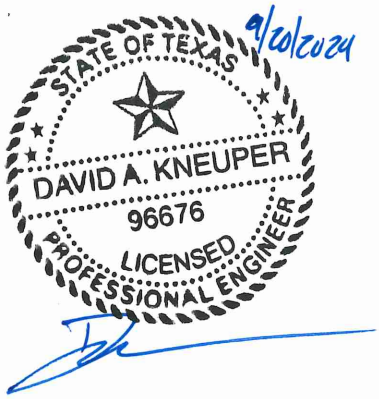
NEW BRAUNFELS UTILITIES
GOODWIN-CONRADS WATER & SEWER RELOCATION PROJECT

TECHNICAL SPECIFICATIONS
SEPTEMBER 2024



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Item No. 120
Utility Trenching and Backfill

120.1 Description

This item shall consist of labor, equipment and/or materials for excavating, bedding, backfilling, compacting, testing, grading and other appurtenant work, prescribed under this item and in accordance with the provisions of Chapter 213 of the Texas Administrative Code as it related to work over the Edwards Aquifer recharge zone, and New Braunfels Water and Wastewater Design Criteria Manual. This item shall include any pumping, bailing, drainage and Item No. 121, "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.

120.2 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C125	Terminology Relating to Concrete and Concrete Aggregates
ASTM D448	Standard Classification for Size of Aggregate for Road Bridge Construction

B. Texas Department of Transportation (TxDOT)

Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material
Tex-115-E	Field Method For Determining In-Place Density Of Soils And Base Materials
Tex-129-E	Measuring the Resistivity of Soil Material
Tex-406-A	Material Finer than 75 µm (No. 200) Sieve in Mineral Aggregates (Decantation Test For Concrete Aggregates)
Tex-410-A	Abrasion of Coarse Aggregate Using the Los Angeles Machine

120.3 Materials

A. Standard Bedding Materials

USE / PIPE MATERIAL	Cement Stabilized Backfill	Natural or Mf'd Sand	Stone Screenings	Pea Gravel	Course Aggregate
WATER					
Service Tubing 1" to 2"		X	X	X	
WATER and WASTEWATER (PVC)					
Up to 15 Inch ID		X	X		
Larger Than 15 Inch ID			X	X	
WATER and FORCEMAINS (DUCTILE IRON)					
Up to 15 Inch ID			X	X	X
Larger Than 15 Inch ID				X	X
WASTEWATER (FRP)					
Larger Than 30 Inch ID			X		

1. General requirements and limitations governing bedding selection.
   a. Crushed gravel or crushed stone shall not be used with polyethylene tubing or polyethylene film wrap.
   b. Pea Gravel or bedding stone shall be used in blasted trenches.

2. 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 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, 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.

   (a) Sand, alone, shall not be used in watercourses, in trenches where groundwater is present, or in trenches with grades greater than 5 percent.

   (b) 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.

   (c) Each 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.

B. Concrete

Concrete shall conform to TxDOT Standard Specifications Item No. 421, "Hydraulic Cement Concrete".

C. Foundation Rock

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

D. Flexible Base

Flexible base shall conform to TxDOT Standard Specifications Item No. 247, "Flexible Base".

E. Pipe Bedding

1. Coarse Aggregate

a. Pipe bedding stone shall be clean gravel, crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C33 for stone quality. Size gradation shall conform to Grade 6 Coarse Aggregate as defined in TxDOT Standard Specifications Item No. 421, "Hydraulic Cement Concrete".

b. Course aggregate shall not exceed 35% loss as determined by the Los Angeles Abrasion test per TxDOT Test Method Tex-410-A.

2. Fine Aggregate

a. Concrete and Mortar Sand

Shall conform to fine aggregate as defined in TxDOT Standard Specifications Item No. 421, "Hydraulic Cement Concrete".

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 washed and screened natural sands or sands manufactured by crushing stones complying with the requirements and tests of ASTM C33.

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

Stone screenings shall have not more than 45 percent passing any sieve retained on the next consecutive sieve of those shown above, and its fineness modulus, as defined in ASTM C125, shall not be less than 2.3 nor more than 3.1.

3. 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

Pea Gravel shall not exceed 35% loss as determined by the Los Angeles Abrasion test per TxDOT Test Method Tex-410-A.

4. 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 6 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.

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(M). 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.

5. Cement Stabilized Backfill

   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 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.

F. Backfill Materials

The Engineer 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 will approve the topsoil for areas to be seeded or sodded.

120.4 Construction Methods

A. General

Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected as set forth in "General Conditions". Clearing the site shall conform to TxDOT Standard Specifications Item No. 100, "Preparing ROW". Maintenance of environmental quality protection shall comply with all requirements of "General Conditions" and TxDOT Standard Specifications Item No. 560, "Temporary Erosion, Sedimentation, and Environmental Controls."

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 New Braunfels Utilities 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 pipe line 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 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 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 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. When such conditions delay the Work, an extension of time for working day contracts will be allowed in accordance with "General Conditions".

B. Trench Excavation

1. General

Underground piped utilities shall be constructed in an open cut in accordance with Federal regulations, applicable State Statutes conforming to Item No. 121, "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 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.

2. 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.

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 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 fill 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.

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

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

a. Water piping installed in natural ground in easements or undeveloped areas, which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 48 inches of cover.
b. Water piping installed in existing or proposed streets, roads or other traffic areas shall be laid with at least 48 inches of cover below finished grade.

Where not otherwise indicated, all wastewater piping shall be laid to the following minimum depths:

(a) Wastewater piping installed in natural ground in easements or other undeveloped areas, which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 48 inches of cover.
(b) Wastewater piping installed in existing or proposed streets, roads or other traffic areas shall be laid with at least 48 inches of cover below finished grade.

4. Classification of Excavation

   Excavation will not be considered or paid for as a separate item of Work, so 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.

5. 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 TxDOT Standard Specifications Item No. 421, "Hydraulic Cement Concrete", with a minimum depth of 3 inches.

6. 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:

   a. 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.
   b. 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.

7. Blasting

   All blasting shall conform to the provisions of the "General Conditions" and/or "Public Safety and Convenience".

8. 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. 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.

9. Lines and Grades

   Grades, lines and levels shall be as indicated on the Construction 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 New Braunfels Utilities.

   The location of the lines and grades indicated on the Construction Drawings 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 batter boards or electronic devices for controlling the Work. Batter boards shall be of adequate size 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 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 will forward all comments of the review to the Contractor for revision. Revisions shall be made and forwarded to the Engineer 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 Contractors procedures modified to the satisfaction of the Engineer. No additional compensation shall be paid for the removal and relaying of pipe required above.

10. Surplus Excavated Materials

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

C. 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 to 12 inches above water and wastewater pipe.

D. 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.

E. Concrete Encasement, Cradles, Caps and Seals

Where called for by the Engineer, or when trench foundation is excessively wet or unstable or installation of water or wastewater pipe will result in less than 48 inches of cover, Contractor shall notify Engineer. Engineer 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 within 6 inches of pipe joints. Concrete cap, cradle and encasement shall conform to NBU Standard Detail No. 421, “Concrete Trench Cap”. The pipe shall be well secured to prevent shifting or flotation while the concrete is being placed.

F. 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, TxDOT Item No. 421, "Hydraulic Cement Concrete”.

G. 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 as defined in TxDOT Item No. 421, "Hydraulic Cement Concrete".

H. Backfilling and Compaction

1. 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 be at the Contractor's expense and conform to the "General Conditions."

   Backfill shall be free of debris, roots, organic matter, rock or gravel larger than 6 inches in any dimension, or any other harmful matter.

2. 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 (6.) 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 98 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 98 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. 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 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 be replaced in kind to the surface removed to construct the pipe.

3. Backfill in County Street or State Highway Right of Way

   All Work within the right of way shall meet the requirements of (2.) 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.

4. Backfill in Railroad Right of Way

   All Work within the railroad right of way shall meet the requirements of (3.) 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.

5. 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 95 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.

   All soil areas disturbed by construction shall be covered with top soil and seeded conforming to TxDOT Item No. 164, "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.

I. Quality Control Testing.

The Contractor shall be responsible for compaction in accordance with the appropriate Specification. Compaction tests may be done at one location point randomly selected or as indicated by the NBU Inspector, per each 12 inch loose lift per 400 linear feet. These tests shall be performed by a nationally-accredited, independent testing laboratory. Payment for

such tests shall be the responsibility of the Contractor, including the material proctor tests and density tests.

Any failed test shall require the Contractor to remove and replace that layer of backfill to 50 feet from either side from the failed test location. The Contractor will also be required at no cost to NBU to provide two additional tests at the replaced location where the initial test failed and at one location point, randomly selected or as indicated by the NBU Inspector.

J. 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 Utility. 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.

120.5 Measurement

Work under this item shall be considered subsidiary to the Work covered under Item 510, “Pipe” unless specified as a separate bid 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 the designated Pay Item.

A. 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.

B. Concrete Retards

When called for in the Bid, Concrete retards will be paid under respected bid Item, “Concrete Retards”.

C. 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.

D. 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.

E. Concrete Encasement

When called for in the Bid, Concrete Pipe Encasement will be paid under respected bid Item, “Encasement and Encasement Pipe".

F. Trench Safety Systems

When called for in Bid, Trench Safety Systems shall conform to Item No. 121, "Trench Safety Systems".

120.6 Payment

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

Pay Item:	Pipe Excavation, ___Ft. Width	Per Linear Foot.
Pay Item:	Pipe Trench Backfill, ___Ft. Width	Per Linear Foot.
Pay Item:	Concrete Seal or Cradle, ___Dia. Pipe	Per Linear Foot.
Pay Item:	Concrete Trench Cap, ___Ft. Width	Per Linear Foot.
Pay Item:	Concrete Cap and Encasement, ___Dia. Pipe	Per Linear Foot.
Pay Item:	Cement Stabilized Backfill, ___Dia. Pipe	Per Linear Foot.

End

Item No. 121
Trench Safety Systems

121.1 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. If special shoring requirements are needed based upon the conditions of the project, they shall be submitted to the Owner for review.

121.2 Trench Safety System Plan Submittal

Prior to, or at the Pre-Construction Conference, the Contractor shall submit to the Owner 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.

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 to complete the design of the Trench Safety System Plan. If the geotechnical information for the design of the improvements is acquired by the Owner or designated representative, it shall be provided to the Contractor for information purposes subject to the provisions of Standard Contract.

The submittal requirements of the Trench Safety System Plan must 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 of the 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 within the street right of way or easement provided by Owner or designated representative.

E. A Certificate of Insurance of the Trench Safety Engineer's Professional Liability Insurance coverage meeting the requirements of the Standard Contact Documents shall be provided.

F. Certificate of Completion of an OSHA-approved program indicating that the Contractor's Competent Person(s) has received training in "Excavation Safety".

121.3 Trench Safety System Plan Review

The review of the Trench Safety System Plan that will be conducted by the Owner or designated representative shall only relate to general conformance with OSHA standards and regulations. The Owner'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.

121.4 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 excavation.

If evidence of possible cave-ins or earthen slides is apparent or an installed trench safety system is damaged, the work in trench shall immediately cease, personnel evacuated from hazardous area and the Owner 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.

121.5 Changed Conditions

When changed conditions require modifications to the Trench Safety System, the Contractor shall provide to the Owner 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 or designated representative in accordance with the requirements of Section 121.2, "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 for a Change Order to address the anticipated work. The Contractor shall notify the Owner in writing within 24 hours of the occurrence of changed conditions that the Contractor anticipates will require 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 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.

121.6 Measurement

Trench Safety Systems shall be measured by linear foot through manholes and other appurtenances along the centerline of trench conforming to the Contractor's Drawings and specifications. Special shoring requirements shall be measured by the square feet of shoring used.

121.7 Payment

Payment for Trench Safety Systems, measured as prescribed above, will be made at unit bid price per linear foot of trench as measured in Section 121.6 per Contractor's 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:

Pay Item: Trench Safety Systems (all depths) Per Linear Foot
Pay Item: Special Shoring Per Square Foot

END

Item No. 304
Manholes

304.1 Description

This item shall govern construction of manholes complete in place for lines smaller than 18-inches, lines 18-inches and greater in diameter shall utilize polymer concrete manholes, covered under Item No. 303. This item shall also govern the materials used therein, including excavation, installation, backfilling and surface restoration. It shall also include furnishing and installing rings, covers, coatings, and appurtenances, as well as any incidental work including pumping and drainage necessary to complete the work. Wastewater manholes shall be 'acceptance tested' by the Contractor.

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. The Standard Product List current at the time of plan approval will govern.

304.2 Standards

Comply with local governing regulations if more stringent than specified herein. Manholes shall meet the following standards (latest edition).

A. ASTM International (ASTM) Standards:

ASTM C478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D6132	Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage
ASTM D7234	Standard Specification for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers

304.3 Quality Assurance

Applicators of coatings to the interior surfaces of wastewater manholes, as specified in shall be listed on the New Braunfels Utilities Standard Products Lists (SPLs). Individual(s) setting up and operating equipment to core through the walls of existing manholes or junction boxes shall have experience in coring similar size holes through the walls of similar size and type structures on at least ten (10) projects (or 15 manholes) in New Braunfels' jurisdiction in the last 5 years.

304.4 Submittals

The submittal requirements of this specification item must include:

A. Products and Materials

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. The New Braunfels Utilities Standard Products Lists (SPLs) form a part of the Specifications for the Work. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the Engineer or designated representative shall still be 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 Engineer or designated representative decide whether the products meet the Contract requirements and the specific use foreseen by the Engineer or designated representative in the design of this engineered Project.

The products included in the SPLs current at the time of plan approval shall govern, unless a specific product or products on the lists have subsequently been removed from those SPLs because of quality or performance issues. Products and materials that are not covered by SPLs shall meet the requirements in the contract documents.

Submittals for the products and materials covered by this specification shall include manufacturer catalog sheets, technical data sheets, shop drawings, product or material test results, requirements listed below, and any other information needed to adequately describe the product or material. For products covered by SPLs, the submittal shall include a copy of the applicable SPL with the proposed product identified. An SPL by itself is not considered an adequate submittal.

The submittal requirements of this specification item include:

1. For pre-cast manholes and junction boxes: shop drawings for each structure showing, at a minimum, the Project and Contractor's name: manufacturer's name and plant location; applicable specifications; list of materials (such as adjusting rings, boots, gaskets, and pre-cast sections) by type and quantity; elevation view showing diameter or size, ring and cover size and elevation, ring type (bolted or unbolted, flared top or flared bottom) wall thickness, elevations of transitions from large diameter sections to smaller diameter sections, base width and thickness, total depth, size of openings, reinforcement, and length of each pre-cast section; structure identification number and station location; pipe line identification; pipe material and size; pipe flowline elevations; plan view showing azimuthal orientation (based on 360 degrees clockwise) of the pipes relative to the outflow pipe; technical data sheets covering pipe-to-manhole or pipe-to-junction box connectors, and gaskets.
2. For cast-in-place manholes and junction boxes: formwork drawings sealed by a registered Professional Engineer licensed in the State of Texas with documented experience in formwork design for wall pours that exceed four (4) feet in height and slabs that are not ground supported.
3. For hydraulic cement concrete; mix components and proportions, material sources, materials test results.
4. For mortar: mix components and proportions, material sources, materials test results.

5. For non-shrink grout: technical data sheet indicating ASTM type and containing instructions on surface preparation, mixing, placing, and curing procedures.
6. For wastewater manhole coatings and linings: technical data sheets that include instructions on surface preparation, mixing, placing, and curing procedures; technical data sheets for coating thickness measuring equipment and for holiday detection test equipment.
7. For connections to existing manholes or junction boxes: details showing the size, location, and method of removal of the wall section, including any temporary supports attached to the manhole or junction box wall; details showing the location of existing joints, other connecting pipes, and other features that penetrate or attach to the wall; and technical data sheets covering the pipe-to-manhole or pipe-to-junction box connectors.

B. Acceptance Test Records

Submittal of acceptance test records is required for wastewater manholes and shall include as a minimum the following items:

1. Name of manhole manufacturer
2. Interior surface coating type and application method.
3. Model and manufacturer of vacuum tester.
4. Date tested/date re-tested.
5. Indication of whether test passed or failed and statement of corrective action taken if test failed.
6. Test Method Used.
7. Location/station of manhole.
8. Type of base: Precast/cast-in-place.
9. Type of repairs made to the joints.

The test records shall also be included as part of the Project records turned in with acceptance package.

C. Acceptance Test Records

The Contractor shall submit evidence that the individual(s) setting up the equipment and coring through the walls of manholes and junction boxes are experienced with the equipment and procedures and have successfully cored through the same types of materials using the same types of equipment.

304.5 Materials and Components

A. Concrete and Cement Stabilized Sand

All concrete shall conform to TXDOT Standard Specification Item No. 421, "Hydraulic Cement Concrete". The cast in place concrete shall be Class A, and the precast concrete manhole base sections, riser sections and appurtenances shall conform to the requirements of ASTM C478/C478M, 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 two (2) bags of Portland Cement per cubic yard. The sand shall meet the requirements for "Fine Aggregate" in TXDOT Standard Specification Item No. 421, "Hydraulic Cement Concrete".

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 TXDOT Standard Specification Item No. 421, "Hydraulic Cement Concrete".

C. Reinforcement

The reinforcing steel shall conform to the requirements of TXDOT Standard Specification Item No. 440, “Reinforcement for Concrete”. Secondary, non-structural steel in cast-in-place wastewater manholes may be replaced by collated fibrillated polypropylene fibers, if approved by the Engineer or designated representative.

D. Rings and Covers

Rings and covers shall conform to the requirements of Standard Specification Item No. 312, “Frames, Grates, Rings and Covers”.

1. Replacement Rings and Covers, 24 in. 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.

3. Rings and Covers, 32 in. Diameter Lids.

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

E. Bulkheads.

Bulkheads shall meet the requirements of Standard Specification Item No. 507 “Bulkheads”

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

Precast concrete base sections, riser sections, and cones shall conform to the requirements of ASTM C478. 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. Where lines enter the manhole up to 24 inches 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 above the flowline of the outlet.

Joints for wastewater base sections, riser sections, and cones shall conform to the requirements of ASTM C443. Precast bases for 48 inch 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

boot shall be filled to the springline with a product recommended by the manhole manufacturer to prevent solids collection.

G. 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 C443.

H. 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 C923 on all wastewater pipe connections.

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

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.

J. 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 New Braunfels Utilities 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 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 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.

K. Precast Grade Rings

Rings shall be reinforced Class A or I concrete.

1. Precast Grade Rings, 24-1/2 inches Inside Diameter:

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

2. Precast Grade Rings, 35 inches Inside Diameter:

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

L. New Manhole Construction and Minor Manhole Adjustment:

New manhole construction and minor manhole adjustments shall be performed as indicated on Standard Detail 322, “New Manhole Construction and Minor Manhole Adjustment”, and shall consist of adding precast reinforced concrete 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. 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. All other existing manholes shall have a maximum allowable ring adjustment, including the depth of the ring casting, of one foot. Any adjustment that will exceed these requirements shall be accomplished as indicated on Standard Detail 321, "Major Manhole Adjustment" and as described below in subsection (M). All manholes not located in paved areas shall have bolted covers.

M. Major Manhole Adjustment:

Any adjustment that exceeds the requirements of subsection (L) Minor Manhole Adjustments, shall be accomplished as indicated on Standard Detail 321, “Major Manhole Adjustment”, 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.

N. Waterproofing Joint Materials.

O-rings and wedge seals for the joints of all wastewater manholes, when indicated on the Drawings, shall conform to the requirements of ASTM C443. The connections between reinforced concrete wastewater manhole structures and pipes shall meet the requirements of ASTM C923.

O. Interior Surface Coatings for Wastewater Manholes

1. New Construction

The interior surface of the wastewater manholes should be properly prepared prior to product application per specifications of the approved product, typically NACE No.6/SSPC-SP13.

The interior surfaces shall be coated with one of the following products:

i. Specialty Coating Products SCP Dropliner – 125 mils

ii. Raven Lining Systems Raven 405 - 125 mils

iii. SprayRoq SprayWall – 125 mils

iv. Kerneos SewperCoat 2000 HS – 250 to 500 mils

v. Kerneos SewperCoat PG – 250 to 500 mils

Product to be applied per specification and by certified personnel. or approved equal product) or designated in writing by the Engineer.

2. Documentation

Contractor shall submit to NBU documentation regarding the certified applicator of the product(s) and type of product(s) used for coating of the wastewater manhole(s).

P. Abandonment of Existing Manholes

When designated on the Drawings for abandonment, existing manholes shall be removed to a level not less than four feet below grade. The inlets and outlets shall be securely plugged and the structure filled with material in accordance with Standard Detail 340, “Abandoned Manhole” or as directed by the Engineer or designated representative.

Q. External Seals

Manholes shall be sealed with Infi-Shield ® Gator Wrap external rubber sleeve as manufactured by Sealing Systems, Inc. The seal shall be made of Stretchable, Self-Shrinking, Intra-Curing Halogenated based rubber with a minimum thickness of 30 mils. The back side of each unit shall be coated with a cross-linked re-enforced butyl adhesive. The butyl adhesive shall be non-hardening sealant, with a minimum thickness of 30 mils. The seal shall stretch around the substrate then overlapped creating a cross-link and fused bond between the rubber and butyl adhesive.

304.6 Construction

All manholes shall have a minimum inside diameter of 48 inches. Manhole base section or junction box dimension shall be appropriately increased to accommodate all converging pipe. A minimum horizontal clearance of 12 inches 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 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 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; 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 304.5(I) above].

Manholes shall be founded at the established elevations on uniformly stable subgrade. Unstable subgrade shall be over-excavated a minimum of 12 inches (and replaced with a material acceptable to the Engineer or designated representative. Precast base units shall be founded and leveled on a 6 inch 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 unreinforced Class A concrete (TXDOT Standard Specification Item No. 421, “Hydraulic Cement Concrete). 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 its expense.

If the adjustment involves lowering the top of a manhole, a sufficient depth of precast concrete rings or brick courses 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 304.5 (L), "New Manhole Construction and Minor Manhole Adjustment", the top of brick or concrete ring shall be cleaned and built up vertically to the new elevation, using new or salvaged concrete 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 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 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 in depth. The foundation shall be cured an additional 24 hours prior to continuing construction above the 12 foot 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, except polyvinyl chloride (PVC), and the top half of the pipe removed to facilitate invert construction. The manhole bottom shall rise from the springline elevation of the pipe, approximately one inch for each 12 inches of run (1:12,8%). Wastewater manholes with lines larger than 18 inches 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.

Wastewater lines, except reinforced concrete pipe, set in cast-in-place foundations, shall require a water stop 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 wastewater manholes, junction boxes and flat-slab transitions shall be reinforced, Class A concrete (TXDOT Standard Specification Item No. 421, "Hydraulic Cement Concrete"). All structural concrete work shall conform to TXDOT Standard Specification Item No. 420, “Concrete Substructures”. Forms will be required for all cast-in-place walls above the 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 Special Specification Item No. 120, “Utility Trenching and Backfill”. 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 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 two (2) sacks of cement per cubic yard up to the bottom of Portland Cement pavement slabs or to within two (2) inches of finish elevation of asphaltic concrete pavements. The cement stabilized sand shall be a minimum of 12 inches 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 (5oC), and when necessary, because of a sudden drop in temperature, joints shall be protected against freezing for at least 24 hours.

When applying manhole protective coating, surface is to be prepped per NACE No.6 / SSPC – SP13. 125 mils of approved protective coating is to be applied per the manufacturer's instructions.

304.7 Acceptance Testing of Wastewater Manholes:

The Contractor shall notify the Inspector and Engineer 48 hours prior to beginning of manhole testing. The Contractor shall perform the testing for all sanitary sewer manholes in accordance with the following:

A. All manholes must pass the leakage test.

B. The Contractor shall test each manhole (after assembly and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means of either a hydrostatic test, vacuum test, or other methods approved by the Engineer.

C. The Contractor is hereby instructed to conduct either Vacuum Testing or Hydrostatic Testing in the following manner:

1. Vacuum Testing: Manholes shall be tested after construction/installation and backfilling with all connections (existing and/or proposed) in place.
    a. Drop-connections and gas sealing connections shall be installed prior to testing.
    b. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole.
    c. The plugs shall be installed in the lines beyond drop connections, gas sealing connections, etc.
    d. Prior to performing the test, the Contractor shall plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole.
    e. Only a cementitious coating may be applied.
    f. Contractor shall use a minimum 60 inch-lb. torque wrench to tighten the external clamps that secure the test cover to the top of the manhole.

g. The test head shall be inflated in accordance with the manufacturer's recommendations.

h. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off.

i. With the valve closed, the level vacuum shall be read after the required test time.

j. If the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test.

k. The required test time is 2 minutes.

2. Hydrostatic Testing shall be conducted by utilizing approved plugs to seal all influent and effluent pipes in the manhole and filling the manhole to the top of the cone with water.

a. Additional water may be added over a 24-hour period to compensate for absorption and evaporation losses.

b. At the conclusion of the 24-hour saturation period, the manhole shall be filled to the top and observed.

c. Any measurable loss within a 30 minute period shall be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval of the Engineer), and notify the Inspector when the retest will be performed.

d. All effort, materials, or other costs shall be solely at the Contractor’s expense.

3. Protective Coating Testing

a. Spark (Holiday)Test – After the coating product(s) have cured in accordance with manufacturer recommendations, all surfaces shall be inspected for holidays per NACE RPO188-99, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates, or ASTM D4787, Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates. All detected holidays shall be marked and repaired according to the coating product(s) manufacturer’s recommendations.

1. Test voltage shall be a minimum of 100 volts per mil of coating system thickness.
2. Detection of a known or induced holiday in the coating product shall be confirmed to ensure proper operation of the test unit.
3. All areas repaired shall be retested following cure of the repair material(s).

b. Adhesion Test – Adhesion of the coating system to the substrate shall be confirmed in a minimum of 5% of the manholes coated (no fewer than one (1) manhole). After the coating product(s) have cured in accordance with manufacturer recommendations, testing

shall be conducted in accordance with ASTM D7234, Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers. Owner's representative shall select the manholes and areas to be tested.

4. Acceptance: Any manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material of which the manhole is constructed.
5. The manhole shall be retested as described above until a successful test is attained.
6. After a successful test, the temporary plugs will be removed.
7. To ensure that the plugs have been removed, Contractor shall only do so in the presence of the Inspector.
    a. Repairs to Existing Manholes: Any existing manhole which fails to pass the hydrostatic/vacuum test shall be closely examined by the Inspector and the Contractor to determine if the manhole can be repaired.
8. Thereafter, the Contractor shall either repair or remove and replace the manhole as directed.
9. Any manhole excavated for repairs or excavated for tie in, shall be backfilled with a minimum of 12 inches thickness of flowable fill to one foot above the top of the cone section to allow for the concrete ring encasement.
10. After abrading and cleaning, additional protective coating material shall be applied to the repair area.
11. All touch-up repair procedures shall follow the protective coating manufacturer's recommendations.

D. If a sanitary manhole fails to pass one of the above tests, it shall be repaired in accordance with the manufacturer's recommendations and re-tested. Should the test fail a second time, Contractor shall perform another leak test utilizing the other testing option in this specification Should the test fail the third time, Contractor shall remove and replace the manhole and perform all the necessary test at no additional cost to NBU. Manholes shall not be accepted until it passes all tests.

E. Engineer of Record must witness all tests over the EARZ.

F. 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.

304.8 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 separate Pay Item is indicated on the Drawings and identified in Standard Contract Bid Form.

An "Extra Depth Manhole" will be measured by linear vertical foot of Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or Tangent Tee Manhole of the indicated size in excess of eight feet of depth. Manhole depth will be measured from the invert flow line to the finished surface elevation.

304.9 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.

Payment for that portion of a Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or Tangent Tee Manhole in excess of eight (8) feet in depth will be made at the unit price bid for "Extra Depth Manhole" of the indicated type and size, complete in place.

Pay Item:	New Manhole Construction, ___ Dia.	Per Each
Pay Item:	Special Manhole, ___ Dia.	Per Each
Pay Item:	Drop Manhole, ___ Dia.	Per Each
Pay Item:	Centered Tee Manhole, __ Dia. x ___ Dia.	Per Each
Pay Item:	Tangent Tee Manhole, ___ Dia. x ___ Dia.	Per Each
Pay Item:	Junction Box, ___ Ft x ___ Ft	Per Each
Pay Item:	Major Manhole Adjustment, ___ Dia.	Per Each
Pay Item:	Minor Manhole Adjustment, ___ Dia.	Per Each
Pay Item:	Abandonment of existing Manholes:	Per Each
Pay Item:	Extra Depth___Manhole, ___Dia.	Per Linear Vert. Foot

End

Item No. 311
Adjusting Structures

311.1 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. 121, "Trench Safety Systems" for trench walls when indicated on the Drawings.

311.2 Submittals

The submittal requirements of this specification item must 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 structures and proposed adjustment technique (lowering, raising, lateral displacement).

D. Type 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.

311.3 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 TXDOT Standard Specification Item No. 421, "Hydraulic Cement Concrete".

B. Mortar

Unless otherwise specified or approved by the Engineer or designated representative, mortar shall conform to requirements of TXDOT Standard Specification item No. 421, "Hydraulic Cement Concrete."

311.4 Construction Methods

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

B. 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 its own expense.

C. 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.

D. 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 Standard Installation Details included in the New Braunfels Utilities Standard Details.

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

311.5 Measurement

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

311.6 Payment

All work performed by this item will be considered subsidiary to other bid items unless it is included as a separate bid item in the contract documents then all work performed as required herein and measured as provided under "Measurement" will be paid for at the unit bid price. The bid prices shall include full compensation for furnishing all labor; all materials; all royalty and freight involved; all hauling and delivering; and all tools, equipment and incidentals necessary to complete the work. Payment will not be made for unauthorized work.

Payment will be made under one of the following:

Pay Item: Adjusting Water Meters and Boxes	Per Each
Pay Item: Repositioning & Adjusting Water Meters and Boxes	Per Each
Pay Item: Adjusting Gas Valve Boxes to Grade	Per Each
Pay Item: Adjusting Survey Monument Boxes to Grade	Per Each
Pay Item: Adjusting Water Valve Boxes to Grade	Per Each
Pay Item: Adjusting Pull Boxes to Grade	Per Each

End

Item No. 312
Frames, Grates, Rings and Covers

312.1 Description

This item shall govern furnishing and installation of frames, grates, rings and covers for portland cement concrete manholes and other structures indicated on the Drawings. Rings and covers for polymer concrete manholes and structures shall meet the requirements of Item No. 303 “Polymer Concrete Manholes.”

312.2 Submittals

The submittal requirements of this specification item must 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.

312.3 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. ASTM International (ASTM) Standards:

ASTM A27	Specifications for Steel Castings, Carbon, for General Application
ASTM A36	Specification for Structural Steel
ASTM A48	Specification for Gray Iron Castings
ASTM A536	Specification for Ductile Iron Castings

312.4 Materials

A. 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. New Braunfels Utilities Standard Products Lists (SPLs) form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPLs; however, submittal to the Engineer or designated representative 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.

B. The purpose of the SPLs is to expedite the review by the Engineer or designated representative and, if necessary, New Braunfels Utilities Products Committee of Contractor product submittals. 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 that are 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 in conjunction with New Braunfels Utilities Standard Products Committee. The Standard Product List current at the time of plan approval will govern.

C. Welded Steel

1. 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 A36/A36M.

D. Castings

1. 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.

2. Steel castings shall conform to ASTM A27/27M. Grade 70-36 (480-250) shall be furnished unless otherwise specified on the Drawings.

3. Cast iron castings shall conform to ASTM A48, “Specification for Gray Iron Castings,” Class 30.

4. Ductile Iron castings shall conform to ASTM A536, “Specification for Ductile Iron Castings.” Grade 60-40-18 (415-275-125) shall be used unless otherwise indicated on the Drawings.

E. Manhole Cover Riser Rings

1. Height-adjustment inserts for wastewater manhole rings, which are used for raising standard manhole covers, shall be those models listed in New Braunfels Utilities Standard Products List.

F. Nuts and Bolts

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

G. Mortar

1. Unless otherwise specified or approved by the Engineer or designated representative, mortar shall conform to requirements of TXDOT Standard Specification item No. 421, “Hydraulic Cement Concrete.”

312.5 Construction Methods

A. Frames, grates, rings and covers shall be constructed of the specified materials in accordance with the details indicated on the Drawings or in New Braunfels Utilities Standard Details. 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.

B. 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, dry.

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

312.6 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

Item No. 315
CCTV Inspection

315.1 Description

A. This item shall govern the construction, labor, materials, equipment and associated appurtenances for cleaning sanitary sewer mains in preparation for rehabilitation. Cleaning shall remove debris and foreign materials from the mains and manholes in preparation for television inspection of sewer mains.

B. Provide all television equipment, technical assistance, labor, tools and associated incidentals and appurtenances required to internally inspect the existing sewer mains and new sewer mains shown on the Drawings. Verify the mains are properly cleaned in preparation of inspection and/or rehabilitation. Locate service laterals and identify pipeline segments that require repair prior to the slip lining, pipe bursting or CIPP installation. The internal TV inspection shall also document the post rehabilitation status of the pipe for comparison and total acceptance of Work done. The video must show an inclinometer and the slope of the pipe. After cleaning, visually inspect the main sections by means of a closed-circuit television. Inspect one line section between manholes at a time, during which the sewer flow in that line section is properly controlled according to the flow control requirements of this Section.

C. Provide control of sewer flow in conjunction with cleaning of sewer mains, and installation of replacement lines. Sewer flow diversion shall not cause surcharging or damage to public or private property. The sewer flow shall be plugged at an upstream manhole for the section of sewer line that is to be rehabilitated (by sliplining, cured in place pipe, or pipe bursting, etc.), for both installation and televised post installation inspection. Provide notification to property owners and tenants on flow control lines a minimum of 48 hours prior to institution of flow control measures.

315.2 Submittals

The submittal requirements of this specification item must include:

A. Television inspection logs in paper and digital format.

B. Digital format video of television inspection with an inclinometer visible on the video which notes the slope of inspected pipe.

C. A graphed report of the inclinometer data gathered for each of the pipe segments.

D. PACP Report and Top View Report and CD / DVD disks of CCTV completed.

E. Flow Control Plan.

1. Listing of safety precautions and traffic control measures.

2. Certification that staff to be used for the Work are properly trained in confined space entry and hazardous environments.

315.3 Quality Assurance

A. Equipment used shall be in good working order and provide continuous operation during TV/video inspection.

B. CD / DVD disks shall be of good visual quality capable of slow motion and pausing without significant reduction of visual quality.

C. Inspector(s) must be NASSCO / PACP certified and certification number submitted to NBU prior to commencement of work.

D. Video image shall be calibrated using a Marconi Resolution Chart No. 1 or equivalent.

315.4 Equipment and Supplies

Cleaning Equipment

A. Selection of cleaning equipment and method of cleaning must be based on the condition of the sewer mains at the time Work commences and is subject to the Owner's representative's approval. Operation of all cleaning equipment and devices shall be by personnel experienced in the use of such equipment. Owner may require the Contractor to demonstrate the performance capabilities of the proposed cleaning equipment. If the cleaning equipment does not give the desired results required by the Owner, Contractor shall use different equipment that does provide the desired results. More than one type of equipment/attachments may be required at any particular location.

Television Camera

A. Camera used shall be 360-degree COLOR RVC camera. The television camera used for inspection must be specifically designed and constructed for internal inspection of sanitary sewer pipe with partial liquid flow through it. Lighting for the camera must allow a clear picture of the entire periphery of the pipe above the existing flow. The camera will operate in 100% humidity conditions. The camera, television monitor, and other components of the video system shall produce a picture quality satisfactory to NBU and, if unsatisfactory, equipment shall be removed and replaced with satisfactory equipment.

Video Recording Equipment

A. Furnish video equipment to provide a visual and audio recording of all areas in the pipe. Video recording system at the site shall be capable of rewind, play back, slow motion and stop motion. The video shall be recorded on a DVD or equal portable storage device whose format is compatible with the latest version of Microsoft Windows. Also, an audio channel for clearly recording the camera locations and operator observations (cracks, leaks, service connections, etc.). The system shall continuously indicate distance, in feet, from manhole to manhole and the manhole-to-manhole run numbers on the video recording.

Communication Equipment

A. When manually operated winches are used to pull the television camera through the main, set up two-way radio or other suitable means of communication between the two manholes of the line section being inspected to ensure good communications between members of the crew.

Power Supply

A. Power supply shall be continuous. If night operations occur, supply all labor, power and lighting equipment for operations, traffic safety, permits, etc.

Methods of Flow Control

A. Furnish temporary plugs as required to provide for diversion of flows and temporary isolation of sanitary sewer sections during rehabilitation. The plugs must be designed so all or any portion of the sewer flow can be released at any time. Insert a plug into the upstream manhole of the line section being worked. A plug in the downstream manhole may be required to prevent any backflow.

B. Furnish bypass pumping equipment as required to provide for diversion of flows and temporary isolation of sanitary sewer sections during rehabilitation. When total bypassing and pumping are required, supply the pumps, conduits, and other equipment to divert the flow of sewer around the line section where rehabilitation work is to be performed. Begin the flow diversion at the upstream manhole. Divert flow to the downstream manhole of the line section being worked. The total bypass system must have sufficient capacity to handle peak flow during a wet weather event. Contractor is responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing. If pumping is required on a 24-hour basis or outside of specified normal work hours, use engines with Hospital Rated noise suppression equipment. A comprehensive bypass pumping plan shall be submitted by the Contractor as required in Paragraph 315.2.E.

315.5 Materials

Cleaning Materials

A. Use only the type of cleaning material which will not create hazards to health or property or affect treatment plant processes.

315.6 Construction Methods

Cleaning

A. General:

1. All materials, equipment, and personnel necessary to complete the cleaning of the sanitary sewer main and manholes must be present on the Site prior to isolating the sewer manhole or line segment and beginning the cleaning process.

2. Clean the sewer lines from upstream to downstream, manhole to manhole. Remove dirt, grease, rocks, sand, roots and other materials and obstructions from the sewer lines and manholes or junction boxes. Dispose of removed materials in accordance with applicable federal, state, and local rules and regulations. It is the sole responsibility of the Contractor to secure a licensed legal dump site for the disposal of this material. Under no circumstances shall sewage or solids removed from the main or manhole be dumped onto streets or into ditches, catch basins, storm drains, or sanitary sewers. The cleaning shall leave the interior pipeline suitable for adequate television inspection and installation of replacement materials as applicable for the Project. Multiple passes and different equipment may be required. TV Inspection shall be used to verify acceptable completion of the cleaning.

3. Satisfactory precautions shall be taken to protect the sanitary sewer mains and manholes from damage that might be inflicted by the improper use of the cleaning process or equipment.

4. Any damages done to a sewer main and/or structure by the Contractor shall be repaired by the Contractor at no additional cost and to the satisfaction of the Owner.

5. Cleaning shall also include the manhole wall and junction box wall by high pressure water jet.

6. Contractor may be required to demonstrate the performance capabilities of the cleaning equipment proposed for use on the Project.

    a. If the results obtained by the proposed sanitary sewer cleaning equipment are not satisfactory, Contractor shall use different equipment and/or attachments, as required, to meet the requirements of the Contract Documents.

    b. More than one type of equipment/attachments may be required at a location.

7. When hydraulic or high velocity cleaning equipment is used, a suitable sand trap, weir, dam, or suction shall be constructed in the downstream manhole in such a manner that all the solids and debris are trapped for removal.

8. Whenever hydraulically-propelled cleaning tools which depend upon water pressure to provide their cleaning force, or any tool which retard the flow of water in the sanitary sewer lines are used, precautions shall be taken to ensure that the water pressure created does not cause any damage or surcharging to public or private property being served by the manhole section involved.

9. Any damage of property, as a result of surcharging, shall be the liability and responsibility of the Contractor.

10. The flow present in the sanitary sewer main shall be utilized to provide necessary fluid for hydraulic cleaning devices whenever possible.

11. When additional quantities of water from fire hydrants are necessary to avoid delay in normal working procedures, the water shall be conserved and not used unnecessarily.

    a. No fire hydrant shall be obstructed or used when there is a fire in the area.

    b. It is the responsibility of the Contractor to obtain the fire hydrant, water meter and all related charges for the set-up, including the water usage bills from respective water purveyor agency.

    c. All expenses shall be considered incidental to the cleaning of the existing sanitary sewer mains.

B. New Mains:

1. All mains and manholes should be clean of debris prior to televising. The sanitary sewer main shall be flushed within 72 hours of televising and recording. This will assure the main is clean of debris as well as identify any potential sags within the main.

2. All sanitary sewer gravity lines shall be CCTV'd at the Contractor's expense; and a video recording of the subject mains provided prior to preliminary acceptance and at the 1-year warranty inspection by NBU. Televiewing may only occur after the stabilized subgrade has been installed and satisfactory density tests have been submitted to the City of New Braunfels. An NBU authorized representative must be present during the

televiewing, unless otherwise approved by NBU. The sewer video inspection shall include rotating the camera lens to inspect the interior of each sewer lateral.

C. Existing Mains:

1. Recommended Cleaning

Purpose of Inspection	Recommended Cleaning
To determine the serviceability of the pipe, e.g. is the pipe silting up	Do not clean prior to CCTV inspection only clean if the camera cannot travel through the pipeline.
Inspection of structurally suspect pipelines	Do not clean prior to CCTV inspection. Cleaning may damage the pipeline.
To identify the general structural condition of the pipeline. Identification of small severity faults is not a concern.	Light cleaning to remove slime and spider webs.
To identify all faults in the pipeline, including small severity faults, e.g. in order to determine whether the pipeline is suitable of grouting.	Full cleaning of the pipeline to remove all foreign material.

D. Methods:

1. Hydraulic Cleaning:

a. Hydraulic-propelled devices which require a head of water to operate must utilize a collapsible dam.

b. The dam must be easily collapsible to prevent damage to the sewer main, property, etc.

c. When using hydraulically-propelled devices, precautions shall be taken to ensure that the water pressure created does not cause damage or flood public or private property.

d. Do not increase the hydraulic gradient of the sanitary sewers beyond the elevation that could cause overflow of sewage into area waterways or laterals.

e. The flow present in the sanitary sewer main shall be utilized to provide necessary fluid for hydraulic cleaning devices whenever possible.

2. High-Velocity Cleaning:

a. Cleaning equipment that uses a high velocity water jet for removing debris shall be capable of producing a minimum volume of 50 gpm, with a pressure of 1500 psi for the sanitary sewer line and 3500 psi for the (manhole) structure at the pump.

b. Any variations to this pumping rate must be approved, in advance, by the Owner.

c. To prevent damage to older sewer mains and property, a pressure less than 1500 psi can be used.

d. A working pressure gauge shall be used on the discharge of all high-pressure water pumps.

e. For sewers 18 inches and larger in diameter, in addition to conventional nozzles, use a nozzle which directs the cleaning force to the bottom of the pipe.

f. Operate the equipment so that the pressurized nozzle continues to move at all times.

g. The pressurized nozzle shall be turned off or reduced anytime the hose is on hold or delayed in order to prevent damage to the line.

3. Mechanical Cleaning:

a. Mechanical cleaning, in addition to normal cleaning when required, shall be with approved equipment and accessories driven by power winching devices.

b. Submit the equipment manufacturer's operational manual and guidelines to the Owner, which shall be strictly followed unless modified by the Owner.

c. All equipment and devices shall be operated by experienced operators so that they do not damage the pipe in the process of cleaning.

d. Buckets, scrapers, scooters, porcupines, kites, heavy duty brushes, and other debris-removing equipment/accessories shall be used as appropriate and necessary in the field, in conjunction with the approved power machines.

e. The use of cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment, in conjunction with hand winching device, and/or gas, electric rod propelled devices, shall be considered normal cleaning equipment.

E. Considerations - Consideration needs to be given to ensure that:

1. Adjacent properties are not damaged or flooded.

2. Sewer overflows do not occur.

3. The sewer being cleaned is not damaged.

4. All debris from the cleaning is collected and removed from the sewer system.

Televising / Inspection

A. The pipeline should be inspected as soon as possible after it has been cleaned. In any case the inspection should be completed within seven days of cleaning. For pipes that have material with high levels of debris or grease flowing through them seven days may be too long and re-cleaning may be required.

B. Inspection shall be done one manhole section at a time.

C. Locate video vehicle on upstream side of manhole. Recording shall begin during the lowering of the camera into the manhole opening. Video in the downstream direction such that camera movement is with the flow. Camera lens shall be positioned looking along the

axis of the sewer. The camera axis should be within ±10% of the vertical sewer centerline of the pipe. For oval shaped pipes, the camera shall be positioned vertically above the invert at a height ⅔ of the vertical dimension of the pipe.

D. Insert the camera in the upstream manhole after flow restrictions required have been accomplished. Flow into the system being inspected shall be stopped, with the exception of service laterals into the system being inspected. Move camera through the pipe lines at a moderate speed not exceeding 30 feet per minute. Excessive use of the pan and tilt features should be avoided. Stop camera at locations where one or more of the following conditions is observed:

1. Infiltration/inflow sources.
2. Service Laterals.
3. Structural defects including broken pipe; collapsed or collapsing pipe, cracks, deterioration, punctures, etc.
4. Abnormal joint conditions such as misalignments, open joints and joints not sealed.
5. Unusual conditions such as root intrusion, protruding pipes, in-line pipe size changes, mineral deposits, grease and obstructions.

E. Stop camera long enough for a thorough visual inspection of the conditions. All such conditions as specified above, along with the corresponding PACP code for each condition, shall be audio recorded on video and the inspection log sheet. Move the camera and rotate to obtain optimum view of the conditions. Each condition should be framed as to provide a full perspective. If requested by an NBU representative, view problem areas in the opposite direction by pulling the TV camera from the opposite direction at no additional cost to the NBU.

1. While the camera is stopped at each service connection, rotate the camera so as to be able to view the service connection for a length of time that enables a good visual inspection of the service connection for damage and infiltration. Be responsible for measurements such as service lateral locations, if used for subsequent rehabilitation work.

2. When, during the inspection operation, the television camera will not pass through the entire manhole-to-manhole section, set up equipment so that the inspection can be performed from the opposite manhole at no additional cost to NBU. All reasonable effort should be given to video the entire segment including the removal of obstructions, reversals, location/exposure of buried manholes, use of more versatile equipment, etc.

3. Any defects or anomalies detected on new construction that does not meet NBU requirements shall be corrected by the Contractor prior to NBU acceptance. Once corrected, the portion(s) shall be videoed, again, to assure the modification(s) was made correctly.

F. Move the camera through the main in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer line condition. In no case shall the television camera be pulled at a speed greater than 30 feet per minute. Use manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer main condition. Identify locations of defects by means of a measurement device (distance meter) above ground. Marking on the cable or similar practices that require interpolation for depth

of manhole is not allowed. Check accuracy of the distance meter with a walking meter, roll-a-tape, or other suitable device satisfactory to the Owner.

Flow Control

A. Provide flow control measures needed to allow for isolation of individual sanitary sewer sections for rehabilitation work. Prior to beginning Work, Contractor shall submit a written plan for flow control as noted in Paragraph 1.02. In providing this Work, protect the sewer main from damage that might result from sewer surcharging. In addition, take precautions necessary to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewer mains involved. Contractor is advised to schedule its Work in section lengths such that in the event of a wet weather event that might cause an increase in the sewer flow, the Work can be adequately secured, the flow diversion stopped, and flow resumed back in the existing main expeditiously and without damage to the new Work.

   1. Notify property owners and tenants a minimum of 48 hours prior to scheduled flow control diversion operations.

   2. Locate flow diversion equipment, facilities, and activities such that local traffic, private property access, or any public activities are not interrupted.

   3. Where diversion piping crosses side streets, alleys and driveways, provide asphalt ramps and covers over the piping to facilitate passage of any traffic. Provide pedestrian cross-over ramps and walkways where needed or requested by the Owner. Do not open cut streets, alleys, or driveways to bury piping.

   4. Divert incoming flow from all service connections and laterals. Provide all the necessary materials and equipment to tie this flow into the main diversion system.

   5. Flow diversion materials and equipment must be in place and successfully operating for a period of 4 hours prior to starting any rehabilitation work requiring flow diversion.

   6. Reduce flow to within the limits required for TV inspection. After the Work has been completed, restore flow to normal.

   7. Keep pumping engine noise complaints from the citizens to a minimum. Owner's representative may terminate all pumping activities if noise control is not adequately addressed.

Repair of Damaged Main

A. If the main is damaged and requires repair prior to rehabilitation, make such repairs as directed by the Owner's representative. Any pavement cut excavation and repair must comply with the details in the Drawings. If the main is damaged through the negligence of the Contractor, make repairs as approved by the Owner's representative at no additional cost to the Owner.

Documentation

A. Television Inspection Logs: Keep printed location records that clearly show the camera location in relation to an adjacent manhole for each infiltration point or defect observed during inspection. In addition, record other points of significance such as locations of

service line entry points, unusual conditions, roots, sewer connections, broken pipe, presence of scale and corrosion, and other discernible features. Submit a copy of such records and copies of the video in digital format to the Owner's representative.

B. Furnish a detailed report and digital video of the system inspected. The minimum information supplied shall be the following:

1. Name and address of Contractor and the Developer.

2. Name of Project, system(s) inspected, and Project's representative involved.

3. Log reports:

   a. PACP Report and Top View Report for each section of pipe using NASSCO's PACP Standards unless otherwise instructed by NBU.

   b. Separate line for each deficiency and location

   c. Corresponding video and location of each section of pipe and deficiencies on digital video.

4. Video shall be labeled with the following information:

   a. System that is video (street name and manhole to manhole numbers) and log report number corresponding to video

   b. Date video was recorded

   c. Contractor's name and representative

   d. Project's name, if applicable

315.7 Measurement and Payment

Payment for CCTV of lines will be made at the unit price bid per linear foot for the various sizes of pipe, of the materials and type indicated. Payment shall include all labor, materials, equipment, cleaning, by-pass pumping, and all other incidentals and appurtenances necessary to complete the work.

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

Pay Item: Pipe, __Dia. ___ (all depths) Per Linear Foot

End

Item No. 330
Wastewater By-Pass Pumping

330.1 Description

This item shall govern the construction, labor, materials, equipment and incidentals necessary to implement a temporary bypass pumping system for the purpose of diverting existing sewer flows around the work area regardless of number of locations, set-ups, length and duration, and shall be for the duration of the Project.

330.2 Submittals

The submittal requirements of this specification item must include:

A. Manufacturer's product data, instructions, recommendations, Shop Drawings, and necessary certifications in order for the proposed Bypass Pumping Plan to be reviewed. The plan shall include, but not be limited to, the following:

1. Staging areas for pumps.
2. Sewer plugging method and types of plugs.
3. Number, size, material, location and method of installation of suction piping.
4. Number, size, material, location and method of installation of discharge piping.
5. Bypass pump sizes, capacity, number of each size to be on site, including spare pump, and power requirements.
6. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted based on bypass pumping schedule at the end of this Section).
7. Standby power generator size and location.
8. Downstream discharge plan.
9. Calculations for selection of bypass pumping pump size.
10. Method of noise control for each pump and/or generator if required.
11. Method of protecting discharge manholes or structures from erosion and damage.
12. Schedule for installation and maintenance of bypass pumping lines.
13. Schedule and emergency contact information for on-site operator or staff in responsible charge.

330.3 Quality Assurance

A. Contractor shall demonstrate that the temporary bypass pumping system is in good working order and is sufficiently sized to successfully handle all sanitary sewer flows by performing a test run for a period of 24 hours prior to beginning Work.

B. Contractor shall be required to have all materials, equipment and labor necessary to complete the repair and/or replacement on the Site prior to isolating the sewer manhole or line segment and beginning flow diversion or pumping operations.

C. Contractor shall provide both a strobe light type, high level alarm, as well as alarm notification to their cell phones, as well as other appointed personnel to be identified by the Owner and ensure adequate alarm notification is attained prior to actual startup of the test period.

D. During active operations, Contractor shall have personnel on the Site 24/7. If multiple locations are active within a project site, Contractor must maintain a ratio of 2 to 1, active bypass pumping areas to personnel. If the two sites are more than 500 feet away from each other or the high-level strobe alarm cannot be seen from each location, then the Contractor must provide dedicated personnel at every site.

E. Contractor shall coordinate all activities through Engineer and Owner.

F. It is anticipated that bypass pumping shall be required at the following locations:

   1. **[Specify project specific information for locations that will require bypass pumping. This is not meant to be a bypass pumping plan.]**

330.4 Materials

A. Contractor shall provide all necessary pumping equipment, piping and all other necessary appurtenances in order to maintain adequate and reliable sanitary sewer flow in the sewer system (excluding manholes) at all times during construction. All materials, equipment, etc., must be in good condition and should not have visible damage such as cracks, holes, foreign material, blisters, etc. Contractor must place a sign and provide an emergency contact on site stating, “In the event of a sewer overflow for other issue, call the emergency contact listed” for citizens to report issues.

B. High-Density Polyethylene (HDPE) is the preferred pipe material for all bypass piping. HDPE must be used when bypass discharge piping will be going through streams, storm water culverts, and/or environmentally sensitive areas.

   1. HDPE pipe must be assembled and joined using couplings, flanges or fusion welding in order to avoid joint leakage.

   2. HDPE fusion welding must be performed by personnel certified as fusion technician(s) by the manufacturer of HDPE pipe and/or fusing equipment.

   3. The bypass pumping plan shall indicate the proposed DR of the pipe to be used.

C. Pipe material other than HDPE shall be submitted to the Engineer for approval. Neither “irrigation type” pipe nor glued PVC pipe will be permitted.

D. Plugs must be selected and installed according to the size of the line to be plugged. An additional plug must be on-site and ready to be installed in the event a plug fails or becomes dislodged. Plug(s) will be reviewed by the inspector and/or Engineer for defects that might lead to failure prior to being installed. It is also imperative that the Contractor notify the inspector at the completion of the Work in order to verify that all plugs have been removed from the system.

330.5 Equipment

A. Pumps must be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps to prime the system. Pumps may be electric or diesel powered. The primary pump must be a grinder or chopper pump, in order to reduce the potential for debris to complicate the safe operation of the pumps.

B. Contractor shall have one backup pump, equal in capacity to the largest pump in the system, connected to the temporary bypass pumping system and ready for operation in case any of the primary pumps fail. The backup pump shall not be used in Contractor's calculations for determining the pumping capacity requirements for the stated flow conditions.

C. Sound-attenuated pump enclosures shall be required on all projects where the bypass pumps are located within 100 feet of any residence, business, park, or other presence of people. If a pump is not located within 100 feet of a residential district, the pump enclosures must suppress sound to 85 decibels at all times. If the pump is located within 100 ft of a residential district, the pump enclosure must limit the sound to 85 decibels between 10:00 A.M. and 10:00 P.M and to 75 decibels at all other times as stated in the City of New Braunfels Noise Ordinance.

330.6 Construction Methods

Preparation:

A. Obtain the Engineer's approval of location of bypass pipelines, staging areas and pump locations prior to installation.

B. Obtain approvals for placement within public or private property.

Construction, Installation, and Removal:

A. During construction, it will be the Contractor's responsibility to maintain a safe and secure environment at all times. All provisions and/or requirements of the temporary bypass pumping plan must be followed throughout the course of any bypass flow operations. Contractor must notify the Owner 72 hours prior to commencing the bypass pumping operations.

B. Contractor shall provide continuous supply on-site fuel storage sufficient for 24-hour operation of the bypass pumping installation.

C. Contractor shall protect all components of the bypass operations from vandalism and vehicular damage by making the site secure.

D. Contractor shall minimize sewer odors by using lids, shroud covers, or any method approved by the Inspector or Engineer.

E. Contractor shall be solely responsible for any and all damages to private and/or public property caused by or during the installation, operation, and/or removal of the bypass pumping system.

F. All piping, joints and accessories shall be designed to withstand at least twice the maximum system pressure, or a minimum of 50 psi, whichever is greater.

G. During flow diversion and/or pumping, no sewage shall be leaked, dumped, or spilled in or onto, any area outside of the existing sanitary sewer system.

H. When flow diversion and/or pumping operations are complete, all pumping shall be drained into the sanitary sewer prior to disassembly and all flow management components shall be removed.

Bypass Pumping Schedule:

A. Flows shown below are based on modeled flows.

B. It is the Contractors responsibility to verify the flows with the city prior to development of bypass pumping plan.

Sanitary Sewer Manhole / Location	Average Dry Weather (MGD or GPM)	Peak Wet Weather (MGD or GPM)
(SSMH No. X or STA _+__ or Line Name and Size)	X.XX	X.XX

330.7 Measurement and Payment

Measurement:

A. Measurement for the Work specified herein will be by lump sum, as the Work progresses, and as required by the Contract Documents.

B. Temporary bypass pumping not specifically required on the Drawings but directed by the Engineer and/or the inspector, will not be measured separately for payment and will be considered incidental. Repair or replacement of manhole sections disturbed as a part of the temporary bypass pumping operations is considered incidental to the line item and will not be measured separately for payment.

Payment:

A. Partial payment of the lump sum bid item for temporary bypass pumping shall be in accordance with the following:

1. When initial setup and operation of the temporary bypass pumping system begins, 40 percent of the line item will be paid.

2. The remaining portion of the line item will be paid when the temporary bypass pumping system operations for the entire job are completed.

End

Item No. 501
Jacking or Boring Pipe

Notes to Specifier:

Delete these notes and not used paragraphs.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Verify all references to paragraphs within this Section and to any applicable Sections, standards or other specified sources of information.

General: This specification is intended for applications that consist of relatively short (less than 200 feet) pipeline crossings for pipelines with nominal diameters of 48 inches or less, in favorable, uniform ground conditions that consist of cohesive soils that are above the groundwater table. This specification shall not be used for high-risk applications of longer (greater than 200 feet) or larger diameter pipeline crossings (pipelines with a nominal diameter greater than 48 inches) or for pipeline crossings in unfavorable ground conditions (non-cohesive soils, variable or mixed ground conditions, ground containing cobbles, boulders or other types of obstructions, in rock, below the water table, in contaminated soils, and/or other unstable conditions).

Geotechnical Information: Obtain site specific geotechnical information to understand the subsurface conditions associated with each pipeline crossing in order to mitigate risk. When planning a geotechnical investigation, borings should be drilled at each proposed shaft location to depths at least 15 feet below the subgrade elevation of the shaft. Borings should be performed at least every 300 feet along alignments that may be constructed by tunnel or trenchless construction methods and such borings shall be offset from the alignment and outside of the potential tunnel/trenchless alignment to prevent conflicts with future tunnel/trenchless construction activities. Deeper depths for borings should be considered if there is a possibility that the pipeline can go deeper to avoid unfavorable ground conditions, existing utilities, or undergo a potential change during detailed design.

Geotechnical Investigation or Geotechnical Reports: If geotechnical information and/or a geotechnical report has been performed for the Project, especially if it involves the pipeline crossing to be specified herein, the Supplementary Conditions or similar front end documents may need to be edited to denote the availability and reliance on the Technical Data contained in such reports and whether or not such reports are to be considered a part of the Contract Documents.

Tunnel or Trenchless Construction Methods: This specification includes guidance for tunnel or trenchless excavation with an auger boring machine, jacking shield (otherwise known as a digger shield), or by manual hand tunneling or mining, all of which can be referred to as jack and bore methods. This specification does not include provisions for advanced tunnel or trenchless construction methods such as the use of a tunnel boring

machine (e.g., earth pressure balance tunnel boring machine), microtunnel boring machine (e.g., slurry type microtunnel boring machine), or other trenchless methods such as horizontal directional drilling, pipe bursting, pipe ramming, or guided boring methods (e.g., pilot tube method).

Finished Pipe Materials: Coordinate this section with the finished pipe material specification, drawings and typical details, and pipe trenching and backfilling specifications to clearly denote which portion of the Project they apply to (the open cut portion of the pipeline or the tunnel or trenchless crossing portion of the pipeline). In some instances, the casing pipe can also serve as the carrier pipe. If such is the case the requirements herein will need to be modified, such as inclusion of requirements for coatings and linings, joint types, etc.

Minimum Clearances and Cover Depth: Tunnel or trenchless excavations shall maintain at least 4 feet of clearance from existing utilities (as measured from the outside diameter of the existing utility to the outside diameter of the new utility, including any casings) or greater if required by authorities having jurisdiction, such as the Texas Commission on Environmental Quality for clearances between water and wastewater lines. Tunnel or trenchless excavations shall maintain at least 6 feet of cover or two times the diameter of the tunnel or trenchless excavation, whichever is greater (beneath the bottom of the subgrade of highways, roadways, non-natural drainage channels, or other structures, beneath the flowline of natural drainage channels, or beneath the bottom of the sub-ballast of railways) or greater if required by authorities having jurisdiction.

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, dewatering, contact grouting, backfill grouting, bulkhead installation, backfilling, and re-vegetation.

501.2 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. American Association of State Highway and Transportation Officials (AASHTO):

AASHTO	Standard Specifications for Highway Bridges

B. American National Standards Institute (ANSI) / NSF International Standards:

ANSI/NSF 61	Drinking Water System Components – Health Effects

C. American Railway Engineering and Maintenance-of-Way Association (AREMA):

AREMA	Manual for Railway Engineering

D. American Society of Civil Engineers (ASCE):

ASCE MOP 106	Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects

E. American Water Works Association (AWWA):

AWWA C200	Steel Water Pipe, 6 In. (150 mm) and Larger
AWWA C206	Field Welding of Steel Water Pipe
AWWA C210	Liquid-Epoxy Coatings and Lining for Steel Water Pipe and Fittings
AWWA M11	Steel Water Pipe – A Guide for Design and Installation

F. Railroad Standards:

BNSF Railway	Public Projects Manual, Utility Accommodation Policy, and Guidelines for Temporary Shoring
Union Pacific	Union Pacific Railroad Public Projects Manual, Guidelines for Track & Ground Monitoring, Guidelines for Temporary Shoring, and General Conditions and Specifications

G. Occupational Safety and Health Administration (OSHA) Regulations:

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
2226-10R	Trenching and Excavation Safety
3115-06R	Underground Construction (Tunneling)

H. TxDOT Test Procedures

Tex-114-E	Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material
Tex-115-E	Field Method for Determining In-Place Density of Soils and Base Materials

I. TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges:

Item 476	Jacking, Boring, or Tunneling Pipe or Box

501.3 Definitions

A. Definitions pertaining to jacking or boring and associated work described herein shall be in accordance with the Glossary of Trenchless Terms published by the National American Society of Trenchless Technology (NASTT), which can be found at https://www.nastt.org/resources/glossary/.

B. The term “jacking” used herein shall be synonymous with the terms “pipe jacking” or the “shield tunneling method” as defined by the NASTT Glossary.

C. The term “boring” used herein shall be synonymous with the terms “auger boring” or “horizontal earth boring" as defined by the NASTT Glossary.

501.4 Submittals

The submittal requirements for this specification item shall include:

A. Work Plan: Prior to beginning the Work, the Contractor shall submit to the Owner’s Representative a work plan as Record Data detailing the procedure and schedule to be used to execute the Project. The work plan should include:

1. A description and product data of all jacking or boring equipment to be used including, capacity, number, and arrangement of hydraulic jacks, as applicable. Provide details of thrust ring, jacking controls, and pressure gages as applicable.

2. A description of the proposed procedures for performing jacking or boring operations, including handling and disposal of excavated materials, installing encasement pipe, including jointing and welding procedures, as applicable, installation of the carrier pipe, including product data and shop drawings of casing spacers and end seals, and batching, mixing, pumping, and placement of contact grout into the exterior or the encasement pipe and backfill grout in the annular place in the interior of the encasement pipe. Include means and methods of line and grade control for the jacking or boring equipment during installation of the encasement pipe and the carrier pipe.

3. Statement of qualifications and experience for the Project Superintendent, Project Manager, and Jacking or Boring Equipment Operators for the jacking or boring operations (including back-up personnel in the event that an individual is unavailable).

4. A list of Subcontractors (if applicable).

5. A schedule of all work activities.

6. A safety plan (including Safety Data Sheets of any potentially hazardous substances to be used).

7. Traffic control plan (if applicable).

8. Geotechnical instrumentation monitoring plan (if applicable).

9. A pit/shaft excavation work plan. Protective systems are required for pit/shaft excavations 5 feet deep or greater per OSHA requirements and Texas Health and Safety Code Sec 756.022. For pit/shaft excavations greater than 20 feet in depth, protective systems are to be designed by a professional engineer retained by the Contractor per OSHA 29 CFR 1926 Subpart P.

10. A site plan indicating all excavation locations, including dimensions of pit/shaft excavations, dimensions of equipment to be utilized, locations where excavated materials will be stockpiled, and storage area of encasement pipe materials or other materials used to perform the Work.

11. Construction dewatering plan (if applicable).

12. Utility relocation plan (if required)

13. Flow bypass pumping plan (if required).

14. Contingency plans that include corrective actions to be taken in the event of excessive ground movement (settlement or heave), excessive deviation from line and grade, slower than anticipated progress, stuck excavation equipment, damage to an existing utility, or encountering greater than anticipated groundwater inflows. Contingency plan should be comprehensive, realistic, and based on actual working conditions for the Project.

B. Shop drawings and mill test certificates of the encasement pipe with material specifications, including size, type, diameter, and manufacturer's data and certifications on piping and jointing methods. The contractor shall include a Certificate of Adequacy of Design stating the pipe and fittings are satisfactory for the loads which will be imposed during for all loading conditions.

501.5 Quality Assurance

A. The requirements set forth in this document specify a wide range of procedural precautions necessary to provide the very basic, essential aspects of a proper jacking or boring installation and are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this Section. Adherence to the specifications contained herein, or the Owner's Representative approval of any aspect of any jacking or boring operations covered by this Section, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the Work authorized under the Contract.

1. Installer's Qualifications: Installation shall be by a competent, experienced Contractor or Subcontractor. The installation Contractor shall have a satisfactory experience record of at least 3 years engaged in similar work of equal scope to that of this project.

2. Performance Requirements: Horizontal or vertical variation in the final position of the encasement pipe from the proposed line and grade shall be permitted only to the extent of the tolerances provided herein, provided that such variation shall be regular and only in the direction that will not detrimentally affect the installation or intended function of the carrier pipe in the opinion of the Engineer.

501.6 Materials

A. Pipe: Encasement pipe and carrier pipe shall conform to Standard Specification Item No. 505, "Concrete Encasement and Encasement Pipe" and Item No. 510, "Pipe", respectively, and shall be size, type materials, thickness and class indicated on the Drawings, unless otherwise specified.

B. Grout

1. Contact grout shall consist of cement, water, and fluidizers as required to produce a satisfactory pumpable grout with a minimum compressive strength of 500 psi at 28 days.

2. Backfill grout shall be either structural grout or cellular concrete.

    a. Structural grout shall consist of a mixture of sand, cement, and water with a minimum compressive strength of 4000 psi at 28 days. Admixtures may be used to control set times and prevent washout of the cement paste.

    b. Cellular concrete shall consist of a mixture of cement, water, and a foaming agent with a minimum compressive strength of 150 psi at 7 days and 250 psi at 28 days. Cellular concrete shall have a minimum wet density of 50 pcf, unless water is present inside the encasement pipe, where a minimum wet density of 65 pcf shall be required. The foaming agent shall conform to ASTM C869 and shall be tested in accordance with ASTM C796. No aggregate or fillers shall be used. No admixtures shall be without specific written approval from the foaming agent manufacturer.

    c. Cement used in the grout mixes shall conform to ASTM C150, Type II.

    d. Water used in the grout mixes shall be potable and conform to ASTM C94.

501.7 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. Execution of work involving the jacking or boring operation and the installation of encasement pipe simultaneously.

The Contractor shall have sole responsibility for the safety of the jacking or 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 CFR 1926/1910), with particular attention to 29 CFR 1926, Subpart S. The Contractor shall conform to the requirements in accordance with Standard Specification Item 121, "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 and for joining of 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 Pit/Shaft Excavation Work Plan.

The location of the work pits/shafts and associated traffic control measures required for the jacking or boring operations shall conform to the requirements of the City of New Braunfels and TxDOT's Texas Manual on Uniform Traffic Control Devices.

Where installation of encasement pipe and carrier 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.

[Owner] [Contractor] shall obtain and comply with **[licenses, agreements, or permits]** from the **[highway, roadway, or railroad agency]** as described or referenced herein. Contractor shall comply with regulations and instructions of the **[highway, roadway, or railroad agency]** as to the methods of performing the Work and shall take all necessary precautions for the safety of the public and protection of existing infrastructure. Coordination with the **[highway, roadway, or railroad agency]** shall be performed by the Contractor, as required, unless otherwise instructed by the [**Owner or Engineer**].

During construction operations, and until the work pits/shafts are backfilled and compacted, traffic barricades and warning lights to safeguard traffic and pedestrians shall be furnished and maintained by the Contractor. The review of the pit/shaft excavation work plan and traffic control plan by the Owner's Representative, however, will not relieve the Contractor from his responsibility to obtain specified results in a safe, workmanlike manner.

Contractor shall perform work in a manner that minimizes ground movement, settlement, or heave.

The pipe shall be jacked or bored from the low or downstream end, if possible. The casing pipe shall be installed to meet the following tolerances along the entire length of the tunnel or trenchless crossing. If the installation exceeds the specified tolerances herein or the required tolerances for the carrier pipe, Contractor shall perform corrective work that is acceptable to the Engineer and at no additional cost to the Owner.

Note to Specifier: Gravity wastewater lines should not be designed for the minimum slope at crossings.

Horizontal Tolerance: Plus or minus 6 inches from theoretical horizontal alignment for every 100 feet of tunnel or trenchless crossing, unless otherwise specified.

Vertical Tolerance: Plus or minus 2 inches from theoretical vertical alignment for every 100 feet of tunnel or trenchless crossing, unless otherwise specified.

After placement of the carrier pipe is complete, the annular space between the casing pipe and the carrier pipe shall be sealed with manufactured end seals.

As soon as possible after the carrier pipe(s) and end-seals are completed, the work pits/shafts, 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. Field density measurements shall be made in accordance with TxDOT Test Method Tex-115-E.

B. Jacking

Jacking shall be performed in general accordance with “pipe jacking” methods as described in the ASCE Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects. Heavy duty jacks suitable for forcing the pipe through the ground shall be provided. In operating the jacks, an even pressure shall be applied to all jacks simultaneously so that the pressure will be applied to the pipe uniformly around the thrust 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 ground shall be excavated just ahead of the pipe, the excavated material removed through the pipe, and the pipe forced through ground by jacking, into the space thus provided by the excavation.

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 1 inch 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 6 inches in any case. This distance shall be decreased, as determined by the Contractor for safety or when directed by the Engineer or Owner’s 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 head end of the pipe extending a short distance beyond the end of pipe with inside angles or lugs to keep cutting edge from slipping back onto the pipe.

After commencement of jacking operations, all subsequent operations shall be carried on without interruption, insofar as practical, to prevent the pipe from becoming firmly set in the ground prematurely.

Contractor shall not exceed the maximum allowable jacking force of the encasement pipe when jacking the encasement pipe. Any encasement pipe damaged during jacking operations shall be removed and replaced by the Contractor at its entire expense.

C. Boring

Boring shall be performed in general accordance with “horizontal auger boring” methods as described in the ASCE Manual and Report on Engineering Practice No. 106, Horizontal Auger Boring Projects. The boring shall proceed from a work pit/shaft provided for the boring equipment and workmen. Excavation for the work pits/shafts and the installation of shoring shall be as outlined in the pit/shaft excavation work plan. The location of the pits/shafts shall be approved by the Engineer or designated representative. The boring shall be performed mechanically using either a pilot tube method or the auger boring method.

In the pilot tube method an approximate 2 inch, steerable pilot tube shall be installed over the entire length of the crossing and shall be checked for line and grade on the opposite end of the work pit/shaft. This pilot tube shall serve as the centerline of the larger diameter hole to be created by reaming and/or by performing the auger boring method to install the encasement

pipe. The use of specialized cutting heads or three-pass systems are acceptable and may be required given ground conditions. The equipment used to excavate the ground shall be removable from within the encasement pipe in the event an obstruction is encountered. If voids develop around the encasement pipe as it is bored, pump concrete or grout to fill all such voids, or fill by other means acceptable to the engineer. Fill all voids as specified hereinafter as soon as possible after completion of boring operation

When the auger boring method is used, a encasement pipe of the appropriate diameter may be equipped with a cutter head or other cutting tools to mechanically perform the excavation. Augers shall be used to perform the excavation and shall be of sufficient diameter to convey the excavated material back to the work pit/shaft. If non-cohesive or unstable conditions are encountered, the end of the auger and cutting tools, if used, shall be retracted into the encasement pipe a distance of at least three times the diameter of the encasement pipe to create a soil plug at the end of the encasement pipe to prevent ground movement. The diameter of the auger and cutter tools shall not be greater than the outside diameter of the pipe.

Excavated material will be removed from the working pit/shaft 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, where allowed by authorities having jurisdiction.

D. Dewatering

Dewatering requirements can be found in TxDOT Standard Specification Item No. 400 “Excavation and Backfill for Structures”.

E. Installation of Contact Grout

Install contact grout in the void space between the outside of the encasement pipe and the excavation, especially in any voids created by over-excavation, caving, or collapse. For the encasement pipe, install contact grout mix immediately upon completion of setting the encasement pipe.

Unless specified otherwise, install contact grout through grout ports or grout fittings installed in the encasement pipe that are 42 inches in diameter or larger or if voids are suspected. Grout ports or fittings shall be fabricated into casing pipe at a maximum spacing of 10 feet.

Grouting operations shall be performed in such a manner to prevent damage to the encasement pipe, the surrounding ground, or adjacent facilities or existing utilities. Contact grout shall be injected at a pressure that will not distort or imperil any portion of the Work.

Remove fittings and plug grout ports and fittings after completion of contact grouting.

Note to Specifier: Include backfill grouting section below only if required by railroad or roadway utility.

F. Backfill Grouting

After installation of the carrier pipe, the annular space between the encasement pipe and the carrier pipe shall be completely backfilled throughout the entire length from the low (downstream) end of the pipeline crossing. Seal the low end of the encasement pipe and place backfill grout until grout is extruded from the opposite end.

The carrier pipe and any other piping or conduits whether temporary or permanent shall be firmly anchored or blocked in place, while maintaining required clearances, to prevent floatation or movement during backfilling operations.

After backfill grouting is completed, seal or plug the ends of the encasement pipe with End Seals as required herein.

G. Finishing

Touch up protective coating after field welds to provide coating equal to those specified in Item 505 “Concrete Encasement and Encasement Pipe.”

Note to Specifier: Include cathodic protection if required by project conditions.

H. Cathodic Protection

Include cathodic protection per Specification Item No. 540 “Cathodic Protection”.

I. Joints

All carrier pipe joints in encasement shall be restrained for water lines and force mains.

J. Site Restoration

Following drilling operations, Contractor will de-mobilize equipment and restore the work site to original condition. All excavations will be backfilled and compacted to 90% modified proctor in non-paved areas and 95% modified protector in paved areas of original density based on Specification Item No. 120 “Utility Trenching and Backfill”. Landscaping will be subcontracted to a local professional landscaping company.

501.8 Measurement

Jacking or boring pipe will be measured by the linear foot of pipe complete in place. Such measurement will be made between the ends of the pipe along the central axis as installed.

501.9 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" 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:

Pay Item: Jacking or Boring __ In. Pipe, Class ___ Per Linear Foot.

End

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.

505.2 Submittals

The submittal requirements of this specification item must 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 per the requirements of TXDOT Standard Specification Item No. 421, “Hydraulic Cement Concrete

B. Steel Encasement Pipe

1. Steel Pipe shall conform to ASTM A53, Schedule 40. Extra Heavy Weight shall meet the requirements of ASTM A53, Schedule 80. Casing pipes shall have a minimum thickness as indicated below or as otherwise required by the authority having jurisdiction, and shall be considered the minimum thickness acceptable.

2. Pipe used as casing of a separate carrier pipe shall be new, smooth bore, steel pipe, with a coal-tar protective coating in accordance with the requirements of C203 both inside and outside. Joints shall be welded to form a true alignment of each pipe length.

Nominal Diameter of Steel Casing Pipe (Inches)	Minimum Wall Thickness of Steel Casing Pipe (Inches)	
	Roadway/Highway Crossing	Railway Crossing
16	0.250	0.282
18	0.250	0.313
24	0.375	0.375
30	0.4375	0.469
36	0.500	0.532
42	0.500	0.625
48	0.500	0.688

C. End Seals

1. End seals shall be designed to seal the annular space between the casing pipe and the carrier pipe at the ends of the casing pipe.

2. Approved Manufacturers:
   a. Advance Products & Systems, LLC
   b. Cascade Waterworks Manufacturing Company
   c. CCI Piping Systems
   d. Approved equal.

D. Grout

Grout shall consist of not less than 6 sacks Portland cement per cubic yard 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

A. 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:

1. the top of the pipe would have less than 48 inches of cover,
2. the ground water invades the trench, or
3. the trench bottom is of unstable material.

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

1. encase the pipe with concrete,
2. change pipe material, or
3. use a higher strength class of pipe.

C. 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 Standard Detail 310," Concrete Encasement".

505.5 Measurement and Payment

A. Concrete encasement will be measured by the lineal foot, 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.

B. 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

A. 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" 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:

Pay Item: Concrete Encasement for ___ Dia. Pipe Per Linear Foot.
Pay Item: ___ Dia. Steel Encasement Pipe Per Linear Foot

End

Item No. 510
Pipe

510.1 Description

This item shall consist of furnishing and installing all pipe and/or materials for constructing water mains, force mains, sanitary sewers, laterals, stubs, and service connections including all applicable Work such as jointing, prescribed under this item in accordance with the provisions of the Edwards Aquifer Protection Ordinance, when applicable, and New Braunfels Utilities Design Criteria Manual. The pipe shall be of the sizes, types, class and dimensions indicated or as designated by the Engineer/Architect (E/A) and shall include all joints or connections to new or existing mains, pipes, sewers, manholes, 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 on the plans. This item shall include any pumping, bailing, drainage and Item No. 121, "Trench Safety Systems" for trench walls, when indicated or applicable. Trenching and back fill shall be covered under Item No. 120, “Utility Trenching and Backfill.” Acceptance testing shall be covered under Item No. 515, “Testing and Acceptance.”

510.2 Submittals

A. Furnish Shop Drawings, product data, design calculations and test reports as described below:

1. 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.

2. 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.

3. Product data to show compliance of all couplings, supports, fittings, coatings and related items.

510.3 Standards

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Water Works Association (AWWA):

AWWA C104	Cement-Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber Gasket Joints for Ductile-Iron
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron

AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast, Sizes 3 inches through 64 inches
AWWA C153	Ductile-Iron Compact Fittings
AWWA C600	Installation of Ductile Iron Mains and their Appurtenances
AWWA C602	Cement-Mortar Lining of Water Pipelines, 4 inches and larger in Place.
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and and Molecularly Oriented Polyvinly Chloride (PVCO) Pressure Pipe and Fittings.
AWWA C800	Underground Service Line Valves and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inches through 60 inches
AWWA M23	PVC Pipe – Design and Installation.
AWWA M41	Ductile – Iron Pipe and Fittings

2. ASTM international (ASTM):

ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated PVC Pipe (SDR) Series
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	“Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679 & Annex	Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1674	Standard Test Method for Joint Restraint Products for Use with PVC Pipe

3. NSF International

NSF 61	Drinking Water System Components – Health Effects

510.4 Materials

A. Fire Lines

Fire line leads and fire hydrant leads shall be ductile iron, only.

B. Force Mains

All wastewater force mains shall be constructed of the following pipe materials:

a. Ductile iron pipe of pressure class 250 minimum for pipe greater than 12-inch size, and ductile iron pipe pressure class 350 for pipe 12-inch size and smaller,

b. D2241 PVC Pressure Class 200 (SDR 21) for pipe 12-inch size and smaller, integrally colored green,

c. PE4710 HDPE DR-9 with a minimum diameter of four (4) inches,

d. Polyvinyl Chloride Pipe meeting all requirements of section 510.4.D, integrally colored green,

e. Ductile iron wastewater pipe shall be in accordance with New Braunfels Utilities Standard Products List and shall have a corrosion resistant interior lining acceptable to the Owner.

C. Ductile Iron Water Mains

a. 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.

b. Ductile Iron Pipe - Pipe shall be ductile iron pipe meeting all requirements of standards as follows:

i. For push-on and mechanical joint pipe: AWWA C151

ii. For flanged pipe: AWWA C115

Barrels shall have a nominal thickness required by Table 1 of AWWA C115, 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 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 New Braunfels Utilities 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.

iii. 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:

1. Grade 60-42-10:

a. Minimum tensile strength: 60,000 psi (414 mPa).

b. Minimum yield strength: 42,000 psi (290 mPa).

c. Minimum elongation: 10 percent.

2. Grade 70-50-05 (for AWWA C115 pipe):

a. Minimum tensile strength: 70,000 psi (483 map).

b. Minimum yield strength: 50,000 psi (345 mPa).

c. Minimum elongation: 5 percent.

c. Ductile Iron Fittings:

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

1. Sizes 4 inch through 24 inch: AWWA C110 or AWWA C153

2. Sizes larger than 24 inch: AWWA C110.

d. 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.

e. Linings and Coating:

i. Interior surfaces of all ductile iron water pipe shall have cement-mortar lining in accordance with AWWA C104 and bituminous seal coat.

ii. Interior surfaces of all ductile iron wastewater and force main fittings shall be coated with Protecto 401. Lining primers, applications, and thicknesses shall be in accordance with manufacturer’s recommendations for sanitary sewer applications, but shall not be less than 40 mils.

iii. Exterior surfaces for buried pipe and fittings shall be coated with a 1 mil bituminous coating in accordance with AWWA C110 and C151, unless specified otherwise.

iv. Exterior surfaces for pipe and fittings installed above grade or within vaults shall be coated as required by the applicable coating specification.

f. Joint Materials

i. Gaskets for mechanical joints shall conform to ANSI/AWWA A21.11/C111.

ii. 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.

iii. 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/C111 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.

iv. 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/C111.

v. 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.

vi. 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 E/A.

vii. 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.

g. 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 C105, 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. 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.

D. Polyvinyl Chloride (PVC) Water Pipe

a. 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 305 psi (DR-14) or 235 psi (DR-18) as indicated. All pipe 4 inches and larger must be approved Underwriter's Laboratories for use in buried water supply and fire protection systems.

b. 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 when required by the E/A. 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 E/A.

c. Applicable Specifications

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

i. AWWA C900, DR 18 or DR 14 for PVC Pressure Pipe, in 4, 6, 8, 12, 16, and 24 inch nominal sizes, having Cast Iron Pipe size outside diameters.

ii. Fittings used with PVC Pressure pipe shall be AWWA C110 or AWWA C153 compact ductile iron fittings.

d. Material Requirements

All pipe and fittings shall be made from clean, virgin, NSF approved, Class 12454B PVC. Clean reworked materials generated from the manufacturers own production may be used within the current limits of the referenced AWWA C900.

e. Marking

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

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

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

iii. Dimension Ratio (e.g., DR 18).

iv. Pressure Class (e.g., PC 235).

v. AWWA designation with which the pipe complies (e.g., AWWA C900-16).

vi. Manufacturer's name or trademark and production run record

vii. The National Sanitation Foundation (NSF) mark.

E. Service Lines

a. Clamps or Saddles

Approved service clamps or saddles shall be used when tapping ductile iron pipe and PVC pipe 16 inch size and smaller. Outlets of service saddles shall be tapped with AWWA IP thread (female). External threads of corporation valve inlet must be compatible with internal threads of the service saddle.

b. Service Line Materials

1 inch service lines shall be annealed copper tubing meeting the requirements of paragraph 510.4.E.e. High Density Polyethylene (HDPE) meeting the requirements of paragraph 501.4.E.c may be allowed for 1 inch diameter service lines with approval from NBU. 2 inch diameter service lines shall be High Density Polyethylene (HDPE) meeting the requirements of paragraph 510.4.E.c and in no case shall copper tubing be allowed.

c. HDPE Tubing

i. HDPE pipe with 1” to 2” diameter shall be PE 4710 conforming to the latest edition of AWWA C901 and ANSI/NSF Standard 61. PE 4710 shall conform to ASTM D3350 minimum cell classification PE 445574C-CC3.

ii. Pipe shall have a minimum pressure class of 250 psi. The outside diameter of the pipe shall be based upon the CTS sizing system.

iii. The pipe shall be marked in accordance with the standards to which it is manufactured. Markings shall include nominal size, outside diameter base (e.g. CTS), dimension ratio (e.g. DR 9), manufacturer’s name or trademark, standard materials designation code (PE 4710), cell classification (e.g. PE 445574C), PE compound oxidative resistance for potable water (CC3), pressure class (e.g. PC 250), standard’s designation (AWWA C901), manufacturer’s production code, date of manufacture, mark of the certifying agency for potable water (such as NSF).

iv. Color of exterior pipe product (pipe with color code E) shall be blue for potable water.

v. Tracer wire shall be required on all HDPE Service Lines and in accordance with Paragraph 510.4.J of this Section and Item No. 512 “Conductive Trace Wire for Non-Metallic Pipe Installation”.

d. HDPE Fittings

i. Butt Fusion Fittings – HDPE Fittings shall be made of PE4710 and with a minimum Cell Classification of PE 445574C-CC3. All HDPE fittings shall meet the requirements of AWWA C901 and shall have a pressure rating equal to the pressure rating of the pipe to which the fitting is joined.

1. Molded fittings shall be manufactured, tested and marked per ASTM D3261.

2. Fabricated fittings shall be manufactured, tested and marked per ASTM F2206, or individual fittings standards.

3. Socket fittings shall meet ASTM D2683. Fittings shall be butt fusion welded, made of PE 4710 material with the same minimum cell classification used for the service line.

ii. Electrofusion Fittings - Fittings shall be PE4710, with a minimum Cell Classification of PE 445574C-CC3. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

iii. Flanges and Mechanical Joint adapters (MJ adapters) shall be PE4710, with a minimum Cell Classification of PE 445574C-CC3. Flanged and MJ adapters can

be made to ASTM D3261 or if machined, must meet the requirements of ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be per ASTM F2206.

iv. Mechanical Fittings for service pipes - Three primary mechanical fittings or connections can be used, which are: Stab or insert type; compression type; and clamp ring. Per MAB-4, “Internal stiffeners should be used for all mechanical fittings”.

v. Mechanical fittings shall be designed to restrain and to prevent pull-out or rotation.

e. Copper Tubing

All copper service tubing shall be 1” diameter 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
1	1.125	± 0.0035	0.065	± 0.0045

f. Service Connection Fittings

All fittings used in customer service connection - tapping mains, connecting meters, etc. must be currently listed on the Standard Products List, or called for in the New Braunfels Utilities Standard Details.

g. Brass Fittings

i. 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 detail Standards, Standard Products Lists, and AWWA C800, except as herein modified or supplemented.

ii. Unless otherwise noted, the goods described herein shall be fabricated of Waterworks No-Lead Brass meeting the requirements of ASTM B584, UNS Copper Alloy C89833 or C89836, having not more than one fifth of one percent (0.2%) total lead content by weight.

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

iv. Brass goods of each type and class shall be compatible with other fittings in common usage for similar purposes.

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

h. Corporation Valves

i. Inlet threads of corporation valves shall be AWWA iron pipe (IP) thread (male). AWWA IP threads shall conform to ANSI/ASME B1.20.1 as required by AWWA C800 for “General Purpose (Inch) Pipe Threads”. For 1” size 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.

ii. Connections of all new copper 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.

iii. Connections of all new polyethylene tubing or pipe shall be by compression fittings. PE tubing or piping must have a stainless steel insert stiffener at the compression connections per manufacturer’s recommendations.

iv. 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.

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

F. Certification

For pipes 16-inches 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 E/A 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 City Representative 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 as listed in the Standard Products List (SPL).

G. Polyvinyl Chloride (PVC) Pipe (Non-pressure) and Fittings for Gravity Wastewater Mains

a. General

Where PVC gravity wastewater pipe is indicated, it shall conform to ASTM D3034 for pipe sizes 4 inch to 15 inch or ASTM F679 for pipe sizes 18 inch to 48 inch. Cell Class shall be as required by applicable ASTM pipe specification; pipe stiffness shall be 115 psi minimum.

Where pressure rated PVC gravity wastewater pipe is indicated, it shall conform to ASTM D2241 SDR 26 or meet the requirements of paragraph 510.4.D.

b. Joint Material

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

c. Pipe Markings

Permanent marking on the pipe shall include the manufacturer's name and/or trademark, nominal pipe size, PVC cell classification per ASTM D1784, and be marked at intervals of not more than 5 feet:

d. Fitting Markings

Fittings shall include the manufacturer's name or trademark, nominal size, material designation "PVC", PSM, and the designation, "Specification D3034".

e. Pipe Color

Pipe shall be integrally colored green by the manufacturer.

H. Fiberglass Reinforced Plastic (FRP) Pipe (Non-pressure) and Fittings for Gravity Wastewater Mains

a. General

FRP shall conform to Item No. 320 “Fiberglass Gravity Sewer Pipe”.

I. Tracer Wire

Tracer wire shall be installed on all non-ferrous water mains, water services and force mains. The wire shall be installed in such a manner as to be able to properly trace all mains without loss or deterioration of signal or without the transmittal signal migrating off the tracer wire. Tracer wire shall be placed as per specifications in 512, “Conductive Trace Wire for Non-Metallic Pipe Installation”.

J. Tracer Tape

Tracer tape shall be installed on all force mains in accordance with TCEQ §217.66 rules. The tape should be a minimum of 12 inches below subgrade, or a minimum of 18 inches below finished grade on areas outside the limits of pavement. The tape shall be encased in a protective, inert, plastic jacket and color-coded in accordance with APWA Uniform Color Code.

K. Concrete

Concrete shall conform to TxDOT Item No. 421, "Hydraulic Cement Concrete".

L. Material Approval

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. **New Braunfels Utilities Standard Products Lists (SPL)** forms a part of the Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the E/A is still required. Should the Contractor elect 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, decides whether the products meet the Contract requirements and the specific use foreseen by the E/A in the design of this engineered Project. The purpose of the SPL's is to expedite review, by the E/A of Contractor product submittals. 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 E/A. The Standard Product List current at the time of plan approval will govern.

510.5 Construction Methods

A. Water Line/New Wastewater Line Separation

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

1. 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.

2. 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 AWWA C900 (DR-18) 150 psi rated PVC or ASTM D 2241 (SDR-26) 160 PSI rated PVC.

3. 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 length of AWWA C900 (DR-18) 150 psi rated PVC or ASTM D 2241 (SDR-26) 160 PSI rated PVC shall be centered at the point of crossing the water line.

4. 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.

B. Utility and Storm Sewer Crossings

1. When the Contractor installs a pipe that crosses under a utility structure or storm sewer and the top of the pipe is within 24 inches of the bottom of the utility structure, the pipe shall be encased in concrete 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 E/A, concrete encasement will not be required for ductile iron or AWWA C900 (DR-18) 150 psi rated PVC in sizes to 12 inch. 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 C900 (DR-18) 150 psi rated PVC in sizes to 12 inch, unless otherwise specified by the E/A.

2. Steel casing must be used when water mains cross under box culverts, large storm drain pipes (48 inches or greater in diameter), or multiple barrel storm drains of any size. Casing sizes shall be in accordance with NBU Construction Specifications. Casing must extend 5' beyond the OD of the storm drain crossing.

3. Where trenches wider than 12 inches cross under existing wastewater lines, the sewer lines shall be replaced with one 20-foot joint of AWWA C900 (DR-18) 150 psi rated PVC or ASTM D 2241 (SDR-26) 160 PSI rated PVC centered over the trench.

C. Laying Pipe

1. 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.

2. 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.

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

4. 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.

5. 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 E/A. Joints, which have been placed, but not joined, backfilled, etc., shall be protected in a manner satisfactory to the E/A.

D. Assembling of Pipe

1. 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.

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

3. 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.

4. 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.

E. Joints

1. O-Ring and Push-on Joints

i. 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.

2. 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.

F. HDPE Service Line Joints

1. The pipe and fittings shall be joined by butt fusion or electrofusion couplings, mechanical joint (MJ) adapters, or by flange connections in accordance with manufacturer's recommendations and as required in this document. Unless otherwise shown on Drawings and except for connections to existing utilities, all joints shall be fused.

   a. Butt Fusion: The pipe shall be joined by heat fusion of the ends. Prior to fusion the pipe shall be clean and the ends shall be cut square. Butt-fusion joining is applicable to pipes that have the same nominal outside diameter and wall thickness, within one SDR. Field site butt-fusion system operators shall be trained in the use of the high-quality butt-fusion equipment that secure and precisely align the pipe ends for the fusion process. Operators shall be trained by the pipe supplier or manufacturer of the fusing machine and be experienced in the operation of the equipment. Fusion quality shall be recorded, the recording of the information must be provided to the Owner. The Owner will review documents within 7 days and identify any fusion records that might indicate the need to replace an existing fused connection. The recorded fusion information must meet the standard requirements of ASTM F3124. All fusions failing to meet these requirements shall be removed and refused. Refer to ASTM F2620, ASTM F3124, ASTM F3183 and ASTM F3190.

   b. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure and ASTM F1055, ASTM F1290, MAB-01 and MAB-02. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment and pipe sizes to be utilized for this project. Installers shall follow the guidance shown in the previous documents to fabricate EF assemblies. The installer must remove oxidation from the pipe and maintain a clean surface on both pipe and fitting to ensure acceptable joint quality.

   c. Mechanical:

      i. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use flanges or mechanical joint adapters and other devices in conformance with the AWWA Manual of Practice M55, Chapter 6. Mechanical connections shall be manufactured for HDPE pipe and approved by the connection manufacturer for use with polyethylene pipe. Uncontrolled tapering or hand-beveling in the field is not allowed.

ii. Mechanical connections on pipe 3” and smaller are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of stab fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for use with HDPE and with potable water.

iii. Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings and clamps shall be recommended by the manufacturer as being designed for use with HDPE pipe at the required pressure class; all mechanical couplings shall be fully restrained either by themselves or by an alternate means.

d. Mechanical Joint/Flange: A flange assembly consists of a metal back-up flange or bolt-ring and a polyethylene flange adapter. MJ assembly consists of a MJ adaptor with gland ring, gasket and bolt kit. Both MJ adapters and flange adapters are fused onto the plain end of the pipe main. Bolting guidance for MJ connections is provided in AWWA C600 and guidance for flanges and gaskets is provided in PPI-TN38. Note that an HDPE flange adapter acts as both a flange and a gasket, and as such, no ‘gasket’ is required. For further information, refer to PPI TN38

G. Placing Pipe in Tunnels

Piping installed as a carrier pipe in a tunnel, encasement pipe, etc., shall have uniform alignment, grade, bearing, meet all requirements of the carrier pipe as specified, and conform to the reviewed Shop Drawings. All necessary casing spacers, joint restraints, 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 Owner attached to the carrier pipe in accordance with the manufacturer's recommendations. The insertion pushing forces shall not exceed the pipe manufacturer's recommendation. Carrier pipe may be pulled into place inside the encasement or tunnel using lubricants to ease pipe installation. Lubricants such as flax soap or drilling mud may be used for this purpose. Use of petroleum products such as oil or grease for this purpose shall not be permitted.

H. Temporary Pipe Plugs, Caps, Bulkheads and Trench Caps

1. 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.

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

3. Trench caps shall be reinforced Class D concrete as indicated.

I. Corrosion Control

1. 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 C105 to provide a continuous wrap.

J. Pipe Anchorage, Support and Protection

Pressure pipeline tees, plugs, caps and shall be secured with thrust restraints. Joint restraints lengths shall be determined by the Engineer. Concrete thrust blocking may be approved on a case-by-case basis for connections to existing mains or other situations where restraint lengths cannot be achieved.

1. Concrete Thrust Blocking

   a. Concrete for use as reaction or thrust blocking shall be Class B conforming to TxDOT Item No. 421, "Hydraulic Cement Concrete".

   b. 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 E/A. The blocking shall, unless otherwise indicated, be so placed that the pipe, fittings and joints will be accessible for repair.

   c. 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.

   d. 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.

2. 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.

3. 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.

4. 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 (a) 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.)

K. Wastewater Connections

1. Connections to Mains 12 Inches and Smaller

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

   b. Service stubs shall be installed as indicated. Minimum grade shall be 2 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.

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

   d. 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 E/A's approval.

   e. 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.

2. Connections to the Existing System

   a. Unless otherwise specified by the E/A, 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 E/A. Extreme care shall be exercised to prevent material from depositing in the existing pipe as the taps are being made.

   b. When connections to existing mains are made, a temporary plug approved by the E/A 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.

L. Water System Connections

1. 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 E/A before beginning any Work.

2. Line Stoppers

   NBU will require contractors to use line stoppers to take an outage during construction if system valves are not available or existing valves do not function. Line stoppers will be required based on the following criteria.

   a. If the number of residential customers affected is greater than 20 and expected to last more than 4 hours.

   b. If any commercial customers are affected by the outage then the use of line stoppers will be determined on a case by case basis.

c. If any critical care customers are affected by the outage then the use of line stoppers will be determined on a case by case basis.

d. System conditions may require a line stopper and may not be known until construction commences.

3. Shutoffs

a. New Braunfels Utilities will make all shutoffs on existing water mains. The Contractor shall be required to notify the E/A's field representative on the job at least 72 hours prior to the desired time for any shutoff. The E/A's field representative will notify any affected utility customers at least 24 hours prior to the shutoff. The Utility will make the shutoff after ensuring that all appropriate measures have been taken to protect the water system, customers and employees.

b. New Braunfels Utilities 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 Utility. The operation of the valve is to be conducted under the immediate supervision of the E/A's field representative.

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

4. Wet Connections to Existing Water System

a. 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.

b. 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.

c. 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 Utility and the disposal operations will be witnessed by an authorized representative from the Utility.

5. Pressure Taps to Existing Water System ***(Note: Pressure taps can only be performed by NBU pre-approved Contractors.)***

a. 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.

b. 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 NBU makes the tap, NBU crews will tap the main and install the service to the property line. In this case, the Contractor must pay for the tap in advance at NBU's Service Center located at 355 FM 306.

c. If a private Contractor makes the tap, a Utility 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.

6. Service Connections

a. Service connection taps into PVC, AC, CI, or DI pipe 16 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 E/A. Direct tapping of these pipes will not be permitted.

b. 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.

c. 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.

d. 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.

7. Cleanup and Restoration

a. 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 Utility. The E/A 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.

b. 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.

M. Water Main Abandonment

1. Water mains to be abandoned shall be disconnected from pipes that are to remain in service and entirely filled with pumpable grout. All connections to existing mains to remain in service shall be cut or plugged as appropriate and thrust blocks installed as necessary. All valves on the water main shall be abandoned as per the section below. Contractor is responsible for all labor, equipment, and materials required to complete the work.

2. Service lines to be abandoned shall be disconnected at the corporation stop at the main, and all other valves and appurtenances, including the water meter, shall be removed. All meters to be removed shall be returned to NBU.

N. Valve Abandonment

1. Valves to be abandoned shall only occur when an abandoned valve is left on an abandoned water main that is no longer in service. A valve to be abandoned shall have the valve box, casing, and valve stem extension (if present) removed to a minimum of 18-inches below grade. The remaining casing shall be filled with non-shrink grout to the top of the casing.

O. Wastewater Main Abandonment

1. Wastewater mains to be abandoned shall be cleaned and televised per Item No. 315 “CCTV Inspection” to verify all existing laterals have been transferred to another wastewater main.

2. Wastewater mains to be abandoned shall be disconnected from pipes or manholes that are to remain in service and entirely filled with pumpable grout. All connections to existing mains to remain in service shall be cut or plugged as appropriate. Contractor is responsible for all labor, equipment, and materials required to complete the work.

3. Wastewater manholes to be abandoned shall be abandoned per NBU Standard No. 340 “Abandoned Manhole.”

510.6 Measurement

Pipe will be measured by the linear foot for the various types, sizes and classes. Parallel lines will be measured individually.

Pipe to be abandoned shall be measured by the cubic yard of pumpable grout required to completely fill the pipe.

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 iron fittings 24-inch and smaller will be measured by the ton and paid for in accordance with the schedule in Standard Product List. Unless otherwise provided, fittings larger than 24-inch sizes will be subsidiary to the pipe. These will be subsidiary to the bid item Pipe.

Excavation and backfill, when included under 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.

510.7 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.

A. 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:

1. Clearing
2. Constructing any necessary embankment
3. Excavation
4. Disposal of surplus or unusable excavated material
5. Furnishing, hauling and placing pipe
6. Fittings larger than 24 inch
7. Field constructed joints, collars, temporary plugs, caps or bulkheads
8. All necessary lugs, rods or braces
9. Pipe coatings and protection
10. Connections to existing systems or structures, concrete blocking and thrust blocks and restrained joints
11. Preparing, shaping, pumping for dewatering, and shoring of trenches
12. Bedding materials
13. Backfill materials
14. Hauling, placing and preparing bedding materials
15. Particle migration measures
16. Hauling, moving, placing and compacting backfill materials
17. Temporary and permanent pavement repairs and maintenance

18. Temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction
19. Cleanup
20. Vertical stack on deep wastewater services
21. All other incidentals necessary to complete the pipe installation as indicated

B. No separate payment will be made for thrust restraint measures.

C. 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.

D. 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:

1. AWWA C153 for all fittings 4-inch through-24 inch sizes, regardless of whether AWWA C110 or AWWA C153 fittings are furnished or the type of end connections supplied.
2. AWWA C110 for all fittings larger than 24-inch size.

E. 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.

F. Trench Safety Systems

When called for in Bid, Trench Safety Systems shall conform to Item No. 121, "Trench Safety Systems".

G. Water Main Abandonment

Water main abandonment shall be paid for at the unit price bid, complete in place, according to the size of the main to be abandoned, and shall be full payment for furnishing all labor, equipment, and materials necessary to fill the existing main with pumpable grout. Unless otherwise provided herein, as separate pay item(s), subsidiary items to the bid price shall include:

1. All excavation required to access the existing main
2. Installation of plugs or caps
3. Installation of thrust blocks
4. Backfill, compaction, and restoration
5. Temporary and permanent pavement repairs and maintenance
6. Disposal of surplus or unusable excavated material

7. Removal and legal disposal of existing water main
8. Temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction
9. Cleanup

H. Water Service Abandonment

Water service abandonment shall be paid for at the unit price bid, complete in place, according to the size of the service to be abandoned, and shall be full payment for furnishing all labor, equipment, and materials necessary to plug or cap the connection to the existing main and remove all existing valves and appurtenances. Unless otherwise provided herein, as separate pay item(s), subsidiary items to the bid price shall include:

1. All excavation required to access the existing main
2. Installation of plugs or caps
3. Backfill, compaction, and restoration
4. Temporary and permanent pavement repairs and maintenance
5. Disposal of surplus or unusable excavated material
6. Removal and legal disposal of existing service materials
7. Delivery of water meters to NBU storage facilities or inspection personnel, as directed
8. Temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction

I. Wastewater Line Abandonment

Wastewater line abandonment shall be paid for at the unit price bid, complete in place, according to the size of the main to be abandoned, and shall be full payment for furnishing all labor, equipment, and materials necessary fill the existing line with pumpable grout. Unless otherwise provided herein, as separate pay item(s), subsidiary items to the bid price shall include:

1. Cleaning and televising the existing main
2. All excavation required to access the existing main
3. Installation of plugs or caps
4. Installation of thrust blocks
5. Backfill, compaction, and restoration any required excavation
6. Temporary and permanent pavement repairs and maintenance
7. Removal and legal disposal of surplus or unusable excavated material
8. Removal and legal disposal of existing sewer materials
9. Temporary and permanent removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction
10. Cleanup

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

Pay Item: Pipe, __Dia. ___ (all depths), including Excavation and Backfill	Per Linear Foot
Pay Item: Pressure Taps, ___ Dia. x ___ Dia.	Per Each
Pay Item: Wet Connections, ___ Dia. x ___ Dia.	Per Each
Pay Item: Ductile Iron Fittings 4 inch through 24 inch	Per Ton
Pay Item: Abandon and Grout Fill, ___ Dia. Water Main	Per CY
Pay Item: Abandon and Grout Fill, ___ Dia. Wastewater Main	Per CY

End

Item No. 511
Water Valves & Fire Hydrants

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 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 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 below the proposed ground or paving surface of the finished project.

This item shall govern the furnishing of labor, materials, equipment and incidentals necessary to install fire hydrant and appurtenances, operators, bolts, nuts and gaskets.

511.2 Submittals

The submittal requirements of this specification item must include:

A. Test Data.
B. Product Catalog Data.
C. Shop Drawings.
D. Operation and Maintenance Manuals.
E. Hydrant cut sheets and Certification of Compliance with AWWA C502 as record data.
F. Hydrant and flow results from hydrant flow testing in section 511.7 for approval.

511.3 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

B. American Society for Testing and Materials (ASTM) Standards:

ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A307	Carbon Steel Bolts and Studs, 60,000-psi Tensile Strength
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM D2000	Classification System for Rubber Products in Automotive Applications

C. American Water Works Association (AWWA) Standards:

AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe System
AWWA C111	Standard for Rubber-Gasket Joints
AWWA C500	Metal-Seated Gate Valves For Water Supply Service
AWWA C502	Standard for Dry-Barrel Fire Hydrants
AWWA C504, Class 150B	Rubber-Seated Butterfly Valves
AWWA C507	Ball Valves, 6 in. Through 60 in.
AWWA C509	Resilient Seated Gate Valves for Water and Sewerage Systems
AWWA C512	Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
AWWA C514	Air Valve and Vent Inflow Preventer Assemblies for Potable Water Distribution System and Storage Facilities
AWWA C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C530	Standard Specification for Pilot-Operated Control Valves
AWWA C540	Standard for Power-Actuating Devices for Valves And Slide Gates
AWWA C550	Standard for Protective Interior Coatings for Valves and Hydrants
AWWA M51	Air Valves: Air-Release, Air/Vacuum, and Combination

D. NSF International

NSF 61	Drinking Water System Components – Health Effects

511.4 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. New Braunfels Utilities' 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, decides 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 E/A. 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.

511.5 Valves

A. All valves shall be of the close right type.

B. Gate Valves

   Gate Valves 4" through 36", including Tapping Valves, shall be resilient wedge type with non-rising stem in strict conformance with AWWA C509/C515 unless otherwise indicated. All valves for potable water service must comply with NSF 61 standards.

   Gate Valves larger than 36", including Tapping Valves, shall be double disc, parallel seat internal wedging type valves meeting the requirements of AWWA C500.

   1. Quality Assurance

a. Acceptable Manufacturers
   i. American Flow Control.
   ii. M&H.
   iii. Mueller.
   iv. Clow.
   v. U.S. Pipe.
   vi. Kennedy Valve

b. Experience Requirements: The manufacturer shall have at least 10 years of experience in the manufacture of valves used in the water and wastewater treatment environment. References and installation list shall be provided on request.

2. Functional Requirements

a. 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.

b. Operation: All valves shall have non-rising stems with a 2" square operating nut, or with a spoke type handwheel when so ordered, turning clockwise to close.

c. Gearing: Gate valves in 16 inch 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.

d. Bypass: Unless otherwise indicated, 36 inch 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.

e. Valve Ends: Valve ends shall be push-on, flanged, mechanical joint, ALPHA restrained joint, as indicated or approved.

f. Tapping valves shall have inlet flanges conforming to MSS SP-60, with bolt holes 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.

g. 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.

h. Valve Body: Double disc gate valves in 36 inch and larger sizes installed in the horizontal position shall have bronze rollers, tracks, scrapers, etc.

i. Gate: Gate for resilient wedge gate valves shall be ductile iron with rubber-seat compound bonded to the valve gate. Gate for double disc valves shall be ductile iron with bronze mounted wedges and seats.

C. Butterfly Valves:

Unless otherwise indicated, all valves shall conform AWWA C-504 and AWWA C-550 and comply with NSF61 standards, except as modified or supplemented herein.

1. Quality Assurance:

a. Acceptable Manufacturers
   i. DeZurik.
   ii. M&H.
   iii. CMB/K-Flo.
   iv. Pratt.

b. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing tight-closing, rubber-seated butterfly valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 year's experience in the manufacture of valves.

c. Manufacturer's Representative for Startup and Testing: The Valve Vendor or Manufacturer shall provide the services of a competent manufacturer's representative for an indefinite period of time as required to insure proper adjustment, installation, and operation of the valve.

2. Functional Requirements

a. Valve Bodies: Valves shall be the short body design and shall have flanged connections on both ends unless otherwise called for. Valve bodies shall be constructed of cast iron ASTM A126, Class B or ASTM A48, Class 40 or ductile iron in accordance with ASTM A536, Grade 65/45/12. Valve class shall be suitable for the pressure class of the adjacent pipe in which it is installed or as shown in the valve list herein.

b. Valve Discs: 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 A536, Grade 65-45-12 (448-310-12); seating edge shall be stainless steel or other corrosion resistant material.

c. Valve Shafts: Valve shafts shall be constructed of wrought stainless steel conforming to ASTM A276 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.

e. On 24 inch 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.

f. Unless otherwise indicated, valves shall be provided with manual operators with vertical stems and 2 inches 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 below finish grade.

g. Unless otherwise indicated, motorized butterfly valves shall be equipped with 460/230 VAC, 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 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.

3. Performance Requirements

   a. Unless otherwise indicated, valve operators shall be sized to seat, unseat, open and close the valve with 150 psi shutoff pressure differential across the disk and allow a flow velocity of 16 fps past the disc in either direction.

   b. Motorized valve motors shall be capable of producing at least 140% 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% of nominal voltage. Motor bearings shall be permanently lubricated and sealed.

D. Ball Valves:

Unless otherwise indicated, Ball Valves, shall conform to AWWA C507.

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.

E. Air-Vacuum Release Valves:

Unless otherwise indicated, Air-Vacuum Release Valves, Combination Air Valves, shall conform to AWWA C512 and C514. Valves in potable water applications must adhere to NSF 61 requirements.

1. Quality Assurance

   a. Acceptable Manufacturers:

      i. Vent-O-Mat

      ii. Vent-Tech

      iii. A.R.I. Flow Control

2. Air-Vacuum Release Valves

   a. Shall be air-vacuum units having small and large orifice units contained and operating within a single body or assembled unit.

   b. 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.

   c. Valve body, float, and assembly shall be designed for the pipeline's overall maximum working pressure and shall seat at the minimum pressure.

3. Combination Air Valves

   a. Shall be designed to exhaust large volumes of air as the pipeline is being filled; permit large volumes of air to enter the pipeline during pipeline drainage; release accumulated pockets of air while the pipeline is in operation and under pressure; and dampen surge pressures caused by water column separation or rapid air discharge.

   b. Combination air valves shall be heavy-duty, single-chamber air and vacuum valves with disc floats. Floats shall include discs drilled with the small and large orifices, and an anti-surge float. Internal clearances around the floats shall be equal to the inlet/outlet area. The anti-surge float should be normally opened and have drilled orifices to throttle water flow.

   c. Combination air valve inlet/outlet cross-sectional area shall be equal to the nominal size of the valve. CAV outlet for raw water use shall be fitted with a cover or with a vent pipe where indicated on the Drawings. Combination air valves outlets for treated water use shall be connected to piping to vent air out of the manhole. The vent piping shall extend to 4 feet above the ground or as indicated on the Drawings.

4. Material Requirements

   a. Interior components should be stainless steel. Interior components that are not stainless steel shall be coated in accordance with Specification Item No. 530 “High Performance Coatings.”

   b. Valve exterior bodies and covers shall be 316 stainless steel.

   c. Internal bushings, hinge pins, float guide and retaining screws, pins, etc., shall be stainless steel.

   d. Orifice seats shall be Buna-N rubber.

   e. Floats shall be stainless steel, rated at 1000 psi.

   f. Unless otherwise indicated, these valves shall be as included in the Standard Products List.

F. Control Valves:

   All control valves to regulate pressure, flow, pump, etc., in New Braunfels Utilities’ lines shall be models listed in the Standard Products List (SPL).

511.6 Fire Hydrants

All fire hydrants shall be Dry Barrel, Traffic Model (break-away), Post Type having Compression Type Main Valves with 5 1/4" or 6” opening, closing with line pressure. Approved models are listed on Standard Products List.

New Braunfels Utilities reserves the right to limit purchases of fire hydrants to traffic models equipped with safety flange on the hydrant barrel and stem, manufactured by the following manufacturers providing such products conform to the provisions contained here in:

A. Mueller Company (Mueller A423 Super Centurion 200)

B. American-Darling Valve and Manufacturing Company (American-Darling 6-inch B-84-B)

C. Clow Valve Company (Clow Medallion)

D. EJ (East Jordan Iron Works)

All fire hydrants shall be provided with (1) 5" Harrington Integral Hydrant Storz, "HIHS" or equivalent (approved by NBU engineer).

A. Mueller – Harrington # HIHS-MLR-50-45 (or Mueller's 5" Quick Disconnect, part # 287304)

B. American Darling – Harrington # HIHS-WAT-50-45

C. Clow – Harrington # HIHS-Clow-50-45

D. EJ (East Jordan Iron Works) – Harrington # HIHS-EJIW-50-45

Applicable Specifications

A. AWWA C-502 current: "AWWA Standard for Dry-Barrel Fire Hydrants".

B. NFPA 1963: "Standard for Fire Hose Connections".

C. ANSI A-21.11 current: "American National Standard for Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings".

Functional Requirements

A. Design Working Pressure shall be 250 psi or greater.

B. Inlet shall be side connection hub end for mechanical joint (ANSI A-21.11-current). Shoe shall be rigidly designed to prevent breakage.

C. Lower Barrel shall be rigid to assure above ground break at traffic feature. Bury length of hydrant shall be four (4) feet minimum, five (5) feet 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. Barrel shall have an inside diameter of not less than 7 inches. Hydrant shall have non-rising stem.

D. Hydrant Main Valve shall be 5 1/4 or 6-inch 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 point to flat at base, and 1 7/16 inches at top and 1-inch 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.

E. 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.

F. Outlet Nozzles shall be located approximately 18 inches above ground. Each hydrant shall have two (2) 2 ½ inch nozzles 180 degrees apart with National (American) Standard Fire Hose Coupling Screw Thread NFPA 1963 and one (1) 5-inch Harrington Integral Hydrant Storz Nozzle, Harrington, Inc. model "HIHS" or equivalent (approved by NBU engineer). 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, with exception to the Storz Cap, which shall not have a pentagon-operating nut and shall be attached by cable to the hydrant.

G. Hydrants shall be Dry-Top Construction, factory lubricated oil or grease with the lubricant plug readily accessible.

H. 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.

Material Requirements

A. 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.

B. Coatings shall be durable and applied to clean surfaces. Exterior surfaces above ground shall receive a coating of Sherwin Williams' silver metallic paint or approved equal. 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. Bonnets and caps shall be painted based on NFPS Standard 291 recommendations shown in Figure 1 below per flow testing results after approval by the Engineer.

Bonnet and Cap Colors

Color Name	Code	Color	Available Flow
Red	C		Less than 500 GPM
Orange	B		500-999 GPM
Green	A		1,000-1,499 GPM
Light Blue	AA		1,500 GPM & above

Figure 1: Bonnet and Cap Color Based on Flow Rate Calculated at 20 psi Residual Pressure

511.7 Water Flow Testing for Fire Hydrants

A. Guidelines

These guidelines are to be followed when a building, facility, residential subdivision, or multi-family dwelling units, within the City of New Braunfels or its Extraterritorial Jurisdiction, ETJ, is required to have a water (fire) flow test completed.

All water flow testing criteria for the purposes of these guidelines and any other guidelines shall conform to the International Fire Code as adopted by the City of New Braunfels, NFPA 291.

This guide does not replace, nor supersede any codes and/or ordinances adopted by the City of New Braunfels, or determinations and positions of the Fire Chief or Fire Marshal.

Fire flow testing is the determination of actual flow conditions within a hydrant system. A hydrant system is the system of mains, whether looped or not, capable of providing fire flow to a site. A site may have one or more hydrant systems with different flow and pressure characteristics.

Available fire flow is measured in gallons per minute (gpm) at a residual pressure of 20 psi.

The water system shall pass all construction acceptance testing (bacteriological and hydrostatic) prior to flow testing.

B. Hydrant Requirements

Following is a list of requirements for fire hydrant acceptance.

1. Water system (water mains, valves, services, hydrants and all appurtenances) must be in place and have passed all NBU acceptance testing.
2. Fire hydrant spacing must be in compliance with International Fire Code and local city ordinance for new construction.
3. All fire hydrants must have a 5-inch Storz connection with a standard Storz cap (not a pentagon nut). The cap must be tight fitting so that it cannot be turned or taken off by hand.
4. All fire hydrants must be at a level so that the center of the 5-inch (Storz) connection will be a minimum of 18 inches above the planned finished grade.
5. All fire hydrants must be flow tested following the guidelines set forth in NFPA 291. Flow testing may only be done by a fire sprinkler company (licensed by the State Fire Marshal's Office), fire protection engineer (licensed by the Texas Board of Professional Engineers), or civil engineer (licensed by the Texas Board of Professional Engineers). Flow testing costs and coordination are the responsibility of the Contractor.
6. Engineer to provide NBU with updated CAD file (preferably GPS located, at the very least geospatially located) 3 business days prior to flow testing. NBU will number the new hydrants that will be used for the numbering on the flow testing form.

C. Flow Testing Requirements

Following is a list of steps for fire flow testing.

1. All valves in open position.
2. Follow flow testing procedures listed in NFPA 291 "Recommend Practice for Water Flow Testing and Marking of Hydrants."
3. Input information using NBU's *Fire Hydrant Flow Test Form (Appendix C)*.
4. Results of the flow test will be given to the New Braunfels Fire Marshal's Office, a copy to NBU and the Engineer. (NB Fire Marshal's Office – 424 S Castell Ave; NBU – 355 FM 306)
5. A copy of the state issued engineer license or fire sprinkler license of the person/company who performed the test must be included with the results which are turned in to the Fire Marshal's Office.
6. Flow tests must be able to be duplicated prior to final acceptance by NBU or New Braunfels Fire Department (NBFD).
7. Acceptance of the constructed water system will depend upon NBFD's and NBU's approval of the fire flow(s) of the hydrant(s), among other criteria.
8. NBU field inspector should be consulted prior to testing for observation and coordination purposes. Contractor should give NBU field inspector 48-hour notice prior to any flow testing.
9. NBU field inspector must be on-site during flow testing.

511.8 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 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. 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, 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 3 feet, nor more than 6 feet, except that no part of a hydrant or its nozzle caps shall be within 6 inches of any sidewalk or pedestrian ramp. Fire hydrants shall not be installed within nine feet vertically or horizontally of any sanitary sewer line regardless of construction.

All hydrants shall stand plumb; those near curbs shall have the 5-inch Storz nozzle facing the curb and perpendicular to it. Hydrants shall be placed with no obstructions within 3’ of the pentagonal operating nut. 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. Lower barrel length shall not exceed five (5) feet. Ground to bottom of connection pipe shall be 4 feet. Barrel extensions are not permitted unless approved by the Engineer or designated representative. Each hydrant shall be connected to the main by 6-inch ductile iron pipe; a 6-inch gate valve shall be installed in the line for individual shutoff of each new hydrant.

Fire hydrants on mains under construction (or out of service) shall be securely wrapped with a poly wrap bag (5 mils or greater) or envelope taped into place. When the mains are accepted and placed in service (or hydrant repaired or replaced) the bag shall be removed.

C. Pressure Taps: Refer to Section 510.3 of Standard Specification, "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 of Standard Specification, "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 low density polyethylene film or a minimum 4-mil 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 A48, 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. Air Release Assemblies:

Shall be installed as directed by the engineer.

H. Pressure/Flow Control Valves:

Assemblies shall be installed as indicated.

I. Connections to Existing System:

Refer to Item No. 510, "Pipe" for connections to the existing system.

J. Shutoffs:

Refer to Item No. 510, "Pipe" for shutoffs.

K. Abandonment:

Refer to Item No. 510, "Pipe" for abandonment.

511.9 Measurement

All types of valves will be measured per each. Fire hydrants and drain valves will be measured per each. Pressure/Flow control valve assemblies and both manual and automatic air release assemblies will be measured per each.

Unless indicated otherwise in the Drawings, bury depths that exceed 5.5 feet shall be considered subsidiary to the completed unit.

511.10 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.

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 (and flow testing) shall be paid for at the unit bid price for all fittings, piping, valves, between the main line and the fire hydrant; setting, adjusting to grade, anchoring in place, installing blue hydrant reflectors, and other appurtenances necessary for proper operation. Flow testing shall be coordinated and results recorded by Contractor;

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 all fittings, piping, and valves between the main line and the drain valve; setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation;

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:

Pay Item: Valves, _____ Type, _____Diameter Per Each.

Pay Item: Fire Hydrants Per Each.

Pay Item: Pressure or Flow Control Valve Assemblies Per Each.

Pay Item: Drain Valve Assemblies Per Each.

Pay Item: Manual Air Release Assemblies, _____Diameter Per Each.

Pay Item: Automatic Combination Air/Vacuum Release Valve Assembly, _____ Diameter Per Each.

END8

Item No. 512
Conductive Trace Wire for Non-Metallic Pipe Installation

512.1 Description

Install electrically continuous trace wire with access points as described herein to be used for locating non-metallic pipe with an electronic pipe locator after installation.

512.2 Materials

A. Trace Wire

Trace wire for direct bury applications shall be twelve (12) gauge minimum solid copper or high-strength copper-clad steel (HS-CCS) with HDPE or HMWPE insulation recommended for direct burial.

Trace wire for trenchless applications shall be twelve (12) gauge minimum extra-high-strength copper-clad steel (EHS-CCS) with HDPE or HMWPE insulation recommended for direct burial.

Trace wire for all applications shall have insulation color per the APWA Uniform Color Code for the specific utility being marked.

B. Wire Connectors

Wire connectors must be watertight, provide electrical continuity, and be filled with dielectric moisture resistant grease. Connectors shall be 3M Direct Bury Splice Kits, Copperhead Snakebite Locking Connectors, or approved equal.

C. Access Points

Access Points shall meet the requirements of NBU SPL 18.1.0.

512.3 Construction Methods

Tracer wire shall be installed on all non-metallic water mains and force mains. The wire shall be installed in such a manner as to be able to properly trace all water mains or force mains without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.

Tracer wire shall be installed in the same trench and inside bored holes and casing with non-metallic pipe during pipe installation. It shall be secured to the pipe as required to ensure that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at tracer wire access points installed per NBU standard details. Sections of wire shall be spliced together using approved splice caps and waterproof seals. Twisting the wires together is not acceptable. No bare tracer wire shall be accepted. Detection tape shall not be used in lieu of tracer wire.

A. Wastewater – Force Mains

For access points along force mains, tracer wire access points shall be placed at intervals of no greater than 500 feet including one at the pump station and one at the discharge point.

B. Water

Tracer wire access points are to be placed at intervals no greater than 600’ and adjacent to isolation valves or fire hydrants.

C. Pipe Application

At the point of connection between cast or ductile iron water mains, with any non-iron water main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of 2 inches thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.

Tracer wire shall be laid flat and securely affixed to the top of the pipe at 10-foot intervals. The wire shall be protected from damage during the execution of the works. No breaks or cuts in the tracer wire or tracer wire insulation shall be permitted. At water service saddles, the tracer wire shall not be allowed to be placed between the saddle and the water main.

The tracer wire will be allowed some slack to allow for bends in laying and for future installation of joints, splices, tapping saddles, etc. The slack should also be sufficient to allow for small earth movements occurring in compacting trench fill or through natural subsidence.

At all water main end caps, a minimum, of 6 feet of tracer wire shall be extended beyond the end of the pipe, coiled and secured for future connections. The end of the tracer wire shall be spliced to the wire of a six-pound zinc anode and is to be buried at the same elevations as the water main.

D. Boring

For directional drilling, auguring or boring installations, four #12 tracer wires shall be installed with the pipe and connected to the tracer wire at both ends, or cad welded to the existing iron pipe at both ends.

E. Splicing

Except for approved spliced-in connections, tracer wire shall be continuous and without splices from valve chamber to valve chamber.

Spliced connections between the main line tracer wire and branch connection tracer wire shall only be allowed at water main tees, crosses or at water services where a portion of the branch connection water main or water service is replaced with a non-iron or non-copper material. The branch connection tracer wire shall be a single tracer wire properly spliced to the main line tracer wire. Where the existing branch connection is neither iron nor copper, then the new branch connection tracer wire shall be properly spliced to the existing tracer wire on the branch connection.

When tying new construction to old construction, tracer wire will not be terminated to or on another tracer wire or metallic utility line unless the two systems are demonstrably compatible. This is to reduce the potential for rapid corrosion of one system due to a ‘reverse’ cathodic effect.

At all repair locations where there is existing tracer wire, the tracer wire shall be properly reconnected and spliced as outlined above.

512.4 Testing Requirements

Contractor shall perform a continuity test on all trace wire in the presence of the Engineer or the Engineers' representative.

A. All tracer wire for new utility installations will be tested before acceptance. The test will take the following form:
    1. A standard 5-watt generator will be used to provide an AC current on the wire.
    2. The frequency of the signal from the generator will be initially restricted to 33 kHz or less.
    3. A standard handheld detector will be used to trace the signal.

B. The installed tracer wire will be deemed to pass the test if using this set up:
    1. The tracer wire is accessible at all access points.
    2. The tracer wire can be traced from access point to access point.
    3. Widely spaced access points can be traced out in the worst case from each 'end' to a common meeting point between them.
    4. Depth readings are consistent and accurate to within 15 to 1 depth to diameter ratio.

C. If the trace wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of the wire.

512.5 Measurement and Payment

There is no separate payment for the supply and installation of tracer wire on any construction or installation of non-metallic water main or force main by the Contractor. The Contractor shall consider the supply and installation of the tracer wire incidental to all construction of non-metallic water main and force main.

End

Item No. 515
Pipeline Testing and Acceptance

515.1 Description

This item shall consist of the testing and acceptance of water and wastewater pipes, including hydrostatic testing for pressure pipes, low pressure air testing for gravity pipes, deflection and settlement testing.

A. Tests shall be required in accordance with the following table:

	Bacteriological Testing	Hydrostatic Testing	Exfiltration Test	Infiltration Test	Low Pressure Air Test	Settlement Testing	Deflection Testing	CCTV Inspection
Water Mains	X	X						
PVC Gravity Sewer Mains					X	X	X	X
Other Gravity Sewer Mains			X	X		X	X	X
Force Mains		X						

515.2 Submittals

A. Furnish test reports as described below:

1. Submit written plan for disinfection.
2. Submit detailed hydrostatic test procedure 10 days prior to conducting the test.
3. Contractor shall submit his proposed pipe mandrels or testing balls to the E/A or his designated representative for concurrence prior to testing the line.
4. Submit Hydrostatic Pipe Test Reports.

515.3 Standards

A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ASTM International (ASTM):

ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

ASTM F1417-11A	Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Line Using Low-Pressure Air

2. American Water Works Association (AWWA):

AWWA B300	Hypochlorites
AWWA C200	Steel Water Pipe, 6 In (150 mm) and Larger
AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C604	Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	Disinfecting Water Mains
AWWA M9	Concrete Pressure Pipe
AWWA M11	Steel Pipe – A Guide for Design and Installation
AWWA M23	PVC Pipe – Design and Installation
AWWA M41	Ductile-Iron Pipe and Fittings
AWWA M55	PE Pipe – Design and Installation

515.4 Products

A. Water for Testing

1. Obtain water for filling and testing the pipeline and provide all temporary pumps and piping necessary to fill the pipeline.
2. If chlorinated water is used, then dechlorinate it before disposal per all regulations.
3. Water for the Work shall be metered and furnished by the Contractor in accordance with of the Standard Contract Documents.

B. Test Plugs

1. Design plugs or blind flanges to withstand the test pressure on either side with only atmospheric pressure on the opposite side.
2. Provide a 30-inch access manhole in one side of the plug and a 12-inch flanged outlet on the other side of the plug unless shown differently on the Drawings.

C. Pressure Gauge

1. Use a pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.0625 psi. (One ounce per square inch.)

D. CCTV Equipment

1. General

   Equipment used shall be designed for use in gravity wastewater collection systems per Specification Item No. 315 “CCTV Inspection”.

515.5 EXECUTION

A. General

Perform tests in accordance with this Section, AWWA Standards, AWWA Manuals, and the supplier's recommendations.

B. Water Pipe Acceptance Testing

Acceptance testing for potable water pipes requires two tests, bacteriological and hydrostatic. Bacteriological testing should be done on the pipe after disinfection and prior to the hydrostatic testing, unless the pipe is isolated in the system such that there are no services or trunk line connected and approved by an NBU inspector. After the pipe has been installed and backfilled and all service laterals, fire hydrants and other appurtenances installed and connected, a hydrostatic test will be conducted by the Contractor.

1. 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-inches in diameter or smaller, cleaning shall consist of flushing the pipeline. For pipelines greater than 16-inches 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).

   c. Procedure and Dosage

      i. The Contractor, at its expense, will supply the test gauges and the Sodium Hypochlorite conforming to ANSI/AWWA B300, which contains approximately five percent (5%) to fifteen percent (15%) 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-inch diameter or smaller lines, if it is included as part of the written plan of disinfection that is approved by New Braunfels Utilities. 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 Utility.

      ii. 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.

iii. 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.

iv. For pipelines larger than 16-inches 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.

v. Unless otherwise indicated, all quantities specified herein refer to measurements required by the testing procedures included in the current edition of “Standard Methods for the Examination of Water and Wastewater,” jointly published by AWWA, WEF, and AHPA. 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 NBU before flushing of the line may begin. Additionally, the flushing must be witnessed by an authorized representative of NBU.

Approval for discharge of the diluted chlorine water or heavily chlorinated water into the wastewater system must be obtained from New Braunfels Utilities. 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 Utility shall designate its own representative to oversee the work. Daily notice of line discharging must be reported to New Braunfels Utilities Dispatch office.

2. Bacteriological Testing

After final flushing of the disinfecting solution, the system will be tested for bacteriological quality by the Utility and must be found free of coliform organisms before the pipeline may be placed in service. All stubs shall be tested before connections are made to existing systems.

a. Contractor must collect two (2) sets of water samples taken at least twenty-four (24) hours apart. 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.

b. 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.

c. 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 Utility, at its expense, will furnish the sterile sample bottles and may, at its discretion, collect the test samples with Utility personnel.

d. 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.

e. 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 for the Examination of Water and Wastewater." 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 collects a second series of test samples for testing by the Utility. 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.

f. New Braunfels Utilities Water Quality Laboratory will notify the assigned Utility 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.

3. Hydrostatic Test

a. The Contractor will furnish the pump and gauges for the tests. The Utilities Representative shall be present during 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.

b. Determine the HGL for each test section, and test such that the pressure range below is achieved (lower pressure at high point and higher pressure at low point).

   i. Test pressure shall in no case be less than 200 psi, or more than 2X the working pressure.

c. 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.

d. Prior to pressure testing against an existing system valve, a bacteriological test shall be performed to determine potability of water.

e. A hydrostatic test will be conducted on the entire project or each valved section to test for leakage. The leakage test shall be at 150 psi for at least 4 hours.

i. 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.

$$\frac{(\ 25\ \text{gpd}\ )}{(\text{in.} - \text{mi.})}$$

ii. 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.

C. Wastewater Pipe Acceptance Testing

Gravity sewer pipe installed in the New Braunfels Utility System 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. Finally, the pipe shall be inspected with closed circuit television (CCTV) camera per Specification Item No. 315 “CCTV Inspection”.

Force main sewer pipe shall be tested in accordance with the hydrostatic test procedure outlined in the “Water Pipe Acceptance Testing.”

The Contractor shall be solely responsible for making proper repairs to those elements which do not pass these test requirements.

1. Wastewater Exfiltration Test

a. The pipeline shall be completely filled with water for its complete length or by sections as determined by the E/A. 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.

b. 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.

2. Wastewater Infiltration Test

   a. 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.

   b. 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.

   c. 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.

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

3. Low Pressure Air Test of Plastic Gravity Flow Wastewater Lines

   Wastewater lines, at the discretion of the E/A, 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. Use only qualified personnel to conduct the test.

   a. Plugs

      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.

   b. Pressure Relief Device

      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.)

c. 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.

d. Test Procedure

i. The E/A may, at any time, require a calibration check of the instrumentation used. 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.

ii. 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.

iii. 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.

e. Edwards Aquifer Recharge/Transition Zone Test Procedure

i. Low-pressure air tests must conform to the procedure described in ASTM F1417-11A 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 must be air tested at each joint.

ii. 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.

iii. 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:

$$T = 0.0850\ (D)(K)/(Q), \text{ where}$$

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 (ft^3/min/ft sq) of internal surface area.

iv. 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.

f. Manholes

i. Manholes must be tested separately and independently in accordance with Standard Specification Item No. 304, “Manholes”.

D. Settlement Testing

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 flushed into the pipe to permit meaningful observations. Prior to flushing, the manholes and pipes should be cleared of all debris. 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. Deflection Testing

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.

1. Test(s) must be performed without mechanical pulling devices and must be witnessed by the E/A or his designated representative.
2. Any deficiencies noted shall be corrected by the Contractor and the test(s) shall be redone.

F. Closed Circuit Television (CCTV) Inspection

1. CCTV Televising / Inspection shall be in accordance with Specification Item No. 315 “CCTV Inspection”.

510.5 Measurement and Payment

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this Item but shall be considered subsidiary to the particular items required by the bid.

End

Item No. 530
High Performance Coatings

Notes to Specifier:

Delete these notes and parts that are not applicable.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Verify all references to paragraphs within this specification and to any applicable Sections, standards or other specified sources of information.

This specification must be modified for removal of existing coatings or rehabilitating existing facilities where the existing coatings contain heavy metals.

Verify specification with approved manufacturers prior to use.

530.1 Description

Furnish labor, materials, equipment and incidentals necessary to apply protective coatings to material and equipment as specified herein, including the preparation of surfaces prior to application of coatings.

A. Protective coatings are special coatings to be used at specific locations or on specific surfaces as indicated herein in that every surface of every description, except those which are specifically noted not to receive a coating finish, must be covered by a paint system as specified in this Section.

B. Protective coatings must be applied to the following surfaces:

   a. Metal surfaces located outside of buildings and other structures anywhere on the Site.

   b. Structural steel located in the following areas: **[Specify/list as necessary for each project.]**

   c. Hot-Dip Galvanized Steel: **[Specify/list as necessary for each project.]**

   d. New piping and valves, except **[including]**: **[Specify/list as necessary for each project.]**

   e. Concrete surfaces at the following locations: **[Specify/list as necessary for each project.]**

   f. Existing Piping and Valves: **[Specify/list as necessary for each project.]**

   g. Petrolatum (Wax) Tape at the following locations:
      i. Buried flexible couplings.,
      ii. **[Specify/list as necessary for each project.]**

C. The following must not be coated and must be protected from drips, overspray, etc. unless indicated otherwise

   1. Stainless steel piping, materials and equipment.

2. Galvanized steel piping, materials and equipment unless specifically indicated to be coated.
3. Aluminum materials and equipment.
4. Interior electrical items.
5. **[Specify/list as necessary for each project.]**

D. Special applications for painting include the following:

1. Aluminum surfaces in contact with or embedded in concrete must be coated with a zinc rich primer. Primer shall be:
    i. Tneme-Zinc; Tnemec Company, Inc.
    ii. MasterProtect P 8100AP; Master Builders Solutions US LLC.
    iii. Approved equal.
2. Buried pipe and valves must receive a shop applied protective coating as described in the appropriate Section of the Specifications.

E. Contain, treat, and dispose of any dust, spray, drainage, or spillage resulting from coating operations. It is the Contractor's responsibility to determine if the materials to be disposed of are classified as Hazardous Waste. Disposed of waste, hazardous or otherwise, must be in accordance with applicable regulations. Contractor must be aware of and understand the regulations concerning disposal of waste generated by coating operations.

530.2 Quality Assurance

A. Acceptable Manufacturers: Products which comply with the Contract Documents and are manufactured by the following companies will be acceptable:

1. Tnemec Company, Inc.
2. Carboline.
3. PPG Protective & Marine Coatings.
4. The Sherwin-Williams Company.
5. Akzo Nobel / International Paint, LLC.
6. ICI Devoe High Performance Coatings.
7. Plasite Protective Coatings.

It is desired that the paint products be furnished by as few manufacturers as possible to meet the requirements of the Specifications. Coating products of the same type must be supplied by the same manufacturer. Do not mix products from different sources.

B. Applicator's Qualifications: Applicators must be qualified in this line of work and have a minimum of 5 years of experience in the application of the protective coatings of the types specified herein. Submit a list of recent projects and names of references for those projects.

C. Product Quality:

1. Use only the coatings specified in this Section. Use only those thinners and solvents recommended by the manufacturer, only in the amounts necessary to

produce the manufacturer's recommended spreading rate, and in amounts not exceeding the maximum quantities stated in the manufacturer's literature.

2. The coating material must not show excessive settling in a freshly opened full can and must be easily re-dispersed with a paddle to a smooth, homogeneous state. It must show no curdling, livering, caking, or color separation and must be free of lumps or skim surfaces.

D. Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of paint manufacturer whose product is to be applied.

2. Provide Engineer and NBU minimum 3 days of notice prior to start of surface preparation work or coating application work.

E. Perform Work only in the presence of Engineer, unless Engineer grants prior approval to perform such Work in Engineer's absence. Approval to perform Work in the Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the workday.

1. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, does not relieve the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

2. Contractor is solely responsible for testing for this Section, at no further cost to the Owner. Engineer may also make such tests if it is considered necessary. Cooperate with the Engineer, providing equipment, scaffolds, and other equipment as requested by the Engineer.

F. Testing Equipment: Furnish the testing apparatus necessary for testing coatings, including the following:

1. One set of U.S. Department of Commerce thickness calibration plates, certified by the National Bureau of Standards, to test dry film thickness.

2. Wet-film thickness gauges. Give one to Owner's representative. Each painter must keep one to test paint as it is applied.

3. One electronic dry-film thickness gauge capable or measuring 0-200 mils with calibration standards approved by the Bureau of Standards.

4. One Elcometer 319 Dewpoint Meter or approved equal.

5. One Tinker and Rasor Model M 1 Holiday Detector and recommended wetting agent and/or High Voltage Holiday Detector if required for coating thickness specified.

6. One set of SSPC-VIS 1, 3 and 4 - Visual Standards as applicable.

G. Testing Reports: Submit an inspection report for each coating applied on the Project. The testing report must be completed on a form furnished by the Engineer and must bear the signature of the Contractor and the Owner's representative.

530.3 Submittals

The following Product Data for products, including manufacturer's data sheets, are due prior to ordering coating and surface preparation materials:

A. Coating manufacturer's color selection literature for coating materials and caulk.

B. Sample warranty document for products.

C. Provide certification from the manufacturer that all coatings will not contain more than 0.06 percent by weight of lead in the cured coating for each coat applied.

D. Coating manufacturer's Product Information and Safety Data Sheets (SDS) for each coating and caulk material. Product Information must include the following:

1. The manufacturer's published instructions for use in specifying and applying all proposed coatings.
2. Application instructions written and published by the coating manufacturer.
3. All anticipated limitations, precautions and requirements that may adversely affect the coating, that may cause unsatisfactory results after the application or that may cause the coating not to serve the purpose for which it was intended, must be clearly and completely stated in the instructions. Limitations and requirements must include, but are not necessarily limited to the following:
    i. Surface preparation.
    ii. Method(s) of application.
    iii. Thickness of each coat (maximum and minimum DFT).
    iv. Drying and curing time of each coat.
    v. Time (minimum and maximum) allowed between coats.
    vi. Thinner and use of thinner.
    vii. Proper mixing of coating before application.
    viii. Weather limitations during and after application (temperature and humidity, time weighted).
    ix. Physical properties of coating, including percent solids content by volume.
    x. Equipment settings (air cap, fluid tip, equipment pressure settings, etc.).
    xi. Pot life at various temperature and humidity conditions.
    xii. Provide documentation that interior coating system is compatible with the cathodic protection system.

The following samples are required prior to ordering the materials:

A. Three samples of selected exterior finish colors for approval on 6-inch by 6-inch swatches. Label each swatch with the manufacturer's name, coating name/type, color name and number.

The following Product Data is required prior to coating Work:

A. Coating Plan:

1. Anticipated coating process schedule by date, including dates when hold-point inspections are anticipated. Schedule must indicate detailed activities on a daily basis.

2. Detailed procedures and schedule for all pre-cleaning, surface preparation and application of coating, including touch-up and repair procedures for all coating systems.
3. Recoat schedule on the submitted coating materials.
4. Data sheets must include curing characteristics and recommendations regarding complete coating curing.
5. Provide a written plan documenting how spent cleaning debris and/or paint over spray or droplets will be contained/confined to the jobsite and tank site during the surface preparation and coating application operations. Reasonable care must be exercised by the Contractor to prevent damage, nuisance, or hazardous conditions to adjacent or nearby property owners. Include all materials and method to be used for protection of exterior surfaces and allow for recovery and disposal of paint scraps and blast media.

B. Provide documentation on proposed containment system methods for blasting and coating operations.

C. Contractor must submit evidence of notification of the appropriate office of the Texas Commission on Environmental Quality (TCEQ) prior to abrasive blasting as required. Submit copies of any obtained permits.

D. Coating Manifest - Within 48 hours of coating delivery to the jobsite, the Contractor must record the batch number stamped on each coating container and submit a typed list to the Owner's representative. Minimum information required is listed below.

1. Date of delivery to jobsite.
2. Name and signature of superintendent recording the data.
3. List of batch number including corresponding coating identification, color, date of manufacture and volume of each container.

E. The following Certified Test Report(s) are required prior to coating Work:

1. SDS sheets for all abrasive to be used on the Project.
2. Certification and laboratory test results indicating recycled metallic abrasive per SSPC. AB 2 or 4 and atomic absorption test results.

530.4 Standards

The following standards dictate standards used in project:

A. NSF International (NSF) / American National Standards Institute (ANSI):

NSF/ANSI Standard 61	Drinking Water System Components – Health Effects
NSF/ANSI/CAN 600	Health Effects Evaluation and Criteria for Chemicals in Drinking Water

B. ASTM International (ASTM):

ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D523	Standard Test Method for Specular Gloss

ASTM D610	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D4259	Standard Practice for Abrading Concrete
ASTM D4260	Standard Practice for Liquid and Gelled Acid Etching of Concrete
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4285	Standard Test Method of Indicating Oil and Water in Compressed Air
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tester
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Pull-Off Adhesion Testers
ASTM D7682	Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty
ASTM E337	Standard Practice Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

C. American Water Works Association (AWWA):

AWWA C210	Liquid-Epoxy Coating and Linings for Steel Water Pipelines
AWWA C222	Polyurethane Coatings and Linings for Steel Water Pipe and Fittings

D. Consumer Product Safety Act, Part 1303.

E. Environmental Protection Agency (EPA).

F. International Concrete Repair Institute (ICRI):

Technical Guideline No. 03732	Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers and Polymer Overlays
Standard 310.2	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays and Concrete Repair with CSP Chips

G. Association for Materials Protection and Performance (AMPP) (formally NACE/SSPC):

NACE TPC2	Coating and Lining for Immersion Service: Chapter Safety, Chapter 2 Surface Preparation, Chapter 3 Curing, and Chapter 4 Inspection
NACE SP0178	Design Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service
NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0178	Surface Finishing of Welds Prior to Coating; Weld Replica Only to be used with NACE SP0178
NACE RP0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC-VIS 3	Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning
SSPC Vol. 1	Good Painting Practices
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-AB 2	Cleanliness of Recycled Ferrous Metallic Abrasives
SSPC-AB 3	Ferrous Metallic Abrasives
SSPC-AB 4	Recyclable Encapsulated Abrasive Media in a Compressible Matrix
SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning
SSPC-SP 11	Bare Metal Power Tool Cleaning
SSPC-SP I6	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-PA 1	Shop, Field and Maintenance Painting of Steel
SSPC-PA 2	Determining Compliance to Required DFT
SSPC-PA 10	Guide to Safety and Health Requirements for Industrial Painting Projects
SSPC-PA 17	Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements
SSPAC Paint #20	Organic Zinc Rich Primer, Type II
SSPC Guide 6 (CON)	Containment of Debris
SSPC Guide 12	Illumination of Painting Projects

SSPC Guide 15	Retrieval and Analysis of Soluble Salts
SSPC-SP 5/NACE 1	White Metal Blast Cleaning
SSPC-SP 6/NACE 3	Commercial Blast Cleaning
SSPC-SP 7/NACE 4	Brush - Off Blast Cleaning
SSPC-SP 10/NACE 2	Near - White Metal Blast Cleaning
SSPC-SP 13/NACE 6	Surface Preparation of Concrete

H. National Association of Pipe Fabricators (NAPF):

NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

I. Occupational Safety & Health Administration (OHSA):

1915.35 Standards - 29 CFR	Painting
1926.62 Standards - 29 CFR	Lead

J. Texas Commission on Environmental Quality (TCEQ):

30 TAC Chapter 290, Subchapter D	Rules and Regulations for Public Water Systems

530.5 Environmental Conditions

1. Do not apply coatings under conditions that are unsuitable for the production of good results. Remove trash and debris from enclosed buildings and thoroughly clean prior to application of coatings. Do not begin application of coatings in areas where other trades are working, or where construction activities result in airborne dust or other debris. Do not apply coatings in conditions which do not conform to the recommendations of the coatings manufacturer.
2. Coatings must only be applied when conditions fall within the parameters listed in the manufacturer's printed data.
3. Contractor must provide dehumidification equipment sized to maintain dew point temperature 5 deg F or more above surface temperature of metal surfaces to be prepared and coated.
4. Do not apply any coatings when weather conditions are unfavorable. In the event that climatic conditions are not conducive for best results, postpone application of coatings until conditions conform to the manufacturer's recommendations and the provisions of this Section.
5. Do not apply coatings to a wet or damp surface in wet or damp weather conditions, or when there is dust in the air. Surfaces exposed to direct sunlight must be shaded by awnings or other protective devices while coatings are being applied, if recommended by coating manufacturer. When necessary, provide temporary heating devices of a type that produces no fumes or water vapor which will discolor the paint system.

6. Heating and Dehumidification:

   A. Dehumidification equipment must be used to control the environment during surface preparation, rehabilitation, coating application and coating curing at no additional cost to the Owner, if acceptable environmental conditions cannot be met.

   B. If the Contractor cannot meet the required environmental conditions to apply the interior coating system per this Section and the coating manufacturer's written recommendations, Contractor will cease operations until approved dehumidification equipment has been provided and acceptable environmental conditions are achieved.

   C. If coating system is applied without dehumidification or in conditions not acceptable by this Section and by the coating manufacturer's written requirements, Contractor must fully remove coating system applied and replace per the Engineer's direction.

   D. Contractor must furnish all labor, materials, equipment, fabrication and quality control inspections, and all other incidentals required to control and maintain the environment of the reservoir within the parameters stated in this Section and must incorporate these and any other expenses into its bid.

   E. Owner reserves the rights, in the event the dehumidification equipment is not performing to the minimum requirements stated in this Section, to require the Contractor to modify and or add additional equipment to satisfy the conditions of this Section, at the sole cost to the Contractor.

   F. It is the Contractor's responsibility to provide adequate dehumidification equipment to meet this specification and the coating manufacturer's requirements of this Section and coating manufacturer's requirements. The coating manufacturer's limits of surface temperature, tank inside air temperature and relative humidity requirements will govern, if more stringent than the requirements stated within this Section.

7. Forced Ventilation:

   A. Provide continuous forced fresh air ventilation when working inside of containment systems or enclosed areas that are not openly vented from the beginning of surface preparation through final coating operations and coating curing.

   B. Forced ventilation must be supplied per the recoat time required by the coating manufacturer and at least 48 hours after the final coat has been applied.

   C. From the beginning of interior coating applications to until the coating system is cured, the Contractor must monitor the air for the lower explosion limit (LEL) as published in the coating manufacturer's product SDS.

   D. Contractor is responsible for supplying, installing and maintaining the forced ventilation system.

8. Containment System:

   A. Contractor must provide containment methods, either full or partial, which allows for the containment of the environmentally sensitive waste, dust and paint over spray that will be generated during the abrasive blasting and painting operation.

Note to Specifier: Class 1A/1W/1P should be specified when removing coatings with heavy metals. Class 2A/2W/2P may be specified for most projects with abrasive blasting. For smaller projects, minimal coatings, class 3A/2W/2P may be specified as a minimum.

B. Minimum Containment for Field Surface Preparation:

1. Provide a minimum SSPC Guide 6 (CON) Class **[1A] [2A] [3A.D1.E3]** containment system when dry abrasive blasting.
2. Provide a minimum SSPC Guide 6 (CON) Class **[1W] [2W]** containment system when wet abrasive blasting. All water must be contained and properly disposed of.
3. Provide a minimum SSPC Guide 6 (CON) Class **[1P] [2P.E3]** containment system when power tool cleaning.

C. The ground surrounding the project area must be protected from all debris, emissions, dust, and other materials generated in the cleaning operations with a minimum of two layers of polyethylene covered with plywood or the same material used for the perimeter containment system.

D. Containment is not required when blasting on the interior of a completely enclosed area (i.e. roof is in place) as long as no visible emissions are created.

E. Contractor must ensure that no spent cleaning/blasting debris, dust, overspray, coating droplets, or emissions of any kind, escape to the atmosphere, or to adjacent buildings, private property, work sites, parking lots, etc.

F. Owner reserves the right to stop Work or require containment, additional containment or different containment methods if the Contractor's operations create a nuisance beyond the tank site property line in the sole opinion of the Owner, the Engineer, the Owner's representative, any regulatory agency, or neighbor. All costs of providing an adequate containment system must be included by the Contractor in the Base Bid.

G. Contractor will be responsible for all materials that are used and for any apparatus used to contain dust emissions, debris, overspray, and coating droplets. The containment system attachments to existing or proposed structures must be designed by a professional engineer, licensed in the state where the Project is located, not to impose excessive loading on the structure. Contractor must submit the designed and sealed details of the containment system on the tank.

H. Any damage to the structure(s) as a direct or indirect result of the containment system must be repaired or sections replaced by the Contractor at no additional cost to the Owner. Neither the Owner, nor the Owner's Engineer, assumes any responsibility for the structural ability of the structure to support the containment system.

I. If tarps are used as part of the containment system, the tarps must be an impervious, solid, flame-resistant material, reinforced with a fiber mesh and must allow as much light as possible to pass through the material.

9. Visible Emissions:

A. Contractor must control visible emissions and releases while dust producing activities are underway.

B. Visible emissions more than SSPC Guide 6, Level 1 (1 percent of the workday or 5 minutes in an 8-hour shift) are unacceptable. Sustained emissions of more than 1 minute, regardless of the total time of emissions for the day is unacceptable. If unacceptable emissions are observed, Contractor must shut down immediately and correct the situation and clean up any debris generated from the release to the satisfaction of the Engineer before continuing Work.

530.6 Working Conditions

A. Provide adequate lighting at any location that coatings are being applied or testing is performed. Illumination must be of sufficient intensity to achieve good results. Provide explosion-proof lighting when required.

B. Temporary ladders and scaffolds must conform to applicable safety requirements. Erect temporary scaffolds where needed to cover large areas. Provide ladders or scaffolding during testing procedures.

530.7 Materials

A. Coating products are to be as follows:

Type A - Alkyd-Phenolic Universal Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 37H Chem-Prime H.S.
Sherwin-Williams	Kem Kromik Universal
Akzo Nobel / International Paint, LLC	Interlac 573
Devoe Coatings	Devprime 1403
Carboline	Carbocoat 150UP
PPG	Multiprime 4360

Type B - Epoxy-Polyamide Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Copoxy Primer
Akzo Nobel / International Paint, LLC	Intergard 251; Intergard 269 for valves and gates, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Devran 201V Series
Carboline	890
PPG	Amercoat 385

Type C - Penetrating Epoxy Pre-Primer	
Manufacturer	**Approved Coating**
Tnemec	Approved Equal
Sherwin-Williams	Macropoxy 920 Pre-Prime
Akzo Nobel / International Paint, LLC	Interbond 600
Devoe Coatings	Approved Equal
Carboline	Rustbond Penetrating Sealer
PPG	Amerlock Sealer

Type D - Inorganic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-98 Tneme-Zinc
Carboline	Carbozinc 12 VOC
Sherwin-Williams	Zinc Clad II Plus
PPG	Dimetcote 9 VOC

Type E - Organic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-97 or 90G-1K97 Tneme-Zinc
Carboline	Carbozinc 859
Sherwin-Williams	Corothane I Galvapac
PPG	Amercoat 68HS
Akzo Nobel / International Paint, LLC	Interzinc 52

Type F - Alkyd Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 2H Hi-Build Tneme-Gloss
Sherwin-Williams	DTM Alkyd Enamel
Akzo Nobel / International Paint, LLC	Interlac 665
Devoe Coatings	Devlac 1431
Carboline	Carbocoat 8225
PPG	Fast Dry 35

Type G - Epoxy-Polyamide Coatings	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Macropoxy 646 Epoxy
Akzo Nobel / International Paint, LLC	Intergurd 475HS; Interseal 670HS for valves and gates, PVC pipe and conduit, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Bar-Rust 235
Carboline	Carboguard 60
PPG	Amerlock 385

Type H – NSF/ANSI 600 Coatings for Potable Water (NSF 61 Certified)	
Manufacturer	**Approved Coating**
Tnemec	Approved Equal
Sherwin-Williams	Sher-Plate 600 Epoxy
Akzo Nobel / International Paint, LLC	Interline 850 or Interseal 670HS (NSF colors)
Devoe Coatings	Bar-Rust 233H Series
Carboline	Carboguard 61
PPG	Amerlock 2/400

Type I - Aliphatic Polyurethane Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 1094 Endura-Shield
Sherwin-Williams	Hi-Solids Polyurethane
Akzo Nobel / International Paint, LLC	Interthane 990 Series
Devoe Coatings	Devthane 379 Series
Carboline	Carbothane 133HB (Satin) or Carbothane 134HG (High Gloss)
PPG	Pitthane Ultra Series

Type J - Silicone Aluminum Coatings for High Temperature	
Manufacturer	**Approved Coating**
Tnemec	Series 39 Silicone Aluminum
Sherwin-Williams	Heatflex 500 Aluminum

Type J - Silicone Aluminum Coatings for High Temperature	
Manufacturer	**Approved Coating**
Akzo Nobel / International Paint, LLC	Intertherm 50 Series
Devoe Coatings	Intertherm 50 Series
PPG	Hi-Temp 500
Carboline	Carbozinc 11; Finish: Thermaline 4700 Series (up to 1000 deg F); Thermaline 4900 (up to 450 deg F)

Type K- Epoxy Concrete Coating	
Manufacturer	**Approved Coating**
Tnemec	Series 46H-413 Hi-Build Tneme-Tar
Sherwin-Williams	Tar Guard Epoxy
Akzo Nobel / International Paint, LLC	Interzone 954
Devoe Coatings	Devtar 5A Series
PPG	Amercoat 78HB Coal Tar Epoxy
Carboline	Bitumastic 300M

Note to Specifier: If Project includes bulk storage areas for chemicals, coordinate with coating manufacturers to verify the coating will protect the concrete based on what is being stored. The products listed in the table below are typical.

Type L - Novolac Vinyl Ester/Novolac Epoxy Concrete Coating - High Friction Surface (HFS)	
Manufacturer	**Approved Coating**
Tnemec	Series G436 Perma-Shield / Chembloc Series 252SC
Sherwin Williams	Dura-Plate 8200
Akzo Nobel / International Paint, LLC	Ceilcote 380 / 242GF Flakeline System
PPG	SFT 675 / FlakeRez 8303
Carboline	Carboguard 510 Series / Plasite 4500 Series

Type M - High Solids Epoxy Siloxane	
Manufacturer	**Approved Coating**
Carboline	Carboxane 2000
Sherwin-Williams	Sher-Loxane 800
PPG	PSX 700 Polysiloxane

Type N - Epoxy Mastic	
Manufacturer	**Approved Coating**
Carboline	Carbomastic 15
Sherwin-Williams	Macropoxy 646 Epoxy
PPG	Amerlock 2/400 AL
Tnemec	Chembuild Series 135 or Series 133 ProTuff
AkzoNobel/International Paint, LLC	Interseal 670HS

Type O - Elastomeric Polyurethane Hybrid	
Manufacturer	**Approved Coating**
Carboline	Reactamine 760 Series
Sherwin-Williams	Poly-Cote 115
PPG	Amerthane 490
Tnemec	Elasto-Shield Series 406
AkzoNobel/International Paint, LLC	Polibrid 705E Elastomeric

Type P - Glass Flake Reinforced Epoxy	
Manufacturer	**Approved Coating**
Carboline	Carboguard 890GF
Sherwin-Williams	Sher-Glass FF
PPG	Amerlock 2/400 GF
Tnemec	Pre-Approved Equal Glass Filled Product
AkzoNobel/International Paint, LLC	Approved Equal

Type Q - 100 Percent Solids Epoxy for Wastewater	
Manufacturer	**Approved Coating**
Carboline	Plasite 4550-S Novolac Epoxy
Sherwin-Williams	Dura-Plate 6000 Amine Epoxy
PPG	Novaguard 890 or Novaguard 810 Novolac Epoxy
Tnemec	Perma-Glaze Series G435 or Series G436 Modified Polyamine Epoxy

B. AWWA C210 Liquid-Epoxy Coatings and Linings for Water Pipe and Fittings

1. Line the piping with a liquid epoxy lining in accordance with AWWA C210, with a total thickness of 16 mils minimum DFT. Lining must be factory/shop applied. Install flanged and coupling connections as required to field install and prevent damaging the interior lining by welding as approved by the Engineer.
2. All lining materials must meet the applicable requirements of NSF/ANSI/CAN 600 according to the requirements of NSF/ANSI/CAN 61, including the most current health effects criteria for xylenes, toluene and ethylbenzene for the pipe diameter for which it is being applied.
3. Manufacturer must provide documentation that the product submitted is approved for the diameter of pipe in which it will be applied.
4. Approved Manufacturers:
    i. 3M Scotchkote
    ii. Carboline.
    iii. PPG.
    iv. Tnemec Company, Inc.
    v. Sherwin-Williams Company.

E. Petrolatum (Wax) Tape:

5. Petrolatum (wax) tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.
6. Approved Manufacturers:
    i. Trenton Corp. - Trenton Primer and #1 Wax-Tape.
    ii. Denso North America, Inc. - Denso Paste and Densyl Tape.
    iii. Approved equal.

F. Pipe Wrap Tape System:

1. System must be designed to mechanically protect coated piping from corrosion and abrasion in above ground, below ground and submerged conditions and be compatible with specified pipe coating system(s).
2. System must be UV resistant and may be constructed of HDPE, PVC, or fiberglass with an adhesive backing on one side for application to coated piping.
3. System must include a fiberglass reinforced outer shield for abrasion resistance and be able to be top coated for aesthetics.
4. Approved Manufacturers:
    i. SealForLife.
    ii. Denso North America, Inc.
    iii. Approved equal.

G. Cold Galvanizing Compound:

1. Cold galvanizing compounds must meet the performance requirements of ASTM A780 and SSPC Paint 20. Cold galvanizing compounds are to be used for repair of damaged or corroding galvanized coatings. Cleaning and surface preparation is to be as indicated by the manufacturer. 95% zinc by weight, minimum.
2. Approved Manufacturers:
    i. Rust-Oleum – 7000 System Cold Galvanizing Compound.
    ii. ZRC – Galvanizing Compound.
    iii. Approved Equal.

530.8 Color Selection

A. The color chart must include the complete available range of colors, including tints and shades. Owner will select the colors during construction.

B. Use a multi-color system coating for any surface receiving more than one coat. Each coat must be tinted differently from the preceding coat in a manner that will allow the various coats to be easily distinguished. Colors must generally be from light to dark shades, but the Contractor may have the option to select tint shades to ensure coats will receive adequate coverage without bleeding or otherwise showing through the preceding coat.

C. Piping and equipment must be color coded in accordance with the requirements of the TCEQ.

530.9 Delivery and Storage

A. Deliver coating products to the jobsite in original unopened containers, with manufacturer's label and batch number attached. Do not apply products until the Owner's field representative has approved the product for use.

B. Use one location at each jobsite for the storage of coating products. Protect the floor from spills and other damage. Protect the products from extreme heat or cold. Keep containers covered. Keep the storage rooms clean of trash and debris. Dispose of oily or used rags daily. Under no circumstances will they be allowed to accumulate. Take precautions to prevent fires. The storage of flammable liquids must comply with the city, state, or other fire codes.

C. Storage of coatings and other products must be in accordance with the manufacturer's requirements. Coatings that have been damage or not stored properly must not be applied and must be removed from the jobsite.

D. All products and coatings that are not approved for the Project must be removed from the jobsite and must not be stored at the jobsite.

E. All materials must be delivered to the jobsite in original sealed containers with the date of manufacture and batch number stamped thereon by the coating manufacturer. Materials are subject to random observations by the Owner's representative at the jobsite.

530.10 Construction Methods

A. General

1. All coatings must be applied in strict conformance with the coating manufacturer's published specifications, this Section, or as approved by the Engineer.
2. Surfaces which will be inaccessible after installation must be coated prior to installation or must be coated and approved in stages as the Work is installed.
3. Engineer will approve surfaces for application of coatings at each stage. Any material that is coated prior to the Engineer's approval will be stripped back to bare metal and repainted.
4. At least 7 days or as required by the coating manufacturer, must be allowed for drying of finished surfaces before any machinery can be placed into service.
5. The number of coats called for in this Section are considered the minimum required. If more coats are required to provide the specified dry film thickness or for complete coverage and uniform appearance, they must be provided at no additional cost to the Owner.
6. Illumination equipment must be provided by the Contractor in accordance with SSPC Guide 12. Explosion-proof lights and electrical equipment must be provided. The minimum illumination at the surface of the work during surface preparation and coatings is 215 lux (20 fc). The minimum illumination during inspection is 538 lux (50 fc). Whenever required by the Owner's representative, the Contractor must provide additional illumination and necessary supports to cover all areas to be inspected.

B. Steel Surface Preparation

1. The adequacy of the preparation of steel surfaces will be determined by comparing the surface with SSPC VIS 1 "Pictorial Surface Preparation Standards for Painting Steel Surfaces" and SSPC VIS 3 "Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning." Prepare surfaces in accordance with the following requirements:
    a. SSPC-SP 1 — Solvent Cleaning.
    b. SSPC-SP 2 — Hand Tool Cleaning.
    c. SSPC-SP 3 — Power Tool Cleaning.
    d. SSPC-SP 5 / NACE 1 — White Metal Blast Cleaning.
    e. SSPC-SP 6 / NACE 3 — Commercial Blast Cleaning.
    f. SSPC-SP 7 / NACE 4 — Brush-Off Blast Cleaning.
    g. SSPC-SP 10 / NACE 2 — Near-White Blast Cleaning.
    h. SSPC-SP 11 — Power Tool Cleaning to Bare Metal.
2. The resulting surface profile must be in accordance with the coating manufacturer's recommendations.
3. "Solvent Cleaning" must be performed prior to subsequent surface preparation, including abrasive blast cleaning.

4. All sharp edges and welds must be ground smooth to a rounded contour and all weld splatter must be removed prior to abrasive blasting. Edges of metal to be coated must be rounded to a minimum of 1/16-inch radius of chamfered a minimum of 1/16 inch at an angle of 45 degrees.
5. Welds and adjacent areas:
    a. Prepared such that there is:
        I. No undercutting or reverse ridges on the weld bead.
        II. No weld spatter on or adjacent to the weld or any other area to be painted.
        III. No sharp peaks or ridges along the weld bead.
        IV. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
    b. Weld profiles must conform to NACE RP0178, Profile 'D'.

C. Ductile Iron Pipe and Fittings Surface Preparation
1. Prepare surfaces in accordance with the following requirements:
    a. NAPF 500-03-01 — Solvent Cleaning.
    b. NAPF 500-03-02 — Hand Tool Cleaning.
    c. NAPF 500-03-03 — Power Tool Cleaning.
    d. NAPF 500-03-04 — Abrasive Blast Cleaning for Ductile Iron Pipe.
    e. NAPF 500-03-05 — Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
2. "Solvent Cleaning" must be performed prior to subsequent surface preparation as specified in NAPF 500-03.

D. Petrolatum (Wax) Tape
1. Petrolatum (wax) tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.
2. Tape must be installed on all buried flexible couplings and at locations indicated on the Drawings and as specified.

E. Pipe Wrap Tape System
1. Tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.
2. Tape must be installed on all piping at the transition between above grade and below grade. Coat piping a minimum of 2 feet vertically above and below the ground surface.
3. Paint wrap to match adjacent piping.

F. Concrete Surface Preparation
1. The adequacy of the preparation of concrete surfaces will be determined by comparing the surface with ICRI Surface Finish Comparators. Prepare surfaces

in accordance with the following requirements and the coating manufacturer's recommendations:

a. SSPC-SP 13 / NACE 6 — Surface Preparation of Concrete.

b. ICRI CSP 3 – 5, or as required by the coating manufacturer.

2. Allow a minimum of 28 days curing time to elapse before coatings are applied. Concrete surfaces which are scheduled to receive coatings must be in accordance with the coating manufacturer's moisture requirements. Contractor must provide any primers required by the coating manufacturer to address outgassing, as needed.

3. Contractor must field verify that the pH of the concrete is suitable for application per the coating manufacturer's product requirements.

4. Bug holes, air pockets, voids or imperfections in the concrete surface must be filled or patched with a cementitious resurfacing material approved by the coating manufacturer.

5. All coating terminations points, including from concrete to metal are to include a 1/4-inch key cut.

6. Concrete Surface Preparation Inspection:

a. Adhesion Testing:

i. Tensile testing of the surface preparation must be performed by the Contractor using a Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D7234 using 2-inch diameter dollies for concrete surface adhesion testing. Provide a minimum of three tests (dollies) per area and coating system. Engineer will select location of test dollies.

ii. Concrete surface or applied coating must be scored for concrete adhesion testing.

iii. Adhesive failure greater than 50 percent of the dolly surface area indicate inadequate surface preparation.

iv. Cohesive failures which result in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.

v. Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.

b. Concrete Soundness: Concrete soundness will be determined using the scratching or hammer impact methods as defined in SSPC-SP 13.

c. Moisture Content: Moisture must be tested as specified in SSPC-SP 13 and in accordance with ASTM D4263 and ASTM F1869 (for conditioned spaces). Moisture content cannot exceed the moisture content recommended by the coating manufacturer.

G. Surface Preparation

1. Clean and degrease surfaces prior to abrasive blasting by solvent cleaning as specified using solvents, detergent/water, emulsions, and steam. Proposed

method must be documented in the coating plan. Contractor must contain and properly dispose of all runoff and debris from cleaning.

2. If the following conditions exist or are prevalent, surface preparation and coating must be delayed or postponed until conditions are favorable. Each day's coating must be completed in time to permit the film sufficient drying time prior to damage by atmospheric conditions or changes. No surface preparation can begin or coating applied:
   a. When the surface, air or material is below or above the manufacturer's printed instructions.
   b. When surfaces are wet or damp.
   c. During weather conditions of rain, snow, fog or mist.
   d. When the air and steel temperature is less than 5 deg F above the dew point temperature.
   e. If the relative humidity is above 85 percent.
   f. When it is expected that the dew point, air and/or surface temperature will be below or above the coating manufacturer's recommended temperatures within 4 hours after applications of coating, minimum. Coating manufacturer may require additional time between application and temperature and weather changes.
3. Shop Surface Preparation:
   a. Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints. Work is subject to the Engineer's approval before shipment to the jobsite.
   b. Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed and approved by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with the Specifications.
   c. Prepare surfaces by abrasive blasting as specified and apply shop prime coat. Shop primed steel plates must not have primer extended within 4 inches along all edges to be welded. All primer within 4 inches of an area to be welded must be removed prior to welding. Welding of painted surfaces will not be allowed.
4. All pre-assembled shop primed items must be prepared in accordance with these specifications and inspected by the Owner's representative before and after priming.
5. Abrasive Blasting:
   a. Prior to commencing abrasive blasting operations, the Contractor must perform a test blast to verify that the surface cleanliness and profile meet the requirements of this Section and meet the coating manufacturer's requirements for the coating to be applied. If the test section does not meet the requirements, the Contract must make changes to the abrasive materials and/or methods to provide suitable blast.
   b. Abrasive blast only the amount of surface area which can be primed the same day or before any rust starts to form, whichever occurs first. Areas which are

not painted the same day must be re-blasted on the day the prime coat is applied.

c. Shrouding or recovery of all blast material will be mandatory during all exterior blasting.

d. Contractor must contain all waste and process discharge in accordance with the accepted methods for the process and materials that are in abatement.

e. Where abrasive blast cleaning will not remove or properly prepare metal surfaces, hand and/or power tool cleaning must be used to remove such conditions as weld splatter, laminations and radius-sharp edges. Hand tool or power tool must be used on areas less than 2 feet in diameter or smaller or on corners and edges.

f. All abrasive blast equipment must be equipped with, including but not limited to the following:

i. Noise reducing devices.

ii. Hose coupling safety devices.

iii. Electrical grounding devices.

iv. Moisture traps and filters.

v. Fresh air hoods for all blasters.

vi. “Dead Man” switches on all blast hoses.

vii. Air dryers.

6. Surface profile must be in accordance with manufacturer’s printed requirements.

7. The adequacy of the preparation of surfaces must be determined by comparing the surface with SSPC-VIS 1, SSPC-VIS 3, NACE RP0178 and ICRI Surface Finish Comparators.

8. Adequate surface preparation must be verified throughout surface preparation per SSPC-PA 17. Minimum testing requirements:

a. Test the surface profile within the first 15 minutes and one additional time during each work shift or 12-hour period, whichever is shorter for each gun or blasting apparatus used or at any time the process producing the acceptable profile indicated above is changed, as interpreted by the Engineer.

b. Select a minimum of three 6-inch square locations and take two readings. The average to the two readings is a “profile measurement.” The group of three locations is the “location average.” The location average must be within the specified profile range.

c. Contractor must report the location averages (lowest location average and highest location average, and the profile measurement for each surface preparation apparatus.

d. If the substrate has been previously coated, an existing profile may exist. Contactor must adjust blast media size to ensure that the resulting surface profile meets the profile required.

9. Wherever the words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, or “blast cleaning”, or similar words of equal intent are used in the Specifications or

in paint manufacturer's specifications, they are understood to refer to the applicable specifications indicated.

10. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacuum-blasting methods may be required. Coating manufacturer's recommendations for wet blast additives and first coat application will apply.
11. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.

H. Preparation Of Existing Coated Or Shop Primed Surfaces

1. General:
   a. Factory-applied primers to equipment must be those specified or verified by the Contractor to be compatible with the specified coating systems. Where possible, notify manufacturers which shop prime coats will be required in order to be compatible with field-applied finish coats.
   b. Where equipment is purchased which has the manufacturer's standard primer or a factory finish which is other than as specified in this Section, remove the factory-applied paint system or apply passivators or other special coatings as required to make the surface compatible with the finish coat specified.
   c. Do not apply any coating to machinery, piping, or other surfaces before testing has been completed and systems approved. Any damage to coatings resulting from subsequent corrective procedures must be stripped back to bare metal and repainted with the appropriate paint system as directed by the Engineer.
   d. Check for compatibility when applying coatings over existing coatings. Apply a test patch of the recommended coating system, covering at least 2 to 3 square feet or as directed by the Engineer. Allow to cure 1 week before testing adhesion per ASTM D3359 in the presence of the Engineer. If adhesion does not meet the manufacturer's published data, consult with the Engineer.
   e. Shop primed or coated surfaces must be reviewed with the Engineer to determine if the extent of damage to the coating and suitability of finish coats to adhere to shop applied coats.
   f. If a cured epoxy, polyurethane, or plural-component material is to be top coated provide brush-off blast as specified herein or as recommended by the coating manufacturer.
   g. Surface preparation recommendations of coating manufacturer are subject to approval of the Engineer.

2. To Be Recoated or Final Coated:
   a. Solvent clean.
   b. Perform touch-up repairs of existing coating.
   c. Asphaltic coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.

3. Touch-Up Repairs:
   a. Clean loose, abraded, or damaged coatings to substrate by power tool to bare metal per SSPC-SP 11 and/or NAPF 500-03-03 “Power Tool Cleaning.”
   b. Feather surrounding intact coating.
   c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
   d. Apply one full finish coat of the specified primer or finish coat(s) overall.
4. Application of a Cosmetic Coat:
   a. The exact nature of shop-applied coatings is not known in all cases.
   b. Check compatibility by application to a small area prior to starting the coating.
   c. If lifting or other problems occur, request disposition from the Engineer.

530.11 Application

A. Contractor and painting technicians are responsible for the application of the coating system and must have current applicator approvals from the coating manufacturer, as required.

B. After abrasive blast cleaning, dust and spent abrasive must be removed from the surfaces by vacuum process or with clean, dry, oil-free compressed air.

C. The prime coat must be applied as soon as possible after the blasting and surface cleaning is completed, inspected and approved by the Inspector. Blasted surfaces must be coated before rust forms on the surface. No prepared surface will be allowed to receive a coating if “rust bloom” or surface discoloration has occurred. All blasted surfaces must be coated to within 6 inches of the edge of a blasted area. No visible rust must be coated under any circumstances, including rust bloom or if discoloration has occurred, regardless of elapsed time between blasting and coating. Leave an uncoated strip of exposed metal to clearly identify where abrasive blasting was halted.

D. Provide mist coat if recommended by the coating manufacturer.

E. All weld seams, gaps, edges, bolts and difficult areas to coat must receive a stripe coat. Stripe coat must be a contrasting color. Stripe coat may be applied with intermediate or finish coating, but must be applied prior to the installation of the finish coat.

F. Contractor must apply each coat at the rate and in the manner specified by the coating manufacturer, except as may be modified herein. If material has thickened or must be diluted for application, coating must be built up to achieve the dry film thickness as specified for each coat of the complete system.

G. Maximum and minimum DFT must be per the supplied coating manufacturer’s printed requirements and as required by this Section. DFT will be measured per SSPC-PA 2, Level 2 with an allowable measurement of spot DFT of:
   1. Minimum DFT, as specified.
   2. 120 percent of maximum DFT specified.

H. Contractor and painting technicians are responsible for the application of coating system and must have current applicator certifications from the coating manufacturer. Submit certifications with coating submittal.

I. Coatings which have an expired shelf or pot life may not be used and must be removed from the jobsite.

J. Coating must be applied by skilled workmen and must be brushed out or sprayed evenly, without runs, crazing, sags, or other blemishes.

K. Sand between coats to remove over spray and dry fall.

L. Apply the first coat to the surface, including cutting in around edges, before the second coat is applied. The second coat and any successive coats must not to be applied before notifying the Owner's field representative and obtaining approval. Each coat must be tested before the successive coat is applied.

M. The coating curing period must be adjusted to compensate for less than adequate weather conditions, as recommended by the coating manufacturer, for complete curing of the entire coating system. The full curing time recommended by the manufacturer must be provided.

N. Coating must be continuous and must be accomplished in an orderly manner to facilitate proper inspection control.

O. Where a roller or brush is used to apply the coating, additional coats may be necessary to achieve the recommended dry film thickness and/or to achieve total coverage of the underlying surface. Coated surfaces must be totally free of all roller nap, roller marks, brush bristles and brush marks.

P. When using conventional coating spray equipment for coating operations, effective oil and water separators combined with after coolers or deliquescent dryers must be used in compressed air lines to remove detrimental oil and moisture from the air. Separators must be placed as far as practical from the compressor. Compressors must be tested periodically by the Contractor for oil and water contamination of compressed air. Testing must follow ASTM D4285 "Standard Test Method of Indicating Oil and Water in Compressed Air." All compressor units found to produce unacceptable amounts of oil and or water, as determined by results of ASTM D4285 test data must be replaced with a compressor that is acceptable.

Q. For porous surfaces, such as concrete or masonry, a prime coat may be thinned to provide maximum penetration and adhesion. The type and amount of thinning must be determined by the coating manufacturer and is dependent on surface density and type of coating.

R. Concrete and Steel Floors and Walks, including Bulk Storage Areas:

1. Provide non-skid surface in walkway areas and on floors.
2. Contractor is to include non-skid additive such as aluminum oxide to coatings or may use 50 mesh dry wash silica sand broadcasted into the film and back rolled to encapsulate as recommended by the coating manufacturer.
3. Contractor is to provide a test area to confirm with Owner that the non-skid surface is adequate and consistent. Contractor must modify method or products used as required to provide an acceptable surface.

530.13 Field Quality Control

A. Field Tests: Make wet film tests during painting operations to assure proper thicknesses of coating are being applied. After each coat has been applied, test the paint film thickness with a nondestructive, magnetic type thickness gauge. The total dry-film thickness for each coat must be per Paragraph [3.09.G]. Apply additional coats until the specified thickness is reached or exceeded.

B. Holiday Testing:

1. Holiday testing must be performed in accordance with NACE SP0188 or ASTM D5162 for steel substrates and ASTM D4787 for concrete substrates.
2. Test the entire surface of coated steel and piping in moderate or severe environments, as determined by the Engineer, with a holiday detector. For thickness between 10 and 20 mils (250 to 500 microns) a non-sudsing type wetting agent, as recommended by the holiday detector manufacturer, must be added to the water prior to wetting the detector sponge.
3. Holiday detect coatings in excess of 20 mils with high voltage holiday testers as recommended by the coating manufacturer.
4. Mark and repair failures in accordance with the manufacturer's printed instructions, then retest failure areas. No failures or other irregularities will be permitted in the final coats. Areas containing holidays must be repaired until tests indicate no holidays.

530.14 Protection Of Surfaces Not To Be Painted

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

530.15 Damaged Coatings, Pinholes, And Holidays

A. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.

B. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator must provide liquid repair kits for this purpose as recommended by the coating manufacturer.

C. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

530.16 Unsatisfactory Application

A. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.

B. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.

C. Evidence of runs, bridges, shiners, laps, or other imperfections are cause for rejection.

D. Repair defects in coating system per written recommendations of coating manufacturer.

E. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

530.17 Coating Inspection

General:

A. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.

B. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

C. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper millage in these areas.

Coating Thickness Testing:

A. Owner's representative may conduct coating thickness testing as necessary and without limitation.

B. Measure coating thickness specified in mils with an electronic type dry film thickness gauge.

C. Check each coat for the correct millage.

D. Tests for concrete coating thickness may be taken using a Tooke Gauge or gauge approved for testing coatings over concrete substrates. Contractor must repair coating after thickness testing, if required.

E. Coating Continuity (Holiday) Testing: Owner's representative will witness holiday testing performed by the Contractor.

Cleaning And Adjusting:

A. Promptly remove trash and debris resulting from painting operation from the Site. Remove drop cloths, masking tapes and other protective coverings. Remove paint spills, splatters, overlap of paint from adjacent material and other defects. Spot paint nicks and other defects.

B. Remove paint containers and waste products. Thoroughly clean paint storage rooms, removing spilled paint from walls and floors.

C. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

530.18 Schedule

A. Protective coatings must be applied in accordance with the following paint schedule. If additional or alternate primers, etc. are recommended by the coating manufacturer for any of the coatings specified, they must be provided at no additional cost to the Owner to provide a complete and compatible coating system, as approved by the Engineer.

PROTECTIVE COATINGS PAINT SCHEDULE

System	Application	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
No. 1	**Submerged Metal - Potable Water** All metal surfaces new and existing below a plane 1 ft. above the maximum liquid surface, metal surfaces above the maximum liquid surface which are a part of the immersed equipment, concrete embedded surfaces of metallic items under submerged or buried conditions, such as wall pipes, pipes, wall or floor sleeves, access manholes, gate guides and thimbles, and structural steel. Not to be used for potable water storage tanks. All coatings must be NSF 61 certified.	SSPC-SP 1 SSPC-SP 10 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05	TYPE H - Epoxy-Polyamide TYPE H - Stripe Coat TYPE H - Epoxy-Polyamide	1 2	4.0 4.0
				Total Minimum Dry Film Thickness	**12.0 mils**
No. 2	**Above-Grade Interior/Exterior Steel and D.I. Piping** **Non-Immersion/Non-Corrosive Environment** All metal surfaces new and existing, such as inside pump station buildings, exterior piping and valves, exterior structural steel, etc. **Application Notes:** **1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field.** **2. Proposed Field Coated and Existing Previously Coated Piping and Valves: Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and top coat as indicated.**	**For New Piping and Valves:** SSPC-SP 1 SSPC-SP 6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP 1 SSPC-SP 3 NAPF 500-03-01 NAPF 500-03-03	TYPE N - Epoxy Mastic TYPE C - Penetrating Epoxy Pre-Primer TYPE M - Stripe Coat Type M - HS Epoxy Siloxane	1 1 1	5.0 2.0 5.0-7.0
				Total Minimum Dry Film Thickness	**12.0 mils**
No. 3	**Concrete Floor Surfaces/Bulk Storage Areas of Chemical Storage Areas** All new and existing interior concrete floors, such as inside pump station buildings and chemical storage	SSPC-SP 13 ICRI CSP 3-5	Primer - As Needed TYPE L - Epoxy/Vinyl Ester	1	35 mils

System	Application	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
	areas. All coatings must include skid-resistant additives. **Note to Specifier: The specified coatings have been reviewed for resistance up to 12.5% sodium hypochlorite. Review chemical list below and modify as required. Include concentration for chemicals being stored.** Coatings provided must be resistant to **sodium hypochlorite (12.5%), liquid ammonium sulfate (XX%), hydrochloric acid and sodium chlorite (XX%).** **Application Notes:** Provide epoxy primer as required by coating manufacturer to address outgassing and resurfacing as required.				
				Total Minimum Dry Film Thickness	**35.0 mils**
No. 5	**High-Temperature Surfaces** Interior and exterior surfaces of surfaces with temperatures from 200 to 400 deg F. **Note to Specifier: List and describe high temperature surfaces to be coated. Prior to specifying epoxy, verify tolerance for temperature.**	SSPC-SP 1 SSPC-SP 10	TYPE J - Silicone Aluminum	2	1.0
				Total Minimum Dry Film Thickness	**2.0 mils**
No. 6	**Above-Grade Interior and Exterior PVC Pipe** Exterior surfaces PVC piping.	SSPC-SP 1 Light Sanding	TYPE B - Epoxy-Polyamide Primer TYPE I - Aliphatic Polyurethane Enamel	1 1	3.0 3.0
				Total Minimum Dry Film Thickness	**6.0 mils**
No. 7	**Metal Piping and Valves – Immersion in Wet Wells** **Moderate to Severe Environment (Non-Potable)** Exterior/interior surfaces of submersed valves & pumps, penstocks, piping, sewer interceptors,	SSPC-SP 1 SSPC-SP 6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05	Type Q - 100% Solids Epoxy for Wastewater	1-2	40.0

System	Application	Surface Prep	Product Type	No. of Coats	DFT/Coat (mils)
	wastewater vessels, settling tanks and buried piping connecting to them for severe conditions with exposure to H2S gas, including wastewater digesters, etc. **Application Notes:** Coating may be applied in two coats, as recommended by the manufacturer.				
				Total Minimum Dry Film Thickness	**40.0 mils**
No. 8	**New and Existing Metal Piping and Valves within Vaults and Under Insulation** **Moderate to Severe Environment** All metal surfaces new and existing that will be installed in areas where temporary submerged conditions can occur, such as within vaults and for piping and valves covered with insulation. **Application Notes:** **1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field.** **2. Proposed Field Coated and Existing Previously Coated Piping and Valves: Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and top coat as indicated.**	**For New Piping and Valves:** SSPC-SP1 SSPC-SP6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP1 SSPC-SP3 NAPF 500-03-01 NAPF 500-03-03	TYPE N – Epoxy Mastic TYPE C – Penetrating Epoxy Pre-Primer TYPE G - Stripe Coat TYPE G – Epoxy-Polyamide	1 1 2	4.0 2.0 4.0
				Total Minimum Dry Film Thickness	**12.0 mils**

530.19 Measurement and Payment

There is no separate payment for the supply and installation of coatings on any construction or installation by the Contractor. The Contractor shall consider all labor, equipment, materials, time, incidentals, and other items required for installation of coatings subsidiary to the item for which they are part.

End

Item No. 540
Cathodic Protection

Notes to Specifier:

Delete these notes and parts that are not applicable.

Where options are given, make appropriate selection and delete the other option, fill in all blanks.

Verify all references to paragraphs within this specification and to any applicable Sections, standards or other specified sources of information.

540.1 Description

Section includes:

A. Requirements for cathodic protection systems on steel, ductile iron and concrete cylinder pipe. The cathodic protection systems can be either sacrificial, impressed current or both.

B. Electrical isolation of the pipelines from adjacent metallic structures, steel reinforced concrete structures, structures with dissimilar metal or coatings, conduits and all other metallic components that may impact the operation of the cathodic protection system.

C. Electrical bonding of non-insulated, non-welded pipe joints and mechanical joints.

D. Installation of rectifiers, anode wells, and all other Work described herein and on the Drawings.

E. Removal and disposal of existing rectifiers, anode junction boxes, vent pipe risers and associated items described herein and on the Drawings.

F. Provision of electrical power for rectifiers including any permits, trenching, conduits, services meters and other items required. Not all required items are shown on the Drawings.

G. Installation of galvanic (sacrificial) anodes.

H. Testing of system during installation.

I. Cleanup and restoration of work site.

J. Testing of system after installation and backfill (Final System Checkout).

Related Specification: Item No. 530 High-Performance Coatings

540.2 Performance Requirements

A. If the products installed as part of this Section are found to be defective, damaged or not in conformance with the Specifications then the products and Work shall be corrected at the Contractor’s expense.

B. Any retesting required due to inadequate installation or defective materials shall be paid for by the Contractor.

C. The Work requires coordination of assembly, installation and testing between the Contractor and Owner’s representative.

540.3 Submittals

A. Shop Drawings: Catalog cuts, data sheets and other information for all products proposed.

B. Certification that the equipment and materials proposed meet the Specifications.

C. Certification of experience required for installation and testing of cathodic protection systems.

D. Schedule including the expected start date and planned completion date.

E. Copy of well drilling permits (if applicable).

F. The following procedures and collected data shall be submitted after the completion of the Work:

1. Wire connection testing.
2. Insulating flange testing, before and after backfill.
3. Casing insulator testing (if applicable).
4. Joint bond testing before and after backfill.
5. The following will be submitted for deep well installations only:
    a. Well completion report.
    b. Electrical log with anode-to-earth resistances.
6. System check-out report.
7. Record drawings shall be submitted to and approved before the Work is considered complete.
8. An owner's manual is required and will be submitted for and impressed current system only. It will include the following:
    a. Operations and maintenance instructions.
    b. List of spare parts recommended for 2 years of successful operation.

540.4 Quality Assurance

A. Installation of the cathodic protection system shall be performed by individuals having a minimum of 5 years of experience in the installation of cathodic protection equipment described in this Section.

B. All well drilling shall be performed by a state licensed well drilling contractor.

C. All deep well installations shall be installed in accordance with the State deep well standards and the applicable sections on wells from Local regulations.

D. All testing required shall be performed by a NACE Level 2 CP Technician (or higher) under the direct supervision of a NACE Level 4 Cathodic Protection Specialist.

540.5 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. ASTM International (ASTM):

ASTM A518	Standard Specification for Corrosion-Resistant High-Silicon Iron Castings

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B80	Magnesium-Alloy Sand Castings
ASTM B348	Titanium Substrate Grade I/II
ASTM B418	Cast and Wrought Galvanic Zinc Anodes
ASTM B843	Magnesium-Alloy Anodes for Cathodic Protection
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2220	Standard Specification for Polyvinyl Chloride (PVC) Insulation for Cable and Wire

B. Association for Materials Protection and Performance (AMPP):

NACE SP0109	Application of Tape Coatings for External Corrosion Protection of Buried Metal Pipelines
NACE SP0169	Standard Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE SP0200	Steel Cased Pipeline Practices
NACE SP0286	Electrical Insulation of Cathodically Protected Pipelines
NACE SP0375	Field-Applied Underground Wax Coating Systems for Underground Metallic Pipes
NACE SP0572	Design Installation Operation and Maintenance of Impressed Current Deep Anode Beds
NACE TM0497	Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

C. National Electrical Manufactures Association (NEMA):

NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA TC2	Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC3	PVC Fittings for Use with Rigid PVC Conduit and Tubing

D. National Fire Protection Association (NFPA):

NFPA 70	National Electrical Code (NEC)

E. Underwriter Laboratories (UL) Standards:

UL 6	Rigid Metal Conduits
UL 514B	Fittings for Cable and Conduit

F. Whenever the Drawings or the Specifications require a higher degree of workmanship or higher quality material than indicated in the standards, the Drawings and Specifications shall prevail.

540.6 Permits and Job Access

A. Prior to the start of construction, the Contractor shall apply to the required authorities for permits required for installation of the cathodic protection system.

B. The Contractor shall contact Underground Service Alert prior to commencing construction to locate existing utilities in the area of construction. Existing utilities include, but are not limited to, water lines, gas lines, telephone, streetlights, sewer and storm drains and overhead and underground electric utilities.

C. The Contractor shall be responsible for reviewing the rectifier locations to determine if there are any conflicts with obtaining power from the indicated locations. The Contractor shall report any conflicts to the Engineer prior to proceeding with the Work.

D. The Contractor shall submit an application to the local power company for AC power to the new rectifiers. Contractor shall be responsible for all fees and expenses associated with providing power to the rectifiers.

E. Traffic control shall satisfy the requirements of the governing locality.

540.7 Interference and Exact Locations

A. The locations of cathodic protection equipment, test stations, devices, outlets and appurtenances as indicated are approximate only. Exact locations shall be determined by the Contractor in the field subject to the approval of the Engineer.

B. The Contractor shall field verify all data and final locations of Work done under other Sections of the Specifications required for placing of the electrical Work.

C. In case of interference with other Work or erroneous locations with respect to equipment or structures, the Contractor shall furnish all labor and materials necessary to complete the Work in an acceptable manner.

540.8 Delivery, Storage, and Handling

A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or other appropriate methods.

540.9 Materials

Rectifiers

A. Rectifiers shall be air cooled, single or three phase AC input and DC output rectifiers as manufactured by Universal Rectifiers, Inc., Corrpower Rectifiers, Inc., or approved equivalent. DC output is to be calculated and called out on the Drawings.

B. Rectifiers shall be designed to operate continuously at an ambient temperature of 50 C without damage to the rectifier components.

C. Rectifiers shall be capable of operating continuously at the rated output current at any voltage from zero to 100 percent without damaging any rectifier components. Full rated DC output voltage shall be adjustable by not less than 25 equal steps from approximately 4 percent of rated voltage to full rated output voltage. This adjustment shall be accomplished with silver plated or stainless-steel connectors and adjustment link bars.

D. Transformer shall have separate primary and secondary insulated copper windings that meet NEMA and UL requirements.

E. Rectifier stack (rectifying elements) shall be a full-wave bridge high current density selenium cell or silicon diode stack with efficiency filter, metal oxide thyristors, and current-limiting devices for overvoltage and overcurrent protection of stack. Ratings shall be within the manufacture's recommended current rating for continuous operation at with a 50 C ambient temperature.

F. Rectifiers shall have overload and lightning protection for both AC and DC circuits.

G. Rectifiers will be equipped with a voltmeter and ammeter (digital or analog). Voltmeter and ammeter shall be calibrated and adjusted at the factory and will be delivered with the calibration certification.

H. Rectifier cabinet shall be a NEMA 250 Type 3R enclosure.

I. Rectifier cabinet shall have a single door with a full-length hinge and lockage hatch.

J. Rectifier cabinet shall be constructed of 10-gauge steel and coated with a baked enamel finish.

K. Rectifier and cabinet shall both be equipped with a permanent identification tag affixed. The tags will list the manufacturer, model number, AC and DC voltage and amperage, serial number, manufacture date and manufacturer name.

L. The following electrical tests will be performed by the manufacturer:

1. AC Voltage Input.
2. DC Amperes Input.
3. Apparent Watt Input.
4. True Watts Input.
5. Power Factor.
6. DC Voltage Output.
7. DC Amperes Output.
8. DC Watts Output.
9. Conversion Efficiency.
10. Dielectric Strength.
11. Transformer Primary to Ground.
12. Transformer Primary to Secondary.
13. Stack AC to Ground.

14. Stack DC to Ground.
15. Ripple Voltage at Full Output.

M. The following shall be provided for each rectifier in a waterproof bag or container:
   1. Operations and Maintenance Manual.
   2. Circuit Diagram.
   3. Electrical Test Report.

AC Power Service

A. All AC power components must meet local power company requirements.
B. Meter base to be 120/240-volt, single-phase, 20-ampere.
C. Provide fused disconnect switch in NEMA 1 enclosure. Mount in cathodic protection cabinet with rectifier.
D. Ground rod must conform to the requirements of the utility company having jurisdiction.
E. Ground wire to be bare, No. 6 AWG solid copper wire. Use a bronze, bolt-on ground rod clamp.

High Silicon Cast Iron Anodes

A. Cast iron anodes shall be corrosion resistant high silicon iron castings in accordance with ASTM A518, Grade 3.
B. High silicon cast iron anodes shall be tubular type anodes with a minimum wall thickness of 13/32 of an inch, length of 84 inches, and shall be furnished with the wire attached to the interior of the anode and sealed using manufacturer's standard connection.
C. Anode shall have a 2.65 inch outside diameter, minimum weight of 63 pounds (TA-3) and minimum surface area of 4.9 square feet.
D. The wire attached to the anodes shall be stranded copper wire and insulated for 600 volts. Wire size shall be minimum AWG No. 8. Wire insulation shall be a dual extrusion type. The outer insulation jacket shall be HMWPE and the inner insulation shall be fluorinated polymer. The wire shall be Halar cathodic protection wire or equivalent and shall conform to the requirements of ASTM D1248 Type 1, Class C, Grade 5. Anode wire connection shall have a pulling strength exceeding the wire's tensile strength. Any damage to the wire insulation or anode prior to installation shall require a complete replacement of the wire and anode.
E. The resistance of each anode wire connection shall not exceed 0.004 ohms. Each anode wire connection should be tested for conformance with the Specifications. A record of tests shall be submitted to the Engineer. The records shall include the following information:
   1. Anode numbering system to identify anode under test.
   2. Anode wire length.
   3. Resistance value as indicated by test.
   4. Test equipment.
   5. Test method.
F. Anodes shall be individually labeled with the length of lead wire and anode number. Anodes shall be consecutively numbered with the deepest anode being Number 1.

G. Anode wires shall be one continuous length without splices from the anode connection to the junction box. Anode wires with the attached anodes shall be shipped to the Site with the wire coiled and secure. The minimum coil diameter shall be 6 inches. The anode wire insulation shall be free of surface damages such as nicks, abrasions, scratches, etc., in all respects throughout the entire length of the wire. Precaution shall be taken during fabrication, transportation and installation of the anodes to see that the wire is not kinked or sharply bent.

Mixed Metal Oxide Anodes

A. Anodes shall be 1 inch in outside diameter and a minimum 40 inches in length, mixed metal oxide coated tubes as manufactured by De Nora.

B. Steel canisters (if used) for the anodes shall measure a minimum 3 inches in diameter by 60 inches in length and shall be constructed of thin wall galvanized steel conduit. The ends of the canister shall be sealed with epoxy resin. The anode shall be centered in the canister and the canister filled with calcined petroleum coke breeze. The canister shall be vibrated during filling to ensure the coke breeze is compacted around the anode and the canister is completely filled.

C. Anode wire connection shall have a pulling strength exceeding the wire's tensile strength. Any damage to the wire insulation or anode shall require complete replacement of the wire and anode.

D. The wire attached to the anodes shall be stranded copper wire and insulated for 600 volts. Wire size shall be minimum AWG No. 8. Wire insulation shall be a dual extrusion type. The inner insulation jacket shall be chlorine resistant 20-mil thick chlorofluorethylene (E-CTFE) primary insulation with an outer jacket of 80-mil thick HMWPE. The wire's insulation shall be rated at 600 volts.

E. Anode shall be furnished with a cable attached to the center of the anode using a mechanical wedge connection. The connection shall be sealed by filling the tube with epoxy and the ends of the anode shall then be covered with heat shrink tubing for a watertight seal. The pulling strength of the connection shall exceed the tensile strength of the wire.

F. Anode wires shall be one continuous length without splices from the anode connection to the junction box. Anode wires with the attached anodes shall be shipped to the Site with the wire coiled and secure. The minimum coil diameter shall be 6-inches. The anode wire insulation shall be free of surface damages such as nicks, abrasions, scratches, etc., in all respects throughout the entire length of the wire. Precaution shall be taken during fabrication, transportation and installation of the anodes to see that the wire is not kinked or sharply bent.

Anode Groundbed Casing

A. Solid, Schedule 80, ASTM D1785 PVC casing above anode column. Length and diameter found on the Drawings.

B. Slotted PVC Casing for Anode Column (only if necessary to install deep anode system): Perforated casing for active anode area of deep anode, fabricated of Schedule 40 PVC following ASTM D1785.

   1. Casing:

      a. Diameter: 10 inches nominal.

      b. Length: 20-foot sections, to make up total length of active anode column.

c. Slots: 224 slots per 20-foot length (each slot 0.75 inches, min. wide x 5.5 inches long), to permit normal current output of at least 0.35 ampere/linear foot in 10-inch diameter well.

d. Metallic membrane: 26-gauge sheet metal membrane covering exterior of perforated pipe.

e. Manufacturers: Loresco International or equal.

Calcined Coke Breeze

A. Backfill material for impressed current anodes shall be calcined coke breeze with a resistivity of 25 ohm cm or less when tested with an applied pressure of 2 psi and a bulk density of 64 to 72 pounds per cubic foot. The backfill material shall have a particle size of 200 to 20 mesh.

B. The calcined coke breeze backfill shall have the following chemical properties:

1. Fixed Carbon: 98 percent minimum.
2. Ash: 0.5 percent maximum.
3. Sulfur: 5.8 percent maximum.
4. Volatile Matter: 1 percent maximum.
5. Moisture: 1 percent maximum.

C. Coke breeze backfill shall be Loresco SC-2, Asbury 251 or approved equivalent.

Anode Vent Piping

A. Plastic conduit for the impressed current anode vent piping shall be 2-inch diameter PVC, Schedule 80, conforming to ASTM D1785, Type 1 Grade 1, NEMA TC2 for conduit and TC3 for fittings.

Anode Centralizers

A. Steel centering device: Capable of maintaining each anode in concentric position within the hole.

B. Approved Manufacturers: Ventralizer Model as manufactured by Elgard Corporation or equal.

Galvanic Anodes

A. High Potential Magnesium anodes shall be cast magnesium anodes in accordance with ASTM B843 Type M1C.

1. Ingot Weight: 17 pounds, Packaged Length: 29 to 30 inches.
2. Ingot Weight: 20 pounds, Packaged Length: 62.5 to 66 inches.
3. Ingot Weight: 32 pounds, Packaged Length: 28 to 30 inches.
4. Ingot Weight: 40 pounds, Packaged Length: 64 to 66 inches.
5. Ingot Weight: 48 pounds, Packaged Length: 34 to 38 inches.
6. Ingot Weight: 60 pounds, Packaged Length: 64 inches.
7. Chemical composition as percent of weight shall be as follows:
   a. Aluminum: 0.01 maximum.
   b. Manganese: 0.50 to 1.3.
   c. Copper: 0.02 maximum.

d. Nickel: 0.001 maximum.
e. Iron: 0.03 maximum.
f. Other Impurities: 0.05 percent each; 0.3 percent maximum total.
g. Magnesium: Remainder.

B. H 1 Alloy Magnesium anodes shall be H 1 Alloy, Grade B cast magnesium anodes, in accordance with ASTM B80.
1. Ingot Weight: 17 pounds, Packaged Length: 17 inches.
2. Ingot Weight: 17 pounds, Packaged Length: 29 inches.
3. Ingot Weight: 20 pounds, Packaged Length: 62 inches.
4. Ingot Weight: 32 pounds, Packaged Length: 28 to 30 inches.
5. Ingot Weight: 48 pounds, Packaged Length: 38 inches.
6. Ingot Weight: 50 pounds, Packaged Length: 110 inches.
7. Ingot Weight: 60 pounds, Packaged Length: 64 inches.
8. Chemical composition as percent of weight shall be as follows:
a. Aluminum: 5.3 to 6.7.
b. Manganese: 0.15 to 1.3.
c. Zinc: 2.5 to 3.5.
d. Silicon: 0.30 maximum.
e. Copper: 0.05 maximum.
f. Nickel: 0.003 maximum.
g. Iron: 0.003 maximum.
h. Other Impurities: 0.05 percent each; 0.3 percent maximum total.
i. Magnesium: Remainder.

C. Zinc anodes shall be “High Purity” cast zinc anodes in accordance with ASTM B418, Type II.
1. Ingot Weight: 30 pounds, Packaged Length: 36 inches.
2. Ingot Weight: 30 pounds, Packaged Length: 66 inches.
3. Ingot Weight: 45 pounds, Packaged Length: 51 inches.
4. Ingot Weight: 60 pounds, Packaged Length: 60 inches.
5. Chemical composition as percent of weight shall be as follows:
a. Aluminum: 0.005 maximum.
b. Cadmium: 0.003 maximum.
c. Iron: 0.0014 maximum.
d. Zinc: Remainder.

D. Ribbon anodes shall be 5/8-inch by 5/8-inch zinc ribbon anodes, 1.2 pounds per foot, with a 0.135-inch diameter steel wire core as manufactured by Plattline. Zinc Anode shall meet ASTM B418-88 Type II.

E. Galvanic anodes shall be prepackaged in a cloth bag containing backfill of the following composition; 75 percent gypsum, 20 percent bentonite and 5 percent sodium sulfate. The anodes shall be of the size indicated and placed where indicated.

F. The wire attached to the anodes shall be (AWG) stranded, single conductor, copper and insulated for 600 volts. Wire size shall be minimum No. 10 AWG THHN and shall conform to the requirements of ASTM D1248, D2220 and NEMA WC70. Connection of wire to the anode shall have a pulling strength that exceeds the wire's tensile strength.

G. Anode wires shall be of one continuous length without splices from the anode connection to the test station.

Permanent Reference Electrode

A. Provide a copper/copper sulfate, double membrane, ceramic cell in a geomembrane package, such as a Permacell Plus or approved equal. Equip with No. 14 AWG stranded copper wire with blue HMWPE insulation of suitable length to extend from the pipeline to the rectifier without splicing.

Anode Junction and Test Station Panel Boards

A. Panel boards shall be made of 1/4 inch thick phenolic plastic sized as indicated on the Drawings.
B. Connection hardware shall be brass or bronze. All connections shall be double nutted bolts with lock washers.
C. Copper bus bar shall be 1/8 inch thick and sized to fit. The copper bus bar shall be per ASTM B187, 98 percent conductivity.

Concrete Traffic Valve Boxes

A. Traffic valve boxes shall be rated to withstand AASHTO H-20 traffic loading. The traffic valve boxes shall be G5 Utility Boxes as manufactured by Christy Concrete Products, Inc., No. 3RT Utility Box as manufactured by Brooks Products or approved equivalent. Traffic box covers for test stations shall be cast iron with welded bead legend and labeled "CP TEST" or "ANODE" as required.

Junction Boxes

A. Junction boxes shall be NEMA 250, Type 4, fiberglass construction. Junction boxes shall be sized as indicated on the Drawings. Hinges shall be stainless steel and a neoprene gasket shall be furnished with the box to ensure a watertight seal. Junction boxes shall have a latch with a 1/4 inch diameter hole for installation of a pad-lock.

Solderless Lug Connectors

A. Solderless lug connector shall be made of brass or copper with a brass screw. The lug shall be designed for direct burial and shall be appropriately sized for the connection wire. The lug shall be ILSCO Type XT 6DB or approved equivalent

Shunts for Impressed Current Anodes

A. Shunts for impressed anodes for the impressed current anode systems shall be 0.001-ohm and 25-ampere capacity. Shunts shall be Type SS as manufactured by Holloway or equivalent.

Shunts for Galvanic Anodes

A. Shunts shall be 0.01-ohm, 6-ampere, manganin wire type, or as indicated on the Drawings. Shunts shall be Type RS as manufactured by Holloway or equivalent.

Post Mounted Test Stations

A. Weatherproof Enclosure: Cast aluminum, galvanized steel, or high impact plastic, Lexan, Gyrlyn or equal.
B. Terminal Block: Phenolic resin, plastic, micarta, Lexan, or Bakelite high dielectric material, with eight terminals unless otherwise shown on the Drawings.
C. Terminals: Nickel plated brass 1/4-inch threaded studs, nuts, and washers.

Ready-Mix Concrete

A. Ready-mixed concrete shall be in accordance with ASTM C94.

Conduit and Fittings

A. The minimum conduit size shall be 1 inch unless otherwise indicated. Refer to NFPA 70 (NEC) for additional conduit size requirements.
B. Conduit and fittings placed below grade shall be PVC, Schedule 80.
C. Conduit and fittings placed above grade shall be rigid steel. Rigid Steel conduit shall be galvanized conforming to UL 6.
D. Conduit Straps shall be a two-hole galvanized steel conduit strap.
E. Fittings for use with rigid steel conduit shall be galvanized cast ferrous metal, with gasketed covers, Crouse Hinds Condulets, Appleton Unilets, or equivalent. Rigid metallic conduit fittings shall be galvanized conforming to NEMA FB 1, UL 514B listed.
F. Union couplings for conduits shall be the Erickson or Appleton type EC or O-Z/Gedney three-piece Series 4, or equivalent.

Dielectric Insulating Flange Kits

A. Insulating flange gaskets shall include full faced gaskets, insulating sleeves and washers and steel bolts, nuts and washers. The complete assembly shall have a pressure rating equal to or greater than the flanges between which it is installed. Insulating Gasket shall be neoprene faced phenolic, 1/8 inch thick. Insulating sleeves shall be Mylar, 1/32 inch thick. Insulating washers shall be two sets of 1/8 inch thick phenolic. Sleeves, gaskets and insulating washers shall have a dielectric constant of 300 volts per mil, minimum. Steel washers shall fit well within the bolt facing on the flange. Insulating washers shall fit within the bolt facing the flange over the outside diameter of the sleeve.

Monolithic Insulating Joints

A. Monolithic insulating joints shall be designed to provide for the permanent electrical isolation of piping sections. They shall be completely factory assembled and designed to be welded into the piping section.

Petrolatum Tape

A. Petrolatum tape system shall be Trenton Primer and #1 Wax-tape, as manufactured by Trenton Corp., or Denso Paste and Densyl Tape by Denso North America, Inc., or approved equivalent.

Utility Warning and Identification Tape

A. The warning and identification tape shall be an inert plastic film designed for prolonged underground use. The tape shall be a minimum of 3 inches wide and a minimum of 4 mils thick. The tape shall be continuously printed over the entire length with the wording "CAUTION: CATHODIC PROTECTION CABLE BURIED BELOW". The wording shall be printed using bold black letters. The color of the tape shall be red.

Wire and Cable

A. Direct-Burial Cable: Single-conductor Type HMWPE, insulated cable specifically designed for DC service in cathodic protection installations.
   1. Conductor: Stranded, annealed, uncoated copper, complying with ASTM B3 and B8.
   2. Insulation: High-molecular-weight polyethylene, complying with NEMA WC 70.
   3. Minimum Average Thickness of Insulation: 110 mils (2.8 mm) for No. 8 through 2 AWG, and 125 mils (3.2 mm) for No. 1 through 4/0 AWG; rated at 600 volts.
   4. Connectors: Copper compression type or exothermic welds.

B. Negative cables shall be size #4 AWG, single conductor, seven-strand, copper with medium density, HMW/PE insulation for the rectifier negative cables. The polyethylene to conform to ASTM D1248, Type I, Class C, Grade 5.

C. Test leads shall be No. 12 AWG, solid copper wire with white, TW or THW insulation and of sufficient length to extend from the protected structure to the rectifier without splicing.

D. Cables for Installation in Conduit: Type THWN copper conductors as specified on the Drawings.

E. Joint Bonds:
   1. General: Single-conductor, stranded copper wire with 600-volt HMWPE insulation. Supply joint bonds complete with formed copper sleeve on each end of wire. Bond cable gauge shall be based on the diameter and thickness of the pipe cylinder. Two bond cables shall be used for each non-welded, non-insulating pipe joint.
   2. Push-On, Mechanical, or Flanged Joints: 18 inches long, minimum.
   3. Flexible Coupling Joints: 24 inches long, with two 12-inch long THHN insulated No. 10 AWG wire pigtails, as manufactured by Erico Products Inc. (Cadweld), Cleveland, OH.

F. Concrete Cylinder Pipe: A minimum of two pipe bonding jumpers for each joint. Bond jumpers shall use 12-inch long stranded copper cable with the steel rods welded to the ends of the wire.

Exothermic Welds

A. Exothermic Weld Molds, Weld Powder and Weld Metal Cartridges: Use proper mold and proper size and amounts for wire size, pipe size, pipe material, and weld position. Utilize adapter sleeves as recommended by exothermic weld manufacturer.

B. Approved Manufacturers:

1. Exothermic weld material:

   a. ERICO International – CADWELD products.

   b. Continental Industries – thermOweld products.

   c. Or approved equal.

1. Weld powder: As recommended by each exothermic weld manufacturer for specific wire size and pipe material.

2. Exothermic Weld Caps:

   a. Royston Handy Cap – use Royston Roybond 747 primer.

   b. Royston Handy Cap IP – no primer needed (has integrated primer).

   c. Ci thermOcap – use thermOprimer primer.

   d. Ci thermOcap PC – no primer needed (pre primed cap).

Cable-to-Pipe Coating Materials

A. Coating material for exothermic weld connections to the pipelines shall be two part ProPoxy 20 epoxy putty manufactured by the Hercules Chemical Company, or approved equivalent. The epoxy putty shall be non-conductive and have compression strength of 18,000 psi when cured.

540.10 Construction Methods

Storage of Materials

A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or other method as appropriate.

Rectifier Installation

A. Approximate locations of rectifiers and associated equipment are shown on the Drawings. Rectifier installation includes provision of AC power to the rectifier by the Contractor. The Contractor shall furnish and install all required wiring, conduits, cables, meters, splice boxes, and equipment as necessary for operation of the rectifier and as required by the local power agency.

B. The Contractor may propose an alternative rectifier location to the Owner for review and approval. The reinforced concrete pad shall be constructed such that water will not collect against the rectifier cabinet. The vent pipe riser shall be cast into the concrete pad.

C. The installation is not considered complete until the AC and DC wiring is installed and the rectifier is capable of operating at full rated load. Install AC power such that the rectifier can be activated for test purposes.

Impressed Current Anode Installation

A. Impressed current anode beds shall be installed in accordance with NACE SP0572, state and local well standards, and the Specifications.

B. Well Drilling:

1. The Contractor shall obtain and pay for all fees and permits required for well drilling.
2. Fresh water shall be circulated from the bottom of the hole to clear the well of drilling mud and cuttings after the well is drilled.
3. The Contractor shall protect the well bore from the intrusion of contaminants into the hole at all times. The Contractor is responsible for the cost of all clean up associated with contamination of the well and/or Site resulting from the Contractor's Work.
4. The well shall be covered with a steel trench plate or other heavy device that blocks access and that cannot be removed by hand whenever the well is left unattended.
5. Loading of anodes and other equipment in the well shall be done in the presence of the Owner's representative. A minimum of 48 hours' notice shall be given by the Contractor to the Owner prior to loading anodes. Loading of the anodes into the well shall begin early enough in the day to ensure completion of all loading, including backfilling, during regular working hours.

C. Well Casing: The Contractor may elect to install the well with or without a casing. If the well collapses, for any reason, including the elimination of the casing, the well shall be relocated, redrilled and the original hole abandoned at the Contractor's expense. Only a metallic casing may be used in the coke breeze column.

D. Vent Pipe: Install the vent pipe in the hole with the first anode. Cap the bottom of the vent pipe. Cap the top of the vent pipe throughout the anode and coke breeze backfill installation procedure to prevent intrusion of foreign material. Do not allow drilling mud to enter in the vent pipe.

E. Anodes:

1. The Engineer shall visually inspect the insulation on the anode lead wire for abrasion or other damage to the insulation and wire as the anode is lowered into place. Anodes with damaged insulation or wire are not acceptable and shall not be installed. Splices are not allowed on the anode wire.
2. Record an electric log of the hole using one of the anodes. Previously mark the anode lead wire in 5-foot increments. Mark the anode lead wire for a distance equaling or exceeding the maximum anticipated depth of the hole. As the anode is lowered into the hole, perform a resistance log by impressing a minimum 12-VDC current between the anode and a very well-grounded structure such as the local AC power neutral network. Do not use Nilsson type soil resistance meters to perform this test. A recommended 12-VDC power source is a heavy duty lead acid automobile battery. Lower the anode into the hole at ten foot increments, hold in place, and measure the voltage and current output of the DC current source.
3. Attach the centering devices to the anodes using the adjustable stainless steel bands. The terminal end of the anode cables shall be identified with permanent cable markers.

Anode No. 1 shall be attached to the bottom section of the anode vent pipe with adjustable stainless steel bands and lowered into the hole. A digital soil resistance meter, furnished and operated by the Engineer, shall be connected between the anode cable for Anode No. 1 and the drain cable. The drain cable must be installed and be accessible to the Engineer during time of testing. The Contractor shall stop lowering the anode at 10-foot intervals to tape the anode lead to the vent pipe and to allow the Engineer to measure the resistance profile of the anode well. This shall continue to the bottom of the hole and the vent pipe shall be secured in place.

4. Continuing with Anode No. 2, with centralizers attached, the anodes shall be lowered into the hole supported by the attached lead wires. The Contractor shall fabricate an apparatus that allows the anodes to be lowered by the lead wire but does not bend the wire into a radius less than 2.5 inches. All sharp edges on the centering device assembly shall be taped with vinyl electrical tape to preclude damaging any wires while lowering anodes into place. The vent pipe shall not be attached to Anodes No. 2 to No. 10. The Engineer may adjust the depths of the individual anodes to avoid high resistance soil layers. When an anode has been placed at the final depth it shall be securely fixed in that position prior to coke breeze backfill. Anodes shall not be backfilled until the Engineer has inspected the placement of the anodes and given permission to backfill.

F. Coke Breeze Backfill:

1. Slurry the coke backfill above-grade and then pump into the hole after the anodes are installed. Pump the coke from the bottom of the hole up using a pipe that is the length of the anode hole. Do not use the vent pipe to pump the coke. Raise the pipe as the anode column is filled with coke. Remove the pipe from the hole after the coke installation operation is completed. Use a enough backfill so that the coke breeze column extends a minimum of 5 feet above the top of the uppermost anode. Install the coke backfill uniformly with no voids around the anodes.
2. Take all necessary precautions to avoid entrance of foreign matter into the hole, movement of soil strata, or collapsing of the hole during the progress of the Work. Should movement of soil strata or collapse of the drilled hole interfere with proper completion of the anode groundbed, recover the wires, anodes and vent pipe and ream or redrill the hole at no cost to the Owner.

G. Well Seal:

1. Backfilling operations above the coke breeze column shall begin no sooner than 24 hours after installation of the coke breeze to allow for settling. Backfilling shall be done continuously, without interruption, until the hole is sealed.
2. Collapse of the hole prior to the introduction of the seal material shall be cause for abandonment of the well at the Contractor's expense.
3. If well casing materials are used in the construction of the well, then the annular space between the well bore and the casing shall also be sealed with a conductive grout.
4. Sealing material shall not enter the vent pipe.
5. The Contractor shall record the volume of sealing material installed in the hole.

Wire and Cable Installation

A. Install all underground wires and cables at a minimum of 36 inches below final grade with a minimum separation of 6 inches from other underground structures.

B. Buried wires shall be laid straight without kinks. Each wire run shall be continuous in length and free of joints or splices, unless otherwise indicated. Care shall be taken during installation to avoid punctures, cuts or other damage to the wire insulation. Damage to insulation shall require replacement of the entire length of wire at the Contractor's expense.

C. Enclose all positive and negative cables, and anode lead wires in rigid galvanized steel conduit when above-grade.

Anode Junction Panel Installation

A. Install anode lead panel inside the cathodic protection cabinet, immediately adjacent to the rectifier with the bottom of the panel at a minimum height of 1 foot above grade.

Negative Cable and Test Lead Attachment

A. Install wires, without splices, as shown on the Drawings.

B. Attach negative cables and test leads to the pipe (for the dielectrically coated steel and ductile iron pipe options) or to the "L" bracket (for the concrete cylinder pipe option) by thermite welding.

C. Clean and dry the pipe to which the negative cables and test lead are to be attached.

D. Use a grinding wheel to remove all coating, mill scale, oxide, grease, and dirt from the pipe over an area approximately 3 inches square. Clean the surface to bright metal.

E. Remove approximately 1 inch of insulation from each end of the wires to be thermite welded to the pipe, exposing clean, oxide-free copper for welding.

F. Using the proper size thermite weld mold as recommended by the manufacturer.

G. If the weld is secure, coat all bare metal and weld metal with Kop-Coat. Cover the coated weld with a plastic weld cap.

Permanent Reference Cell

A. When not shown on the Drawings, locate the permanent reference cell near the negative structure connection.

B. Remove the permanent reference cell from the shipping package and place below the 1 foot away from the pipeline. Make certain that the reference electrode is completely surrounded by the special backfill material in the geomembrane package.

C. Run continuous lengths of the blue reference cell wiring, and the white test lead to the rectifier unit in the same trench as the negative cable. Do not nick or otherwise damage the wire insulation.

Galvanic Anode Installation

A. Install prepackaged anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable, permanent container housing the anode metal. Do not use anode connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in 6-inch layers; compact each layer using hand tools. Do not strike anode or connecting wire during compacting. After backfilling and compacting to within 6 inches of finished grade, pour approximately 5 to 10 gallons of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

B. Use clean fill, free from tree roots, wood scraps, vegetable matter, and refuse. Place cable warning tape within 18 inches of finished grade, above cable and conduit.

C. If rock strata is encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

D. Install anodes spaced as indicated, to the pipeline, allowing adequate slack in connecting wire to compensate for movement during backfill operation.

E. At least 18 inches of slack (coiled) shall be left for each wire at each flush-to-grade test station. Wire slack shall be sufficient to allow removal of wire extension for testing. Wire shall not be bent into a radius of less than 2 inches.

Test Station Installation

A. Test stations are to be located as indicated on the Drawings.

B. Test stations are to be placed directly over the pipe except in areas that would place the test station in a roadway.

C. If test stations cannot be placed as indicated on the Drawings, they are to be placed just off the edge of the road or curb.

D. Identify the test station with the number associated with it on the Drawings.

   1. Paint the number legibly inside the test box lid or cover.

   2. Use a permanent or weatherproof paint for metal or plastic surfaces.

E. The Contractor shall provide global positioning system (GPS) coordinates of each test station location with a minimum accuracy of 1 meter or 3 feet. The Contractor shall submit the GPS coordinates of the test stations to the Owner after installation.

F. Flush mounted test stations shall be installed with a 4 inch diameter, Schedule 40 PVC pipe as shown on the Drawings. The PVC pipe shall be 24 inches long and extend 4 inches above the bottom of the test box as shown on the Drawings. PVC pipe shall be filled with native soil.

Exothermic Weld Connection

A. Exothermic weld connections shall be installed in the manner and at the locations indicated. Coating materials shall be removed from the surface over an area of sufficient size to make the connection. The surface shall be cleaned to bare metal by grinding or filing prior to welding the conductor. The use of resin impregnated grinding wheels will not be allowed. A copper sleeve shall be fitted over the conductor. Only enough insulation shall be removed such that the copper conductor can be placed in the welding mold.

B. After the weld has cooled, all slag shall be removed and the metallurgical bond shall be tested for adherence by the Contractor. A 22 ounce hammer shall be used for adherence testing by striking a blow to the weld. Care shall be taken to avoid hitting the wires. All defective welds shall be removed and replaced.

C. After backfilling pipe, all test lead pairs shall be tested for broken welds using a standard ohmmeter. The resistance shall not exceed 150 percent of the theoretical wire resistance as determined from published wire data.

D. The Contractor shall inspect both the interior and exterior of the pipe to confirm that all coatings and linings removed or damaged as a result of the welding have been repaired. The Contractor shall furnish all materials, clean surfaces and repair protective coatings and linings

damaged as a result of the welding. Repair of any coating or lining damaged during welding shall be performed in accordance with coating or lining manufacturer's recommendations.

E. All exposed surfaces of the copper and steel shall be covered with insulating materials as indicated.

F. For dielectrically coated pipes, a bitumastic coating shall be applied to all exothermic weld locations. The coating shall be covered with a plastic weld cap. All surfaces must be clean, dry and free of oil, dirt, loose particles, and all other foreign materials prior to application of the coating.

G. For dielectrically coated pipes, a bitumastic coating shall be applied to all exothermic weld locations. The coating shall be covered with a plastic weld cap. All surfaces must be clean, dry and free of oil, dirt, loose particles, and all other foreign materials prior to application of the coating.

H. The Contractor shall be responsible for testing all test lead and bond wire welds. The Owner, at their discretion, shall witness these tests.

Pipe Joints

A. Bond wires shall be provided across flexible couplings and all nonwelded joints, as necessary to ensure electrical continuity, except where insulating joints have been installed to provide electrical isolation. Joint bonds shall be of the size and number shown on the Drawings and installed as indicated. The bond wires shall be at least 18 inches long and shall be installed to allow for movement of at least 2 inches in the pipe joint. The wire shall be attached by exothermic welding. At least two bonds shall be provided between all discontinuous joints.

B. For ductile iron pipe, the Contractor may, at his or her own expense, provide weld plates, installed by the pipe manufacturer, at the spigot end of the pipe. Provision of the weld plates does not relieve the Contractor from responsibility for repair of damage to the coating or lining as a result of exothermic welding of the pipe. Coating repairs shall be performed in accordance with coating manufacturer's recommendations.

Insulating Flanges

A. Install at locations indicated on the Drawings.

B. Test each insulating flange for electrical isolation prior to backfill. Provide the Owner a minimum of 1 week notice prior to testing.

   1. If flange is not properly isolated, repair or replace all defective components at no additional cost to the Owner.

   2. Test the repaired isolation flange.

   3. Continue this process until the isolation flange is tested to be properly isolated.

Casing Insulators

A. Casing insulators shall be installed as indicated on the Drawings to effectively isolate the pipeline from the casing. The Contractor shall test the performance of the casing insulators before and after backfill.

B. After backfill, testing shall be performed by measurement of native pipe to soil potentials on the pipeline and the casing at both ends of the casing. If the difference in native pipe to soil potentials is greater than 50 mV, the casing shall be considered isolated from the pipeline. If the difference in native pipe to soil potentials between pipe and casing is less than 50 mV, then additional testing shall be performed as follows. Temporary cathodic protection current

shall be applied to the pipeline. “On” and “Instant Off” pipe to soil potentials shall be measured on the pipeline and the casing at both ends of the casing. If the “Instant Off” potential of the casing is more negative than the native potential of the casing, the pipe is not isolated from the casing and shall be repaired and retested at the Contractor’s expense.

Petrolatum Tape System Application

A. Petrolatum tape system shall be applied on insulating joints and as indicated on the Drawings. Petrolatum tape system shall be applied in accordance with NACE SP0375, and the Specifications. The materials shall be applied according to the manufacturer’s recommendations.

B. All loose scale shall be removed from the surface to be coated with hand tools (wire brush, scraper, rags). Debris and moisture shall be wiped from surface with clean rag. Petrolatum tape shall be applied immediately after applying the primer, using a 1-inch overlap. A spiral wrap shall be used and a slight tension shall be applied to ensure that there are no air pockets or voids. After applying the tape, the applicator shall firmly press and smooth out all lap seams and crevice areas. The tape shall be in tight intimate contact with all surfaces.

Remote Monitoring Units

A. Install at approximate locations shown on the Drawings.

B. Work to be completed by electricians licensed to perform these installations and are to follow local Electrical Code, NEC and NFPA 30.

540.11 Continuity Testing

A. Continuity testing of joint bonds shall be performed by the Contractor’s qualified corrosion technician as defined in this Section after backfill. The electrical continuity test may additionally be performed before backfill at the Contractor’s option.

B. The pipe shall be tested for electrical continuity. Continuity shall be verified using the linear resistance method. The pipe shall be tested in spans that are no less than 250 feet unless the pipe is shorter than 250 feet. Each test span shall have two test leads connected to the pipe at each end. Existing test stations can be used. A direct current shall be applied through the pipe using two of four test leads. The potential across the test span shall be measured using the other two test leads. The current applied and voltage drop shall be recorded for a minimum of three different current levels.

C. The theoretical resistance of the pipe shall be calculated. It shall take into account the pipe wall thickness, material, and joint bonds.

D. Acceptance of the test span; The average measured resistance shall be compared to the theoretical resistance of the pipe and bond wires. If the measured resistance is greater than 125 percent of the theoretical resistance, then the joint bonds shall be considered deficient and shall be repaired and retested at the Contractor’s expense. If the measured resistance is less than 100 percent of the theoretical resistance then the test and/or calculated theoretical resistance shall be considered deficient and the test span shall be retested and/or recalculated at the Contractor’s expense. If the piping forms a loop which allows current to flow both in and out of the test span, then consideration shall be made for current circulating through both the loop and the test span.

540.12 Final System Checkout

A. Prior to native state and polarized potential testing, give a minimum of 48 hours' notice to the Owner's Engineer to facilitate observation of the tests by the Owner representative.

B. Measure native state pipe-to-soil potentials at all test stations, sacrificial anodes, permanent reference cells, electrical isolation devices, and locations of exposed pipe prior to energizing the cathodic protection system.

C. Measure casing-to-soil potentials and foreign line potentials, prior to energizing the cathodic protection system.

D. Verify electrical isolation at all insulating joints, insulating unions, and casing insulators per NACE SP0286.

E. Energize the cathodic protection system by either:

1. Turn on rectifier(s) setting outputs at a minimum of current values determined during design phase. Record rectifier output voltage and current values, along with tap settings, AC and DC ratings and adjust the DC current output such that the pipe-to-soil potentials at the nearest test station is approximately -1000 mV to a copper sulfate electrode (CSE).
2. Measure and record current output from each anode at each anode groundbed junction box with rectifiers operating at final output settings.
3. Connect galvanic (sacrificial) anodes as indicated on the Drawings.
    a. Measure and record the initial potential from all test leads.
    b. Measure and record current output from each anode.

F. After initial startup, allow system to operate for minimum period of 2 weeks.

1. For Impressed Current cathodic protection systems:
    a. Install synchronized current interrupters to cycle the power supply "On" and "Off."
    b. Measure and record "On" and "Instant Off" potentials at all test stations, permanent reference cells, electrical isolation devices, locations of exposed pipe, casings, and foreign pipelines. Record interruption cycle (seconds on, seconds off).
    c. If testing described in the above paragraph indicates pipeline is not meeting established cathodic protection criteria, NACE SP0169, output of all rectifiers shall be increased to a level that will achieve full protection without excessive potentials.
    d. Measure and record final rectifier voltage and current outputs.
    e. Measure and record the final current output from each anode at each groundbed junction box.
2. For Galvanic (Sacrificial) cathodic protection systems:
    a. Measure and record "On" and "Instant Off" potentials at all test stations, permanent reference cells, electrical isolation devices, locations of exposed pipe, casings, and foreign pipelines.
    b. Measure and record the final current output from each anode.

G. Test results shall be analyzed to determine compliance with NACE SP0169.

H. Test results shall be analyzed to determine if stray current interference is present. Stray current interference is defined as a +/-50 mV shift in a pipeline's pipe-to-soil potential that is

caused by a foreign current source. Stray current interference shall be tested on the project pipeline and foreign pipelines that have a reasonable chance of being affected by stray currents.

I. Final Report: Prepare a final report after all testing has been completed and system is in compliance with NACE SP0169. Include at minimum the following:

1. Marked-up as-built drawings.
2. All field test data as described in section above.
3. Discussion of the installation.
4. Recommendations for maintenance of the system.
5. Operations and maintenance manual.

540.13 Measurement and Payment

Cathodic protection will be paid for in lump sum. The Contractor shall consider the supply and installation of the cathodic protection to all construction of pipeline projects.

End