3000 hours of salt spray exposure in accordance with ASTM Test Method B-117.

2) Exposure to Ultraviolet Rays:

The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3000 hours, using apparatus Type E and 145°F (63°C), when tested in accordance with ASTM Practice D-1499 and G-23.

(C) Properties After Exposure Tests:

After conclusion of the salt spray and exposure to ultraviolet light tests, the PVC shall not show cracks, blisters or splits, nor any noticeable change in color. In addition the PVC coating shall not show cracks or breaks after the wires are twisted in the fabrication of the mesh, nor shall there be any moisture intrusion under the PVC coating as a result of the test.

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

1) Woven Mesh:

a) The Specific Gravity shall not change more than 6% of its initial value.

b) The Durometer Hardness shall not change more than 10% of its initial value.

c) The Tensile Strength shall not change more than 25% of its initial value.

d) The Resistance to Abrasion shall not change more than 10% of its initial value.

- 2) Welded Mesh:
 - a) The Specific Gravity shall not change more than 6% of its initial value.
 - b) The Modulus of Elasticity shall not change more than 25% of its initial value.
 - c) The Tensile Strength shall not change more than 25% of its initial value.
 - d) The Resistance to Abrasion shall not change more than 10% of its initial value.

(D) Salt Spray Resistance for Fastener:

The fasteners for twisted mesh wire gabions and revet mattresses shall be subjected to Salt Spray Test of Test Method B-117 for a period of not less than 48 (1 hour cycle length. After testing the fasteners, the selvedge, or mesh wire confined by the fasteners shall show no rusty spots on any part of the surface excluding the cut ends.

(5) **Stone**

(A) Gabion Basket Stones

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

Table 3: Gabion Stone Gradation Requirements

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

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

(B) Revet Mattress Stone:

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

(6) **Connections**

(A) Wire

Lacing wire and connecting wire shall be 13.5 gage [0.087 inch (2.20 mm)] PVC coated galvanized steel, Class 3, soft temper, conforming to ASTM A-641. During testing, any separation of 2 inches (50 mm) or more between connecting wires shall be considered as a failure.

(B) Spiral Binder for Welded Wire Mesh

Spiral binders shall consist of 0.106 inch (2.7 mm) PVC coated wire for the gabion and 0.087 inch (2.2 mm) PVC coated wire for the revet mattresses. Spiral binders shall have a 3.0 inch (75 mm) maximum separation between continuous successive loops (3 inch or 75mm pitch).

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

(C) Alternate Fasteners for Twisted Woven Mesh

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

(7) **Fastener System**

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

(A) Each interlocking fastener shall be locked and closed.

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

(8) Panel to Panel Joint Strength

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

(9) Miscellaneous

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

(10) Certificate of Compliance

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

594.3 Construction

Twisted wire mesh Gabon's and revote mattresses shall be supplied in the forms allowed in ASTM A-975, while welded wire mesh Gabon's and revote mattresses shall be supplied in a form allowed in ASTM A-974.

The Gabon/revote mattress manufacturer/supplier will be required to have a qualified representative on site at the start of gabion/revet mattress construction. The Contractor shall submit work experience documentation of the representative for review/approval by the Engineer or designated representative. The representative shall be available for consultation as needed throughout the gabion construction.

Gabions and revet mattresses shall be constructed to the lines and grades shown on the Drawings. Individual or groups of gabions or revet mattresses, which deviate from line and grade, shall, at the direction of the Engineer or designated representative, be removed and replaced at no cost to the owner. Gabions or revet mattresses, which are constructed with bulges, and/or underfilled, loosely filled, or otherwise lacking a neat and compact appearance shall, at the direction of the Engineer or designated representative, be repaired/replaced at no cost to the owner. Underfilling of gabion/revet mattress corners to facilitate insertion of spirals shall not be permitted.

(1) Foundation Preparation

The foundation shall be excavated to the extent shown on the Drawings or as directed by the Engineer or designated representative. All loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. The depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to

a density at least equal to that of the adjacent foundation. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free draining materials.

Any buried debris protruding from the foundation that will impede the proper installation and detrimentally impact the final appearance of the gabion, shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to gabion or revet mattress placement, the prepared foundation surface shall be inspected and approved by the Engineer and no material shall be placed thereon until that area has been approved.

Placement of filter material and/or filter fabric shall be as shown on the Drawings or directed by the Engineer.

(2) **Gabion/Revet Mattress Basket Assembly**

No work shall take place using PVC coated materials unless both the ambient air temperature and the temperature of the PVC materials are at least 15°F (8°C) above the brittleness temperature of the PVC materials.

Assembly of gabions and revet mattresses shall consist of shaping and tying each individual basket. Baskets shall be assembled by connecting all untied edges including diaphragms with lacing wire, spirals or approved fasteners. The connections for the completed assemblies shall conform to the requirements of Section 7 of ASTM specifications A-974 (welded wire) and Section 7.3 and Table 2 of A-975 (double twisted).

Assembly of baskets, connection of baskets together and lid closures shall be accomplished in accordance with one of the following approved procedures:

(A) Lacing Wire:

Using lacing wire of appropriate length, secure one end of the wire onto the basket corner by looping and twisting the lacing wire together. Proceed along the joint by tying with double loops every other mesh opening at intervals not more than 6 inches (150 mm) apart, while pulling the basket elements tightly together. Secure the other end of the lacing wire again by looping and twisting the wire around itself.

(B) Spiral Binders for Welded Wire Mesh:

Spiral binders, meeting the minimum acceptance criteria of article 594.2(6)(c) shall be screwed into position such that they pass through each mesh opening along the joint. To prevent unraveling, each end of the spiral binder shall be crimped back against itself.

(C) Alternate Fasteners for Twisted Woven Mesh:

Interlocking fasteners meeting the minimum acceptance criteria of article 594.2(6)(c), shall be installed with, as a minimum, one interlocking fastener in every other opening.

Ring fasteners meeting the minimum acceptance criteria of 594.2(6)(c), shall be installed with, as a minimum, one split ring fastener in every

opening, having a minimum 1 inch (25 mm) total overlap and securing only the number and diameter of wires for which tested.

Placing of gabions and revet mattresses shall consist of installing baskets to the lines and grades shown on the Drawings. Gabions and revet mattresses shall be securely fastened to each adjoining unit along the vertical and top reinforced edges of all contact surfaces. Overlying rows of baskets shall be staggered appropriately. Empty sections stacked on a filled line of gabions and revet mattresses shall be securely fastened to the bottom unit along the front, back and ends.

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

(3) Filling of Gabions and Revet Mattresses

The gabions and revet mattresses may be filled by machine, in maximum lifts of 12 inches (300 mm). The machine work shall be supplemented with handwork to avoid bulges and provide a compact mass with a minimum of voids. Care will be exercised so as not to damage the gabion/revet mattress elements or wire coating by limiting height of drop during filling to 3.0 feet (0.9 meter) for Gabions and 1.5 feet (0.5 meter) for revet mattresses. Undue deformation or bulging of the mesh shall be corrected prior to further stone filling. Where specified on the Drawings, select large stone shall be hand placed on vertical outside faces to achieve a desired neat appearance.

During placement, the depth of stone in any cell shall not exceed the depth in an adjoining cell by more than one foot (300 mm). Stone smaller than the mesh opening found against vertical faces shall be removed.

Two connecting wires in each direction for end units and two parallel connecting wires perpendicular to the exposed face for exposed face units shall be installed at every 12 inch (300 mm) lift. The connecting wires shall loop around two mesh openings, and the ends of wires shall be securely twisted with a minimum of three twists after looping. Prefabricated connecting wire may be used in lieu of connecting wire.

Connecting wires associated with 18inch (450 mm) gabions shall be installed when and as specified on the Drawings or as recommended by the gabion/revet mattress manufacturer.

The gabion or revet mattress unit shall be overfilled by 1 1/2 to 2 inches (37.5 to 50 mm) and the lid shall be bent and stretched until it meets the perimeter edges of the front and end panels. The stretching shall be accomplished using an approved lid closing tool in order to prevent damage to the PVC coating. Crow bars or similar single point leverage devices will not be allowed. The lid shall then be securely tied with lacing wire, spirals or approved fasteners to the fronts, ends and diaphragms. Excessive deformation of the lid panel to facilitate closing of a bulging gabion or revet mattress will not be permitted.

All backfill shall be placed and compacted in sequence with the filling of the baskets; however, care shall be exercised in compacting the fill behind a single row of baskets since excessive compaction effort can displace the gabions/revet mattresses from the desired alignment.

Gabion or revet mattress units may be cut or shaped to fit odd length or odd shaped areas. They shall be cut at least 6" to 8" (150 mm to 200 mm) larger than the opening to allow sufficient material for overlap and lacing. All edges or faces formed in this manner shall be adjusted to present a finished and pleasing appearance.

At all times, care shall be taken to turn all loose and projecting ends of wire into the gabion units to prevent injury.

594.4 Workmanship

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

594.5 Measurement

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

594.6 Payment

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

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

Payment will be made under one of the following:

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

End

SPECIFIC CROSS REFERENCE MATERIALS

Specification Item 594, "GABIONS AND REVET MATTRESSES"

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
A-974	Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated)
A-975	Standard Specifications for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel with Poly Vinyl Chloride (PVC) Coating)

RELATED CROSS REFERENCE MATERIALS

Specification Item 594, "GABIONS AND REVET MATTRESSES"

City of Round Rock Technical Specifications

<u>Designation</u>	<u>Description</u>
Item No. 101	Preparing Right of Way
Item No. 102	Clearing and Grubbing
Item No. 110	Street Excavation
Item No. 111	Excavation
Item No. 120	Channel Excavation
Item No. 130	Borrow
Item No. 132	Embankment
Item No. 220	Sprinkling for Dust Control
Item No. 230	Rolling (Flat Wheel)
Item No. 232	Rolling (Pneumatic Tire)
Item No. 234	Rolling (Tamping)
Item No. 236	Proof Rolling
Item No. 510	Pipe
Item No. 601	Salvaging and Placing Topsoil
Item No. 602	Sodding for Erosion Control
Item No. 604	Seeding for Erosion Control
Item No. 605	Soil Retention Blanket
Item No. 606	Fertilizer
Item No. 607	Slope Stabilization
Item No. 608	Planting

RELATED CROSS REFERENCE MATERIALS - Continued

Specification Item 594, "GABIONS AND REVET MATTRESSES"

Texas Department of Transportation: Manual of Testing Procedures

<u>Designation</u>	<u>Description</u>
410-A	Abrasion of Coarse Aggregate Using The Los Angeles Machine
411-A	Soundness of Aggregate By Use of Sodium Sulfate or Magnesium Sulfate

American Society for Testing and Materials (ASTM)

<u>Designation</u>	<u>Description</u>
A-313	Standard Specification for Stainless Steel Spring Wire
A-370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A-641	Specification for Zinc Coated (Galvanized) Carbon Steel Wire
A-853	Standard Specification for Steel Wire, Carbon, for General Use
B-117	Test Method of Salt Spray (Fog) Testing
C-535	Standard Test Method for Resistance of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
D-412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
D-638	Test Method for Tensile Properties of Plastics
D-746	Test Methods for Brittleness Temperature of Plastic and Elastomers by Impact
D-792	Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
D-1203	Standard Test Methods for Volative Loss from Plastics Using Activated Carbon Methods
D-1242	Test Methods for Resistance of Plastics Materials to Abrasion
D-1499	Practice for Operating Light and Water Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics
D-2240	Test Method for Rubber Property-Durometer Hardness
D-2287	Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
G-23	Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Non-metallic Materials