

Pipe and Appurtenances Section 600

610 General Requirements

611 Description

These design criteria are minimum requirements to be used in the design of piping and appurtenances within the jurisdiction of the City of Burnet. The jurisdiction of the City of Burnet is defined as the area bound by the ETJ of the City of Burnet. This section describes excavation and trenching work for pipe and appurtenances to be installed under these specifications and shall include the necessary site preparation, excavation and trenching, the handling, storage, shoring and protection of the work, preparation of the subgrades, pumping and dewatering as necessary or required, protection of adjacent property, backfilling, pipe embedment, and other incidentals necessary to complete the work.

Excavation work shall be performed in a safe and proper manner with suitable precautions being taken against hazards of every kind. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation, and shall be in compliance with the latest OSHA regulations for Trench Safety.

Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected

612 Classification of Excavated Material

612.01 Common Excavation: Materials that can be removed by standard construction methods and/or equipment.

612.02 Rock Excavation: All masses of material which cannot be removed by standard construction methods and/or equipment thereby requiring special equipment, or blasting for excavation, shall be considered rock excavation.

613 Grades, Lines and Levels

Grades, lines and levels shall conform to the approved construction plans approved by the City of Burnet Engineering Department. The surveyor will set all necessary stakes required by the specifications and/or the construction plans. Any damage to the above by the Contractor shall be re-established at the Contractor's expense. The Contractor/Engineer 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 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 electronic devices or batter boards for controlling the Work. Electronic devices shall have adequate precision to produce a finished pipe on grade. Batter boards shall be of adequate size material and shall be supported substantially. Control stakes must be protected from possible damage or change of location. The Contractor shall furnish good target for electronic devices, sound twilled lines for use in achieving lines and grades and the necessary plummets, levels and graduated poles.

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

620 Materials

621 General

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. The pipe shall be of the sizes, types, class and dimensions indicated or as designated by the Engineer 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 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 (metal plates) and other provisions for maintenance of traffic or access as indicated.

622 Backfill Materials

622.01 General: 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.

Select Fill – Consist of materials which are classified by ASTM D 2487 as SP, SM, SC, CL, or dual classifications thereof, which have a liquid limit less than or equal to 35, a plasticity index (as determined by ASTM D-4318) of a minimum of 5 and a maximum of 15, a maximum aggregate size of 3 inches, 25 to 50 percent retained on the No. 4 sieve, 50 to 75 percent retained on the No. 40 sieve, and are free of organic materials.

Moisture Sensitive Material - Material with PI of 20 or greater (as determined by ASTM D-4318) and 35% or more passing the #200 sieve (as determined by ASTM D-1140).

Satisfactory Native Material - Material classified by ASTM D 2487 as GW, GP, GC, GM, SW, SP, SM, SC, CL, CH, and is free of rocks larger than three (3") inches and is not 'Moisture Sensitive Material' shall be classified as Satisfactory Native Material.

Unsatisfactory Materials - Materials that do not comply with the requirements for satisfactory material. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than three (3") inches and materials classified in ASTM D2487 as PT, OH, OL, ML, and MH. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

622.02 Bedding Material

- A. Pea Gravel – For water and sewer mains
 - 1. Pipe bedding shall be clean 3/8" to 1/2" pea gravel free of mud, clay, vegetation or other debris.
- B. 3/4" Crushed Stone – For water and sewer mains
 - 1. Pipe bedding shall be clean 1/2" to 3/4" crushed limestone free of mud, clay, vegetation or other debris.
- C. 1 1/4" Crushed Stone – For storm drainage pipe
 - 1. Pipe bedding shall be clean 1 1/8" to 1 1/4" crushed limestone free of mud, clay, vegetation or other debris.

622.03 Trench Backfill Material:

- A. Select Fill
 - 1. This material shall consist of imported or excavated from the trench and it shall conform to paragraph 622.01 of this section. Select fill may be used as backfill at any depth for any trench.
- B. Satisfactory Native Material
 - 1. This material shall consist of suitable material excavated from the trench. It shall conform to paragraph 622.01 of this section. Satisfactory native material may be used as backfill at any depth for any trench.
- C. Moisture Sensitive Material
 - 1. This material consists of material excavated from the trench and conforms to the definition in paragraph 622.01 of this section. The moisture content at the time of compaction shall be within 3 percent of optimum as determined by ASTM D-698 or will require wetting (or drying) and reworking as necessary. Under pavement, moisture sensitive material may only be used as backfill in portions of the trench that are deeper than 2.5 feet. Where the trench is not under pavement, moisture sensitive material may be used as backfill all the way to the surface.
- D. Cement Stabilized Backfill
 - 1. When indicated or directed by the Engineer, all 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 portland cement and aggregates and shall be thoroughly dry mixed with no water added to the mixture except as may be directed by the Engineer.

630 Trench Excavation

631 General

631.01 Trench Opening: The Contractor shall open no more trench in advance of pipe laying than is necessary to expedite the work. The maximum length of open trench permitted on any line under construction shall not exceed the amount of pipe that can be placed in the same day of excavation.

631.02 Trench Safety: Underground piped utilities shall be constructed in an open cut in accordance with Federal regulations "Trench Safety Systems" and with a trench width and depth described below.

631.03 Trench Fill: When pipe is to be constructed in fill above the natural ground, Contractor shall construct embankment to plan grade and meet compaction requirements, and then the trench can be excavated.

632 Excavated Materials

632.01 General: Excavated material from trenching may be used as the satisfactory native material for backfilling the trench, provided the material meets Section 622 specifications.

No excavated material shall be deposited on the site of the work or other improved areas, nor upon private property unless approved by the City Engineer, and such material shall be handled in such a manner as not to obstruct drainage or other parts of the project. Where necessary for compliance with this provision, the material shall be hauled or removed by an approved method.

632.02 Surplus Excavated Materials: Any surplus excavated materials shall be hauled and disposed of as directed by the Engineer. If the Engineer notifies the Contractor that there is no use for this material on the project it shall become the property of the Contractor to be disposed of without injury to the Owner's or any adjoining property at the Contractor's expense.

633 Trench Width

633.01 Water & Wastewater Lines: Trenches for pipes shall be of sufficient width to provide ample working space for handling and jointing the pipe in the trenches. In no case shall the width of the trench inside sheeting and brace lines be less than sixteen (16") inches greater than the normal pipe diameter as follows:

<u>Pipe Diameter</u>	<u>Min Trench Width</u>	<u>Max Trench Width</u>
6"	22"	30"
8"	24"	30"
10"	26"	32"
12"	28"	36"
18"	34"	42"
24"	40"	48"

633.02 Storm Sewer Lines: 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 not to exceed 18 inches on each side beyond the outside surfaces of the pipe.

633.03 Excessive Trench Width: If the trench width within the pipe zone exceeds this maximum, 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 ASTM D-1557 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.

Where, for any reason, width of the lower portion of the trench as excavated at any point exceeds the maximum permitted, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.

633.04 Excavation Below Pipe Subgrade: Except when so ordered by the Engineer, pipe trenches shall not be excavated below pipe subgrade elevations, in which event the bottom of the trench shall be bedded with sandy or acceptable material.

633.05 Bell Holes: Bell holes shall provide adequate clearance for the tools and methods used in installing the pipe. No part of any bell or coupling shall be in contact with the trench bottom or trench walls when the pipe is jointed.

634 Trench Depth and Depth of Cover

634.01 General: 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, subgrade for staged construction, street or other permanent surface to the top or uppermost projection of the pipe.

634.02 Water Piping: Where not otherwise indicated, all water piping shall be laid with at least 3 feet of cover and no more than 5 feet of cover.

634.03 Wastewater Piping: Where not otherwise indicated, all gravity wastewater piping shall be laid with at least 3.5 feet of cover. Force mains shall be laid with minimum 3 feet and maximum of 5 feet of cover.

634.04 Stormwater Piping: Where not otherwise indicated, all stormwater piping shall be laid with at least 1 foot of cover.

640 Pipe Embedment

641 General Requirements

Bedding material shall be used to fill up to a point at least six (6) inches below and above the outside diameter of the pipe. Select Fill and Satisfactory Native Material (defined in Section 622.01) may be used to backfill the remaining depth of the trench; Moisture Sensitive Material may be used to backfill up to depths of 2.5 feet, however, the remainder of the trench shall be backfilled with either Select Fill or Satisfactory Native Material.

642 Compaction & Moisture Requirements

For depths of cover 10 feet and less both the bedding material and the satisfactory native materials shall be compacted to 95-100% of the standard proctor density as determined by ASTM D698 and within 3% (+ or -) of optimum moisture content if the material is "Moisture Sensitive" as defined in Section 622.01.

Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to that density by approved mechanical means. The use of wheel compactors may be allowed in lieu of hand operated mechanical compactors with authorization from the Construction Inspector. When wheel compactors are

used, backfill lifts may be increased to twelve (12") inches provided proper moisture content of the backfill material is maintained and the specified minimum density is achieved. All testing required to validate that adequate compaction is being achieved by the use of the wheel compactor shall be at the expense of the Contractor.

Water tamping by flooding or jetting the trench prior to placing the remainder of the trench backfill may not be used in lieu of hand or mechanical tamping (flooding or jetting only achieves densities in the range of 70-75% which is not acceptable).

The City may perform or have performed any material tests needed as indicated by the situations described below. The Contractor will be charged for all testing regardless of whether or not the test passes or fails. The Contractor will also be charged for all retesting necessitated by failures. Situations requiring testing are as follows:

- A. In determining whether or not minimum density is being achieved.
- B. Visual inspection by the Construction Inspector shows poor quality, workmanship or materials.
- C. Inspector was not notified of backfill operation.
- D. In all trenches placed in a proposed or existing roadway.
- E. Any other unusual circumstance that causes the Inspector to doubt the quality of the workmanship or materials.

650 Construction Methods

651 General

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.

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 City 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 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, 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 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.

Where traffic must cross open trenches, the Contractor shall provide suitable steel plates of the thickness directed by the Engineer. 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

652 Water / Sewer Line Separation

652.01 Water and Sewer Crossings: Installation shall comply with Section 700 of the Standard Specifications.

652.02 Utility and Storm Sewer Crossings: When the Contractor installs a pipe that crosses a drainage structure or storm sewer and the top of the pipe is within 18 inches of the bottom of the structure, the pipe shall be encased in concrete for a distance of at least 1 foot on either side of the ditch line of the utility structure or the storm sewer.

653 Pipe Anchorage, Support and Protection

Pressure pipeline tees, plugs, caps and bends shall be securely anchored with both Mega Lugs and a suitable concrete thrust blocking.

653.01 Concrete Thrust Blocking: Concrete thrust blocking shall conform to the details of these specifications. 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. The blocking shall, unless otherwise indicated, be so placed that the pipe, fittings and joints will be accessible for repair.

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.

653.02 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.

- A. 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.

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.)

- B. 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 Engineer. Engineer may

require Contractor to install a concrete seal, cradle, cap, encasement or other appropriate action.

- C. Trench Caps, Concrete Rip-Rap and Shaped Retards: Where called for by the Contract or as directed by the Engineer, 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, Section 900, "Concrete for Structures".

654 Connections to Existing Systems

654.01 Wastewater Connections: All branch connections of new main lines shall be made by use of manholes. Service stubs shall be installed as indicated in the details, utilizing a 45 degree bend with a wye or a sanitary tee (long sweep). Minimum grade shall be 1 percent downward to main and minimum cover shall be 30 inches at the curb. A double clean-out shall be installed at the property line with a one foot stub-out. Glued-caps shall be installed on the stub-outs before backfilling.

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.

Unless otherwise specified by the Engineer, all connections made to existing mains shall be made at manholes with the flowline of the inlet pipe installed at the same elevation as the flowline of the existing pipe.

Connections to existing manholes shall conform to TNRCC requirements and shall only be made by boring through the manhole wall.

654.02 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 tap all mains using an approved tapping sleeve (full circle stainless steel wrap-around) and tapping valve.

In instances which require shutoffs on existing water mains, the City will make the shut-off. The Contractor shall be required to notify the Engineer's field representative on the job at least 72 hours prior to the desired time for any shutoff. The Contractor 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.

Water for the Work shall be metered and furnished by the Contractor. However, the cost of metered water shall be absorbed by the City on Capital Improvement Projects. Should it be determined that the Contractor excessively wastes water, then billing charges shall be forwarded to the Contractor.

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.

If a private Contractor makes the tap, a City of Burnet Water/Wastewater Inspector must be present.

Service connection taps into PVC or AC pipe or into CI or DI pipe 12 inches or smaller shall be made using tapping sleeve as recommended by the pipe manufacturer and as approved by the Engineer.

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

655 Concrete Encasement and Encasement Pipe

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

655.02 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.

655.03 Materials: The Portland cement concrete shall conform to Class B Concrete. The cement stabilized sand shall have a minimum of 10% (2.5 bags min.) cement per cubic yard and shall contain brown coloring for identification. (TNRCC Section 290)

655.04 Construction Methods: When indicated on the Drawings or acceptable to Engineer or designated representative, concrete encasement shall be placed to protect the pipe. Pipe or bedding shall not be placed where:

- A. the top of the pipe would have less than 30 inches of cover,
- B. the ground water invades the trench, or
- C. the trench bottom is of unstable material.

If either 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, or
- C. use a higher strength class of pipe.

Concrete encasement shall extend from 6 inches below to 6 inches above the outer projections of the pipe over the entire width of the trench in accordance with the City of Burnet Standard Details.

656 Concrete Retards

656.01 Description: This item to consist of Portland cement concrete retards used to anchor pipe. Retards shall be constructed as indicated or as designated by Engineer in accordance with these specifications.

656.02 Materials:

- A. Concrete: Concrete materials used in construction under this item shall conform to Class B.
- B. Reinforcement: Reinforcement shall conform to Section 944.

656.03 Construction Methods: Prior to placing concrete, excavation for retards shall be made to proper section and, if considered necessary by Engineer, bottom of excavation shall be hand tamped and sprinkled. Excavated area for retards shall be moist when concrete is placed.

After concrete has been placed, compacted and shaped to conform to dimensions indicated and after it has become sufficiently set, it shall be given a moderately rough finish by floating with a wood float.

No mortar or concrete work shall be done when temperature is below 40° F and work shall be protected from freezing. After completion of retard, exposed surfaces shall be covered with burlap, cotton mats or other approved covering and kept wet for a period of 3 days. White pigmented curing compound conforming to Section 921.02(e), "Membrane Curing", Type 2, will be permitted when applied to exposed surfaces.

Material excavated from trench shall be uniformly spread on adjacent areas or otherwise disposed of at a permitted site.

657 Blasting

Blasting or other use of explosives for excavation will not be permitted on the site of the work without specific written approval by the City Engineer and the City Fire Marshall.

658 Removal of Water

The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the pipe to be installed therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other causes will result.

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

The Contractor will be held responsible for the condition of any pipe which may be used for drainage purposes, and all such pipe shall be kept clean and free from sediment.

659 Backfilling

659.01 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 12 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.

659.02 Backfill in Street Right of Way: The depth of layers, prior to compaction, shall depend upon the type of sprinkling and compacting equipment used and the test results thereby obtained, but shall not be more than one (1) foot loose. 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 ASTM D-698 and ASTM D-1557.

Each layer of backfill must provide the density as required herein and 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 ASTM D-698 or ASTM D-1557 depending on the depth (see standard drawings for water, sewer and storm drainage pipe).

After each layer of backfill is complete, tests may be required by the City Engineer. 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 City Engineer 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, or sealing. Excessive loss of moisture in Moisture Sensitive Material shall be construed to exist when the subgrade soil moisture content is more than 3 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 replace the same kind of surface removed to construct the pipe.

659.03 Backfill in State Highway Right of Way or County Street: All Work within the right of way shall meet the requirements of 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 Burnet County Road & Bridge 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.

659.04 Backfill in Easements: Where not otherwise indicated, the 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 95 percent or a density superior to that prior to construction.

All soil areas disturbed by construction shall be covered with topsoil and seeded. All turf within city right-of-way shall obtain seventy (70) percent coverage before final acceptance and erosion control structures are removed. All turf, drainways and drainage structures shall be constructed or replaced to their original condition or better. No debris shall remain in the drain-ways or drainage structures.

660 Specialized Construction Methods

661 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.

662 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 details, with outermost point of large nozzle cap 6" to 18" 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 5 feet, nor more than 7 feet, except that no part of a hydrant or its nozzle caps shall be within 6 inches of any sidewalk or pedestrian ramp. Any fire hydrant placed near a street corner shall not be placed within the radius. Fire hydrants shall not be installed within nine feet vertically or horizontally of any sanitary sewer line regardless of construction. Hydrants placed on uncurbed State of Texas right of way shall be located within 18" of the R.O.W. line.

All hydrants shall stand plumb; those near curbs shall have the 4 inch 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 above grade. Each hydrant shall be connected to the main by 6 inch ductile iron pipe; a 6 inch gate valve shall be installed at the main on an anchor tee for individual shutoff of each new hydrant.

Below each hydrant, a drainage pit shall be excavated according to the details 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 situated and to a level 6 inches above the hydrant drain opening. No hydrant drainage pit shall be connected to a sanitary sewer. Cover drain gravel 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). 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.

663 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.

664 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 low density polyethylene film or a 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.

665 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.

670 Boring of Pipe

671 Description

This item shall govern furnishing and installing of encasement pipe by methods of 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.

672 Submittals

672.01 General: The CONTRACTOR shall submit shop drawings in accordance with the project requirements and the following. Submittals shall include the following, as applicable:

1. Carrier pipe and casing materials, including the diameter, wall thickness, specifications, relevant data, and pipe class.
2. Installation schedules for excavation, pipe installation, backfill, grouting, and related horizontal boring operations.
3. Data on lubricants proposed for installation.
4. Locations, dimensions, and shoring plans and sections for boring and receiving shafts, including the method of excavating, shoring, bracing the shaft and thrust block design.
5. Manufacturers' data sheets and specifications describing in detail the system to be used.
6. Layout plans.

672.02 Permits: The CONTRACTOR shall obtain necessary permits from governing agencies having jurisdiction and furnish two copies to the City's designated representative before the start of the Work.

672.03 Qualifications: Horizontal boring shall be performed by a qualified Contractor. The Contractor shall have successfully completed at least 5 previous horizontal boring operations of similar length and diameter. The CONTRACTOR shall provide descriptions of similar projects,

including references, where contractor responsible for horizontal boring has successfully used the proposed horizontal boring system.

672.04 Submittals for Micro-tunneling and Auger Boring: The CONTRACTOR shall submit the following items. Approval of the following submittals shall be obtained before ordering pipe materials or starting operations:

1. Spoil disposal method, including other materials encountered in the construction and maintenance of shafts.
2. Maximum anticipated jacking loads and supporting calculations.
3. Methods to control and dispose of groundwater.
4. Grade and alignment control systems.
5. Intermediate jacking station locations and design.
6. Lubrication and/or grouting system.
7. Plans for monitoring ground surface movement (settlement or heave) due to construction. The plan shall address the method and frequency of survey measurement. At minimum, the plan shall measure the ground movement of all structures, roadways, parking lots, and any other areas of concern within 25 feet on both sides of all micro-tunneling pipelines at a maximum spacing of 100 feet along the pipeline route, or as required by the City of Burnet.
8. Annular space grouting plan.
9. Contingency plans for correction of the following potential conditions:
 - a. Damage to pipeline structural integrity and repair.
 - b. Loss and return to line and grade.
 - c. Loss of ground.
10. Procedures to meet all applicable OSHA requirements. These procedures shall be submitted for record purposes only and will be subject to approval by the CITY. At a minimum, CONTRACTOR shall provide the following:
 - a. Protection against soil instability and groundwater inflow.
 - b. Safety for shaft access and exit, including ladders, stairs, walkways, and hoists.
 - c. Protection against mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.
 - d. Ventilation and lighting.
 - e. Monitoring for hazardous gases.
 - f. Protection against flooding and means for emergency evacuation.
 - g. Protection of shaft, including traffic barriers, accidental or unauthorized entry, and falling objects.
 - h. Emergency protection equipment.

672.05 Submittals for Directional Drilling: The CONTRACTOR shall submit the following items. Approval of the following submittals shall be obtained before ordering pipe materials or starting operations:

1. Manufacturers' data sheets and specifications describing in detail the directional drilling system to be used.
2. Description of similar projects with references on which the proposed system had been successfully used by contractor/operator.
3. Description of method to contain drilling fluids and to separate and dispose of spoils.
4. Maximum anticipated pulling loads and supporting calculations.
5. Pipe design data and specifications. Include design calculations to account for bending and pulling stresses expected during construction.

6. Grade and alignment control systems.
7. Contingency plans for correction of the following potential conditions:
 - a. Inability to complete the pilot hole.
 - b. Excessive fluid loss or hydraulic fracturing.
 - c. Inability to pull the pipe

673 **Materials**

673.01 Pipe: Carrier pipe and encasement pipe shall be the size, type, thickness and class indicated on the Drawings, unless otherwise specified.

673.02 End Seal: End seals shall be sized to securely attach to the exterior of casing and carrier pipe to prevent water, dirt and debris from entering the annular space between the installed pipe. The end seal shall be pull-on, wrap-around or heat shrinkable. No concrete, grout or bricks will be acceptable.

673.03 Casing Spacers: Casing spacers shall be constructed of high-density polyethylene and shall be sized to securely fasten on to the carrier pipe barrel O.D. They shall be furnished with a minimum runner height to prevent the pipe from resting or sliding on its joint during and after installation.

673.04 Grout: Grout shall be used to completely fill any annular space between the bore and installed casing pipe. Grout shall consist of one part Portland cement, three parts sand and the minimum amount of water necessary to obtain the desired consistency; and, all grout mixtures shall contain 2% of bentonite by weight of the cement.

673.05 Lubricants: Water shall be used as a lubricant for jacking operations and may contain clay based and/or polymer additives to reduce the skin friction of the installed pipe.

674 **Construction Methods**

674.01 General: The Contractor is responsible for:

- A. Adequacy of jacking and boring operations,
- B. Installation of support systems as indicated on the Drawings,
- C. Provision of encasement and carrier pipe, and
- D. 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 "Trench Safety System" and shall provide an appropriate Trench Safety Plan.

When the grade of the pipe at the 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 and for placement of end joints of the pipe. 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 boring operations shall conform to the requirements of the TXDOT Manual on Uniform Traffic Control Devices.

Where installation of pipe is required under 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. At a minimum bore pit locations on rural highway crossings, must be 30 (thirty) feet from main lanes and on other high-speed (exceeding 40 mph) highways. On low-volume (less than 750 vehicles per day) highways, the bore pit must be 16 (sixteen) feet from main lanes. On urban (curbed) highway crossings, bore pits must be 30 (thirty) feet from high-speed roadways and 3 (three) feet from low-speed roadways.

During construction operations, and until the work pits are backfilled and fill material compacted, traffic barricades 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.

When grade of pipe at boring end is below ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking or boring operations and for joining pipe. Work shall be securely sheeted and braced as indicated on the Trench Safety Plan to prevent earth caving and to provide a safe and stable work area.

The pipe shall be 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 36 inches 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.

Positioning of spacers should ensure that the carrier pipe is adequately supported throughout its length. Spacers at each end shall not be further than 6" from the end of the casing regardless of the size of casing and carrier pipe or type of spacer used. Casing spacers shall be doubled on each end of the encasement and shall be installed within one foot on each side of the bell or flange. The maximum spacing for casing spacers is 8 feet.

After placement of the carrier pipe is complete, the ends of the encasement pipe shall be sealed with a flexible type end seal as outlined in section 673.02. As soon as possible after the end seals are placed, 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 ASTM D-1557 for depths 10 feet or greater and ASTM D-698 for depths less than 10 feet.

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 augur method.

In the pilot hole method an approximate 2 inch 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 augur method is used, a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augurs 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.

AUGER METHOD

- A. Auger Boring Machine: The auger boring machine selected shall be sized with torque and thrust capacities compatible with the size of pipe or casing to be installed and expected soil and geotechnical conditions. Separate thrust jacks shall be used for advancing the cutter face and advancing the installed pipe. The maximum allowed thrust force of the installed pipe shall not be exceeded.
- B. Casing and Auger: The auger casing diameter shall be sized in conjunction with the cutter face such that the annular space between the installed pipe and bored shaft does not exceed 2-inches. The casing shall be equipped to prevent or correct rolling. The auger shall be sized to transmit the required torque and thrust to the cutting face and transport spoils back to the bore shaft for removal. Additives may be employed to condition the spoils for transport. When operating below the groundwater level, the auger system shall be capable of adjustments required to maintain face stability and prevent loss of soil or uncontrolled groundwater inflow.
- C. Cutter Head: The cutter face shall be selected based on the soil conditions expected and shall be capable of supporting the full excavation face. The cutter face shall be capable of slight steering adjustments to maintain line and grade of the installed pipe.
- D. Support Bedding and Reaction Blocks: An adequately designed and constructed foundation and thrust reaction structure shall be provided. Special attention shall be given to the shaft foundation to ensure it is secure. A concrete slab shall be used in unstable conditions, and crushed stone or equivalent shall be used as a minimum. When thrust reaction blocks are used, care shall be taken to ensure they are perpendicular with the required line and grade.
- E. Excavation Controls: All machine operations shall be monitored and controlled from a central point either in the shaft at the auger-boring machine or remotely from the surface. Control equipment shall integrate excavation spoil removal and installation of pipe. Operations shall be stopped when they result in pipe damage or surface disruption.

- F. **Monitoring Equipment:** Equipment shall be provided to continuously monitor auger thrust and torque, pipe jacking thrust, and advance rate. These parameters shall be recorded and available at all times for review by the CITY. Line and grade shall be continuously monitored by referencing the casing to a design reference. If continuous referencing is not possible due to equipment design limitations, line and grade shall be verified by other suitable means at every 50-feet of advancement.
- G. **Intermediate Shafts:** If an intermediate shaft is requested, the CONTRACTOR shall obtain a written approval from the CITY. The intermediate shaft shall not be located in areas prohibited and as directed by the CITY. The CONTRACTOR's request shall include all necessary permits and approvals, minimize public inconvenience and minimize impacting existing facilities.
- H. **Annular Space Grouting.** The annular space created by the over cut of the auger face in excess of 2-inches shall be filled with an approved material, unless otherwise specified. When grouting is specified, pressure-injected grout shall fill voids outside the limits of the excavation created by caving or collapse of earth cover over the excavation. The CONTRACTOR shall furnish and operate suitable equipment for any required grouting operations depending on the condition of the application. The grouting operation shall not damage adjacent utilities or other properties. Grout shall be injected at a pressure that will not distort or imperil any portion of the work or existing installations or structures.
- I. **Piping:** The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.
- J. **Repair or Replacement of Damaged Pipe:** Damaged pipe shall be jacked through to the reception shaft and removed. Other methods of repairing the damaged conduit may be used as recommended by the manufacturer and approved by the CITY.

MICRO-TUNNELING

- A. **Equipment:** The MTBM shall be capable of installing the pipe while being compatible with the anticipated soil and geotechnical conditions. The MTBM cutter face shall at all times be capable of supporting the full excavated area without the use of ground stabilization and have the capability of measuring the earth pressure at the face a setting a calculated earth balancing pressure. The maximum radial annular space shall not exceed 1-inch, unless otherwise specified. The MTBM shall be capable of controlling shield rotation by means of a bi-directional drive on the cutter head or by use of mechanical fins or grippers. The MTBM shall be mechanically articulated to enable remotely controlled steering of the shield. The MTBM shall control groundwater during excavation without the use of external dewatering equipment. The measuring and balancing of earth and groundwater pressure shall be achieved by use of a slurry or cased auger system. The system shall be capable of incremental adjustments to maintain face stability for the soil conditions encountered.
- B. **Jacking Equipment:** The main jacks shall be mounted in a jacking frame and located in the jacking shaft. The MTBM shall be moved forward by the jacks advancing a successive string of connected pipes toward a receiving shaft. Intermediate jacking stations may be used for long drives where frictional forces would exceed the maximum allowable jacking force. The intermediate jacking station shall employ a steel jacket or other suitable means to prevent soil intrusion into the conduit.

Jacking forces at the intermediate jacking station shall be continuously monitored during jacking operations.

- C. Intermediate Shafts: If an intermediate shaft is requested, the CONTRACTOR shall obtain a written approval from the CITY. The intermediate shaft shall not be located in areas prohibited or as directed by the CITY. The CONTRACTOR's request shall include all necessary permits and approvals, minimize public inconvenience and minimize impacting existing facilities.
- D. Annular Space Grouting: The annular space created by the overcut of the MTBM in excess of 2-inches shall be filled with an approved material, unless otherwise specified. When grouting is specified, pressure-injected grout shall fill voids outside the limits of the excavation created by caving or collapse of earth cover over the excavation. The CONTRACTOR shall furnish and operate suitable equipment for any required grouting operations depending on the condition of the application. The grouting operation shall not damage adjacent utilities or other properties. Grout shall be injected at a pressure that will not distort or imperil any portion of the work or existing installations or structures.
- E. Piping: The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads. Damaged pipe shall be jacked through to the reception shaft and be removed. Other methods of repairing the damaged conduit may be used, as recommended by the manufacturer and approved by the CITY.

DIRECTIONAL DRILLING

- A. Drilling/Pulling Equipment: The equipment used to drill the pilot hole, back ream and pull the product pipe in place shall be adequately sized and compatible to the expected ground conditions. It shall be equipped with instrumentation to accurately locate the alignment and grade of the pilot hole to monitor drilling fluid flow and pressure and measure pulling force applied to the product pipe. Steering information of the drill string, pressures, and pulling forces shall be continuously monitored during operations. The equipment shall be capable of using mechanical and/or hydraulic means to change the boring course. Equipment shall also be used to recover and separate drilling fluids and soil cuttings and subsequent reuse of drilling fluids. Direct disposal of contained drilling fluids may be permitted with prior approval of the CITY.
- B. Pilot Hole: The CONTRACTOR shall drill the pilot hole along the path shown in the Contract Drawings to within the tolerance limits specified. The exit point of the drill string shall also meet specified tolerance limits. At the completion of the pilot hole, the CONTRACTOR shall provide an as-built survey consisting of a three-dimensional coordinate tabulation accurately referencing the pilot hole to the drilled entry point. Drilling must be accomplished with fluid assisted mechanical cutting. Uncontrolled jetting (where fluid force is the primary means for creation of the final bore hole diameter) is prohibited. The minimum pressure and flow of drilling fluids practicable shall be used during drilling operations.
- C. Ream and Pull Back: The number of reaming passes to expand the pilot hole for product pipe installation is left to the discretion of the CONTRACTOR. The maximum allowable tensile load of the product pipe shall not be exceeded during pullback operations or when pre-reaming and pullback are performed simultaneously. A swivel connection shall be used between the reaming device and

the product pipe to minimize stress on the pulled pipe. The pulled pipe shall be supported in such a fashion that it moves freely during pullback with no damage done to any corrosion coatings or linings. When staging area is limited, shorter lengths of pipe may be stockpiled then connected and pulled in segments. The pipe shall be pulled back such that at least one joint at the lead end completely clears the bore so that piping and joint can be inspected.

- D. Loss of Fluid: At installations below bodies of water, the CONTRACTOR shall be diligent to detect drilling fluid losses below the water surface. Operations shall be stopped when they result in any pipe damage or surface disruption. The CONTRACTOR shall propose immediate action for review and approval by the CITY to resolve the problem. Remedial action shall be at no additional expense to the CITY.
- E. Clean-Up: The CONTRACTOR shall be responsible for the removal and disposal of excavated material and excess drilling fluid in accordance with all local, state and federal regulations.
- F. Welding: Welding of steel pipe used for pullback shall be in accordance with ANSI/AWS D1.1. All welds shall be radiographically inspected.

COMPACTION/PIPE RAMMING

- A. Driving Pipe: Pipes shall be driven with an open face. The leading edge shall be equipped with a cutting band for reinforcement and to open a slightly larger path through the soil to reduce the skin friction of the following pipe. The overcut shall not exceed 1-inch from the outer surface of the pipe. The pipe shall be driven in one segment when working space is available. The pipe shall be supported and positioned by adjustable bearing stands to achieve proper line and grade alignment.
- B. Driving Operations: Driving force to install the carrier pipe may be delivered through a conventional hydraulic jacking system or pneumatically powered percussion tools. In either case, the driving force shall be evenly transmitted using pressure plates or other types of adapters. Jacking forces shall be continuously monitored and recorded during installation. The maximum allowable jacking forces shall not be exceeded. Pneumatic tools shall be adequately sized to prevent damage to the pipe from excessive impact forces.
- C. Lubrication: Water or bentonite slurry may be applied to the pipe for lubrication at the CONTRACTOR's option. Lubricant slurries shall be contained on site and excesses shall be properly disposed of by the CONTRACTOR.
- D. Spoil: Spoil shall be removed from the installed pipe by reaming, augering, or water flushing. If flushing is employed, the slurry shall be contained and properly disposed of by the CONTRACTOR. The pipe shall be cleaned after soil removal by flushing or using pressure driven cleanout plugs.
- E. Settlement Monitoring: When the pipeline is in sandy or cohesionless soils, the CONTRACTOR shall monitor the soil surface above the pipe alignment for settlement during the installation. Settlement shall not exceed 1-inch or as specified.
- F. Intermediate Shafts: If intermediate shafts are requested, the CONTRACTOR shall obtain a written approval from the CITY. Intermediate shafts shall not be located in areas prohibited or as directed by the CITY. The CONTRACTOR's

request shall include all necessary permits and approvals, shall minimize public inconvenience, and shall minimize impacts on existing facilities.

- F. Grouting: If the annular space between the casing pipe and outside soil or rock is in excess of 3/4-inch is created by the cutting band, it shall be grouted in accordance with the provisions in this Section for grouting of micro-tunnels.

675 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 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.