

## SECTION 2

### TRENCH AND STRUCTURE EXCAVATION, BACKFILL AND COMPACTION

#### 2.01 GENERAL.

A. Scope. This section covers excavation, trenching, backfilling and grading incidental to the construction of sewers, pipelines and structures shown on the Drawings and described in these Specifications.

B. Contractor's Responsibility. The Contractor shall assume full responsibility for satisfactory performance of the work and for the safety of the work, working personnel and the general public.

Within permanent public right-of-way and easements and within the corporate limits of the City of Topeka, if the trench excavation encroaches upon a street, alley, or sidewalk that has bricks in any part of the pavement structure, including bricks overlain with asphalt, the requirements of Subsection 4.05 BRICK PAVEMENTS shall apply. If the trench excavation encroaches upon pavements not otherwise planned for replacement, the requirements of Subsection 4.06 – PAVEMENT REMOVAL AND REPLACEMENT FOR TRENCHES shall apply.

(1) Permits. All excavation within the City's right-of-way requires a permit from the Development Services Division prior to starting the excavation. No vehicle or machinery may be driven across any curb or sidewalk; or damage, break or cut any curb, gutter or sidewalk except as authorized under a permit. Curb and gutter shall not be bridged or filled with any material to gain access to private property thus obstructing the drainage of the gutter except by written permit.

Refer to Section 1 of these Standard Technical Specifications and Document 700 General Conditions of the Project Manual for further specifications of the Contractor's responsibilities.

#### 2.02 EXCAVATION FOR TRENCHES AND STRUCTURES.

A. General. Unless specifically shown or designated otherwise, all excavation shall be by open cut.

B. Structure Excavation. Structure Excavation is excavation necessary to construct structures. Excavation for structures shall be to lines and grades shown on the Drawings. Extend the excavation for formed structures sufficiently to permit construction and inspection of forms, and for installation of drain tile or other below-grade work. Excavation shall be shored and braced to protect adjacent structures or installations from damage.

The excavation shall be maintained in a condition suitable for placing reinforcing steel and concrete by such dewatering of adjacent and underlying soil as may be required. Dewatering equipment and methods shall be approved by the Engineer. Approved dewatering equipment may be used within the structure provided that any openings in walls or floors shall subsequently be closed watertight, using methods and procedures approved in advance by the Engineer.

Before placing any concrete, excavation shall be inspected and approved by the Engineer.

(1) Measurement and Payment. Structure Excavation shall not be measured or paid for directly, but shall be subsidiary to the structure for which the excavation is performed.

No extra payment will be made for the excavation or removal of rock to provide for the construction of a structure unless “Rock Excavation for Structures” is listed as a pay item on the Bid Form. In which case, the provisions governing rock excavation as set forth in this section shall apply.

C. Trench Excavation. Trench Excavation is the excavation necessary to install sewers, culverts, waterlines, cables, conduit or other underground systems or ducts. Trench excavation shall be to the lines and grades indicated on the Drawings. Banks shall be vertical from bottom of the trench to at least 6 inches above the top of the pipe. Above that point, trench walls may be sloped as required for safety and shall conform to all pertinent OSHA Regulations. Trenches shall be excavated as near as is practical to the widths shown on the applicable Standard Detail sheets of the Drawings. The bottom of the trench shall be undisturbed soil smoothed to the satisfaction of the Engineer by backhoe bucket or hand shovel, or both, prior to placement of bedding material. Over-excavations shall be replaced with bedding material at no additional cost to the Owner. Trenches shall be maintained and dewatered as necessary to permit construction to be carried on in a satisfactory manner. Sheeting and bracing shall be provided in all trenches where required and shall conform to Subsection 2.03.

Trenches within the Corps of Engineers levee critical zone, generally those areas within 500 feet of the Kansas River levee, shall be constructed in compliance with the requirements of the Corps of Engineers.

(1) Bid Item, Measurement and Payment. Trench Excavation shall not be measured or paid for directly, but shall be subsidiary to the sewer, pipeline, or underground system for which the excavation is performed; or, incidental to the item “Trench Excavation and Backfill” when said item, as defined in Subsection 2.10, is included on the Bid Form.

No extra payment will be made for the excavation or removal of rock to construct trenches unless “Rock Excavation for Trenches” is listed as a pay item on the Bid Form. In which case, the provisions governing rock excavation as set forth in this Section shall apply.

D. Rock Excavation for Structures and Trenches.

(1) Rock Excavation for Structures and Trenches is specified in Subsection 3.06.

## 2.03 SHEETING AND BRACING.

A. Construction Requirements. Sheeting and bracing shall be provided in all trenches where required and shall conform to all pertinent OSHA Regulations. Sheeting may be wood or metal. Wherever, because of unstable trench conditions, it is necessary to drive sheeting below the springline of the pipe, it shall be driven to a depth of 2 feet (minimum) below the flowline of the pipe. After the trench has been backfilled up to a level 1 foot above the pipe, sheeting may be removed and the space left because of such removal shall be filled immediately and the backfill re-compacted. Wood sheeting which has been driven to below the springline of the pipe shall be left in place below a level of 1 foot above the top of the pipe.

Trench boxes or shields may be used instead of sheeting and bracing. Excavations shall be braced to prevent subsidence or injury to the adjoining premises. The Contractor shall be liable for all damages arising by reason of neglect or carelessness.

B. Measurement and Payment. Sheeting and bracing shall not be measured or paid for directly but shall be subsidiary to the item for which the sheeting and bracing is required.

#### 2.04 CONTROL OF GROUND WATER AND SURFACE WATER.

A. Construction Requirements. Where ground water or surface water is encountered, trenches shall be dewatered as necessary to permit the construction to be carried on in a satisfactory manner. All waters discharged from the Contractor's dewatering activities shall be appropriately treated to prevent erosion and water pollution. Portions of sewers where all joints have been completed may be used for draining trenches, provided such drainage is free from debris. Drainage may be collected in temporary sumps and then pumped into natural drainage channels as approved by the Engineer. Surface water shall be prevented from entering trenches.

Where approved by the Engineer, and approved in writing by the property owner, existing drainage channels may be temporarily diverted. After completion of the construction, the temporary channels and original channels shall be returned to their original condition unless otherwise approved by the property owner and Engineer. It shall be the Contractor's responsibility to obtain the permission of the property owner, in writing, for the temporary channels.

The Contractor shall at all times maintain appropriate erosion and water pollution control measures as specified in Section 4, Obstructions and Incidental Construction.

B. Measurement and Payment. Control of ground and surface water shall not be measured or paid for directly but shall be subsidiary to other items of the Contract.

#### 2.05 STABILIZING TRENCH BOTTOMS.

A. Construction Requirements. Wet or unstable trench bottoms shall be stabilized by excavating to additional depth as directed by the Engineer and replacing the unsatisfactory soil with crushed material.

B. Materials. Material for stabilizing trench bottoms shall be crushed limestone or recycled concrete with angular shapes for high interlocking capability meeting one of the following gradations as approved by the Engineer:

- 1) 4 inch to 8 inch primary crusher run.
- 2) 3 inch to 4 inch crusher run.
- 3) 1 1/2 inch poorly graded.
- 4) 3/4 inch poorly graded.
- 5) Recycled concrete material with gradation approved by the Engineer.
- 6) Bedding material as specified in Subsection 2.08.

Field conditions shall be the determining factor for individual or combined use of these materials. The upper 2 inches of any stabilized area shall consist of bedding material as specified in Subsection 2.08. In sewer trenches, the minimum depth of bedding material shall be 4 inches under the pipe.

C. Bid Item, Measurement, and Payment.

(1) Bid Item:

**CRUSHED MATERIAL FOR STABILIZING TRENCH BOTTOMS** Unit:  
Ton (nearest 0.1 Ton)

(2) Measurement. Crushed Material for Stabilizing Trench Bottoms shall be measured by the ton in place, as determined by load tickets provided to the Engineer. Measurement shall be to the nearest 0.1 ton.

(3) Payment. The amount of completed and accepted work, measured as provided above, shall be paid for at the Contract unit price per ton for “Crushed Material for Stabilizing Trench Bottom”, which price shall be full compensation for all excavation, furnishing, hauling, placing, and maintaining the materials as specified, and for all equipment, tools, labor, and incidentals necessary to complete the work.

2.06 STABILIZING STRUCTURE SUBGRADE.

A. Construction Requirements. Except for reinforced concrete box (RCB) structures, the normal foundation under structures will be undisturbed soil. Wet or unstable structure subgrade shall be stabilized by excavating to additional depth as directed by the Engineer and bringing the subgrade back to grade using approved material from excavation or borrow sources, uniformly compacted as specified for "Type A" compaction. Alternatives to the above corrective method are:

1. Using the bedding material specified in Subsection 2.08.
2. Increasing the thickness of the concrete base.

If over-excavation occurs through the actions of the Contractor and not at the request of the Engineer, the subgrade shall be brought back to grade, prior to placing, by similar means, but at the sole expense of the Contractor.

B. Bid Item, Measurement, and Payment.

(1) Bid Item:

**STABILIZING STRUCTURE SUBGRADE** Unit: Cubic Yard (nearest 1 C.Y.)

(2) Measurement. “Stabilizing Structure Subgrade” shall be measured by the Cubic Yard of subgrade replaced, except that no measurement will be made for the volume bounded by vertical planes 18 inches outside the base of the structure. Dimensions of the excavated volume shall be measured to the nearest 0.1 foot and individual volumes computed in cubic feet, summed, converted to cubic yards, and rounded to the nearest cubic yard.

(3) Payment. The amount of completed and accepted work, measured as provided above, shall be paid for at the Contract unit price per cubic yard for “Stabilizing Structure Subgrade”, which price shall be full compensation for all excavation of wet or unstable structure subgrade material, excavating replacement subgrade material, furnishing, hauling, placing, and maintaining the materials as specified, and for all equipment, tools, labor, and incidentals necessary to complete the work.

2.07 SUBGRADE FOR CAST IN PLACE AND PRECAST REINFORCED CONCRETE BOX (RCB) STRUCTURES.

A. Subgrade for Cast In Place RCB Structures.

(1) Concrete Seal Course. All cast in place RCB structures shall be constructed on a 3 inch minimum thickness concrete seal course. The seal course concrete shall be Commercial Grade as defined in Section 5, Concrete, and have a minimum compressive strength of 2,500 psi. The seal course under RCB structures shall not be paid for directly but shall be included in the price bid for Reinforced Concrete Box (RCB) Structures.

(2) RCB Subgrade Stabilization. When the subgrade for a cast in place RCB is not capable of supporting the weight of a person without undue deformation, a stabilized stone base of a width and depth determined by the Engineer shall be installed under the concrete seal course. Stabilized stone base shall consist of crushed limestone or recycled concrete with angular shapes for high interlocking capability. Stone gradation shall be one of the gradations listed in Subsection 2.05 B, as approved by the Engineer. Field conditions shall be the determining factor for individual or combined use of these materials.

B. Subgrade for Precast RCB Structures. All precast RCB structures shall be constructed on either a six inch (minimum) thickness of crushed stone, or a three inch (minimum) thickness of concrete seal course. Crushed Stone shall meet the requirements for bedding material specified in Subsection 2.08 B. The seal course concrete shall be Commercial Grade as defined in Section 5, Concrete, and have a minimum compressive strength of 2,500 psi. The crushed stone or concrete seal course stabilization under Precast RCB Structures shall not be paid for directly but shall be included in the price bid for Reinforced Concrete Box (RCB) Structures. When additional stabilization is required below the six inches of crushed stone or three inches of concrete seal course for Precast RCB Structures, the stabilization shall follow Subsection 2.07 A(2) above.

C. Bid Item, Measurement, and Payment.

(1) Bid Item:

**STABILIZED STONE BASE FOR RCB (SET PRICE)**

Unit: Ton  
(nearest 0.1 Ton)

(2) Measurement. “Stabilized Stone Base For RCB” shall be measured by the ton in place, as determined by load tickets provided to the Engineer. Measurement shall be to the nearest 0.1 ton.

(3) Payment. The amount of completed and accepted work, measured as provided above, shall be paid for at the set Contract unit price per ton for “Stabilized Stone Base For RCB”, which payment shall be full compensation for all excavation of wet or unstable structure subgrade material, excavating replacement subgrade material, furnishing, hauling, placing, and maintaining the materials as specified, and for all equipment, tools, labor, and incidentals necessary to complete the work.

2.08 BEDDING MATERIAL AND PLACEMENT.

A. Construction Requirements. Storm and sanitary sewer trenches shall be excavated to a depth not less than 4 inches below the bottom of the pipe and the pipe shall be laid on bedding material. Bedding material shall be placed and compacted uniformly by bucket tamping or other suitable method to the limits described in Subsection 2.10 and as shown on the Standard Drawings for Sanitary and Storm Sewers. Bedding material and placement for waterlines is specified in Section 8, Watermains, Fire Lines and Water Service Laterals.

Bedding material shall not be used in the Kansas River Valley where the native material is primarily sand or silt.

Work within a Corps of Engineers “Critical Zone” must comply with the Corps of Engineer’s requirements.

B. Materials. Bedding material shall be crushed limestone having the following characteristics:

Retained on ¾ inch sieve.....	0%
Retained on ½ inch sieve.....	15% to 35%
Retained on 3/8 inch sieve.....	40% to 70%
Retained on No. 4 sieve.....	90% to 100%
Deleterious Substances, maximum.....	5%

C. Measurement and Payment. Bedding material and its placement shall not be measured or paid for directly, but shall be subsidiary to the storm or sewer sanitary sewer being constructed.

2.09 COMPACTION.

A. Types of Compaction Defined.

(1) Type A Compaction. Compacted density of the material shall be at least 95% of the maximum density determined in accordance with AASHTO T-99. The moisture content of the material at the time of compaction shall be uniform and shall not be more than three percentage points above or below the optimum moisture content of the soil involved. If the soil is unstable at this moisture range, the moisture may be varied to the point at which it is stable as determined by the Engineer. The maximum lift thickness of loose material to be compacted is 6 inches.

(2) Type AB Compaction. Compacted density of the material shall be at least 90% of the maximum density determined in accordance with AASHTO T-99. The moisture content of the material at the time of compaction shall be uniform and shall not be more than three percentage points above or below the optimum moisture content of the soil involved. The maximum lift thickness of loose material is 6 inches.

(3) Type B Compaction. Compacted density of the material shall be equal to or greater than that of the undisturbed adjacent material. The moisture content of the soil at the time of compaction shall be uniform and shall be such that the soil can be compacted to the required density. The maximum lift thickness of loose material is 10 inches.

## B. Applications.

(1) Type A Compaction. Unless otherwise indicated in the Contract documents or geotechnical report, Type A Compaction shall be used under all paved areas, except sidewalks, which lie within the dedicated right-of-way of all public thoroughfares. Type A Compaction shall also be used where sewers intersect stream beds and at other locations designated on the Project Drawings, around structures, and to a level not less than 1 foot above the top of sewer pipes, as specified elsewhere in this section.

(2) Type AB Compaction. Unless otherwise indicated in the Contract Documents or geotechnical report, Type AB Compaction shall be used for all embankment, fill, and / or backfill within the dedicated right-of-way of all public thoroughfares, except areas heretofore specified for Type A Compaction.

(3) Type B Compaction. Unless otherwise indicated in the Contract Documents or geotechnical report, Type B Compaction shall be used for all embankments, fill, behind RCB wingwalls, and / or backfill not heretofore specified for Type A or Type AB Compaction.

C. Construction Requirements. Prior to proceeding with the compaction of materials requiring Type A or Type AB Compaction, a Standard Proctor Curve as determined by AASHTO T 99 (ASTM D 698) shall be obtained for each type of material to receive such compactive effort. Proctor curves shall be obtained from soil samples selected by a certified testing laboratory from materials excavated by the Contractor. All costs associated with the selection of soil samples and performing the necessary tests to obtain the Proctor curves shall be paid by the Contractor.

D. Recommendations for Compaction Equipment. Most manufacturers of compaction equipment provide information for the use of their equipment.

For compaction of cohesive soils such as clay or clay-silt mixes, the recommended equipment includes rammers which shear and knead the soil and sheepsfoot rollers, either towed or backhoe mounted static types or self-propelled static or vibratory, which shear, blend and bond the soil.

The thickness of the soil layer being compacted should not exceed the capabilities of the compacting force of the equipment being used. Proper thickness allows full and uniform densification of each layer and is directly proportional to the number of passes required to achieve the desired result.

Steel wheeled smooth rollers, either static or vibratory or vibratory smooth plates are not normally recommended for use on cohesive soils but are highly recommended for consolidating granular soils.

When compacting a mixture of cohesive and granular soils, equipment designed for the predominant soil type should be used.

E. Basis for Acceptance for Compaction. Normally the nuclear densometer test shall be the basis for acceptance of compaction. However, when materials consist of a mixture of different soil types or contain a substantial amount of rock chips, the nuclear densometer may give erroneous results. Therefore, the test results may be tempered by the judgment of the Engineer's representative after observing the compaction effort. The decision to accept or reject compaction may be influenced by the thickness of lift, type of compaction equipment, number of passes of

compaction equipment, depth of penetration of a steel probe into the compacted material or successful proof rolling with a tandem axle dump truck loaded to a minimum weight of 25 tons.

F. Measurement and Payment. Compaction shall not be measured or paid for directly, but shall be subsidiary to other items of the Contract.

## 2.10 BACKFILL.

A. General. All trenches and excavations for structures shall be backfilled to the lines and grades shown in the project drawings and as specified herein. Where required, bedding material as specified in Subsection 2.08 and as follows, shall be placed, compacted, and approved by the Engineer prior to the placement of backfill.

B. Materials. Backfill material shall be approved excavated material selected from the site or approved supplementary borrow material. Material shall be unfrozen, free of debris, organic material, and rocks or clods larger than three inches in any dimension.

C. Unsuitable Backfill Material. No material shall be used for structure backfill or trench backfill that contains rocks or clods larger than three inches in any dimension, frozen material, debris, junk, or organic material. Such material shall be removed from the backfill material and disposed of as directed by the Engineer. Removal and disposal of unsuitable material is subsidiary to other bid items.

Sand backfill will not be allowed except in areas adjacent to the Kansas River where sand is the existing natural material

D. Construction Requirements. Backfill material shall be deposited in loose layers not more than 6 inches thick, and compacted to the requirements specified below. Backfill procedures should be completed parallel to the trench whenever possible. Jetting or other hydraulic methods intended to compact the backfill are prohibited. Trenches shall be dewatered as much as practical prior to the placement of bedding material and backfill.

(1) Backfill Around Structures. Backfill around structures with approved material after completion of below grade construction and removal and cleanup of all forms, lumber and trash. Backfilling against any structure shall proceed only upon approval of the Engineer and shall be based on concrete attaining 75% of design strength. Each layer shall be placed and compacted as specified for Type A Compaction and shall include emphasis on the area adjacent to the structure walls

Backfill of retaining walls shall proceed simultaneously on the front and back of the wall with care taken to prevent forward tipping and undue bending stress in the wall at its foundation.

(2) Trench Backfill. Backfill trenches only after pipelines, joints, wyes and bedding have been inspected and approved. Backfill with approved material from excavation or supplementary borrow areas, free from rocks or clods larger than 3 inches in any dimension

i) Initial Backfill for Pipes with Pipe Stiffness (PS) of 100 or less. This category includes PVC pipe meeting the requirements of ASTM D 3034 SDR 26 and ASTM F 679 PS 46. Initial backfill shall consist of specified bedding material to

a point 6 inches above the top of the pipe. Care shall be taken to insure that bedding material is worked in around the haunches of the pipe. Bedding material shall be compacted as specified for Type A compaction.

ii) Initial Backfill for Pipes with Pipe Stiffness (PS) over 100. This category includes PVC pipe meeting the requirements of ASTM D 2665 (Schedule 40), ductile iron pipe, vitrified clay pipe, reinforced concrete pipe and corrugated steel pipe. The initial backfill shall consist of specified bedding material to the top of the pipe. Care shall be taken to insure that bedding material is worked in around the haunches of the pipe. Bedding material shall be compacted as specified for Type A Compaction.

iii) Backfill from Springline to One Foot Over Top of Pipe. This applies to all types of pipe regardless of where the top of bedding material is located. Selected backfill material shall be placed to the full width of the trench in loose layers not to exceed 6 inches thick. Each layer shall be compacted as specified for Type A Compaction. Continue to place and compact subsequent layers until the pipe is covered to a depth of at least one foot. All material to this depth shall be compacted as specified for Type A compaction.

iv) Backfill for the Remainder of the Trench. After selected backfill and compaction to 1 foot above the top of pipe, the remaining backfill shall be composed of selected excavated materials free from clods or rocks greater than 3 inches any dimension, frozen materials, debris or junk; or of approved supplementary borrow material. Backfill material shall be deposited and compacted as detailed in the Project drawings and Subsection 2.09 B, above.

E. Basis of Acceptance. Prior to proceeding with the backfill, the Contractor shall provide for the collection and testing of soil samples as specified in Subsection 2.09 C.

During backfill operations, soil density tests shall be taken by the Engineer or their representative. When results indicate that compaction does not meet the requirements of these Specifications, the backfill material shall be removed and replaced or re-compacted as necessary to meet the specified requirements at no additional expense to the Owner. Additional tests shall be performed on re-compacted areas to assure compliance with the requirements.

If the Contractor elects to backfill with material for which no Standard Proctor Curve has been completed, the backfill shall still be tested by nuclear densometer and the readings saved for later comparison with the Proctor Curve. If this comparison indicates that Contractor had failed to achieve the required compaction, the backfill shall be removed and re-compacted at no additional expense to the Owner.

F. Bid Item, Measurement and Payment.

(1) Backfill for Structures. Backfilling of excavations necessary for the construction of structures shall not be paid for directly but shall be subsidiary to the respective structure.

(2) Backfill for Trenches. Backfilling of trenches shall not be paid for directly but shall be subsidiary to the sewer, pipeline, cable, conduit, or other underground system for which the excavation was performed; or, incidental to the item "Trench Excavation and Backfill" when said item is included on the Bid Form.

(3) Bid Item. The bid item “Trench Excavation and Backfill” shall include the excavation of trenches as specified in Subsections 2.02, 2.03, 2.04, and 2.05. The stated bid item also includes providing and placing bedding material, backfill and compaction as specified in this Subsection and Subsection 2.08.

**TRENCH EXCAVATION AND BACKFILL; (\*)' to (\*)', Type (#)  
Compaction** Unit: Linear Foot (nearest 1 L.F.)

- (\*) Depth range of trench.  
(#) A, AB, or B.

(4) Measurement. “Trench Excavation and Backfill” will be measured by the linear foot, to the nearest foot, from center to center of manholes, for each combination of depth range and compaction category used in backfilling the trench. Depths of trench excavation will be considered to be from the surface of the original ground or pavement to the invert grade of the pipeline. The initial increment of depth will be 0 foot to 6 foot. Each succeeding depth increment will be 2 feet.

(5) Payment. Payment for “Trench Excavation and Backfill” shall be made at the Contract unit price per linear foot for each combination of depth range and compaction category of trench completed and accepted, which price shall be full compensation all control of ground water, sheeting and bracing, bedding material, saw-cutting, excavation, trimming, disposal of surplus materials, hauling, compaction, materials testing, and the furnishing of all equipment, tools, labor, and incidentals necessary to complete the work.

2.11 SUPPLEMENTARY BORROW MATERIAL FOR TRENCHES.

A. General. Supplementary borrow material for backfilling trenches shall be provided by the Contractor if excavations within the project limits yield insufficient suitable material to properly backfill the trench following placement of the pipe and bedding material. The Contractor shall notify the Engineer of their intent to import material 24 hours in advance of hauling any supplemental borrow material to the project.

Supplementary material shall be provided, placed, measured and paid for as specified in Subsection 3.08.

2.12 TUNNELING AND BORING.

A. General. This section applies to the installation of pipes, box structures, and conduits by jacking, boring or tunneling. The installation of encasement pipes by boring, jacking or tunneling is specified in Section 4. If the pipe is bored, jacked or tunneled under a highway, railroad, street, structure, or vegetation, the installation of the pipe must not interfere with the highway, railroad, street, structure, or vegetation. Structures and roadbeds shall not be weakened by the installation of the pipe, box structure or conduit. **There shall be no heave or settlement at the surface above the installation.** The Contractor shall submit to the Engineer for approval a detailed plan for the proposed method of installing the pipe. **The maximum size of a boring head shall be 1.5 times the pipe or conduit size. If there is a 1” or more void between the wall of the bore and the outside of the pipe or conduit, the void must be pressure grouted full. The minimum boring depth is 36 inches.** At the Contractors option and when approved by the Engineer, the Contractor may substitute jacking, boring or tunneling for open trench excavation. Payment for optional

jacking, boring or tunneling will be at the established Unit Price for the installation method for which the substitution was made.

B. Materials. Pipes, box structures and conduits to be installed by jacking, boring or tunneling methods shall be as specified in the Project Documents and shall meet the applicable requirements of Sections 5, 6 and 8. Where segmented tunnel liner system is used, it shall be designed and stamped by a Kansas Professional Engineer. The minimum factors of safety shall be as follows:

<u>CRITICAL ELEMENT</u>	<u>FACTOR OF SAFETY</u>
Seam Strength	3.0
Wall Buckling	2.0
Installation Stiffness	3.0

C. Construction Methods. Pipes, box structures or conduits shall not be installed directly by boring or jacking methods unless such installation is specified or specifically permitted in the Project Documents or approved by the Engineer. Install pipes or box structures starting at the lower elevation and ending at the higher elevation. The bore or tunneling pits and trenches necessary to install the pipe shall comply with OSHA requirements. The Contractor shall backfill and compact such pits and trenches upon completion of the pipe installation to the requirements set forth in this Section 2. Installation of the pipe or box shall begin at the lower elevation (downstream) and progress to the higher elevation. The final position of the pipe or box shall not vary from the specified line or grade more than 1 inch in 10 feet. Variations, if any, shall be regular and in one direction. The flowline shall be in the specified direction. The Contractor shall repair or replace, as determined by the Engineer, all pipes, box structures or conduits damaged or misaligned during the boring, jacking or tunneling operations.

(1) Jacking. The Contractor shall use heavy duty jacks suitable for the intended purpose and use a jacking head and bracing between the jacks and the jacking head, to apply uniform pressure around the ring of pipe. The Engineer will allow the use of joint cushioning material. The Contractor shall use a jacking frame or backstop and guides that support and direct the pipe in the proper line and grade. As the pipe is jacked, the Contractor shall excavate the material just ahead of the pipe (maximum of 2 feet in advance) and remove the excavated material through the pipe. Excavation for the underside of the pipe for a minimum of 1/3 of the circumference of the pipe shall follow the contour and grade of the pipe. Over-excavation (maximum of 2 inches) for the upper half of the pipe is allowed. The over-excavation shall taper to nothing at the point the excavation conforms to the contour of the pipe. The Contractor shall fill over-excavation in excess of 1 inch with an approved material (flowable fill, sand or slurry grout) the length of the installation after the pipe is installed. The Engineer may allow the use of the cutting head of steel plate around the head end of the pipe. The cutting edge may extend a short distance beyond the end of the pipe. Construct (with inside angles or lugs) the cutting edge to prevent it from slipping back into the pipe. When the pipe jacking operations begin, to the extent possible, continue the operations without interruptions to prevent the pipe from becoming firmly set in the excavation.

(2) Tunneling. The Contractor shall use a tunnel lining of sufficient strength to support the overburden. Fill the space between the tunnel lining and the limits of the excavation with slurry grout. Provide access holes in the tunnel lining (maximum spacing of 10 feet) for the grouting operations.

D. Bid Item, Measurement and Payment.

(1) Bid item:

( \* ) (Bored, Jacked or Tunneled) Unit: Lineal Ft. (Nearest 1ft.)

( \* ) – Type and size of pipe, box structure, or conduit.

(2) Measurement. “( \* ) (Bored, Jacked or Tunneled)” shall be measured to the nearest foot along the centerline of the pipe from end to end of the bore holes or tunnel.

(3) Payment. Payment for the various types and sizes of pipes, box structure and conduit installed by jacking, boring, or tunneling shall be made at the respective established Unit Prices. Payment for optional jacking, boring or tunneling will be at the established Unit Price for the installation method for which the substitution was made. Such payments shall be full compensation for all labor, materials, equipment and incidentals necessary to complete the work as specified.

2.13 BLASTING.

A. General. Blasting is prohibited unless specifically permitted by the Drawings, Supplementary Conditions, City Engineer or County Public Works Director. The Contractor is required to secure a blasting permit in accordance with applicable provision of the Code of the City of Topeka. Compliance with these procedures does not relieve the Contractor of responsibility for damage to life or property.

B. Construction Requirements. Blasting shall be done only by persons experienced in the handling of explosives.

In locations where flying rock would constitute a hazard to persons or property, blast charges shall be of limited size. Before detonation, the trench shall be backfilled or covered with woven metal protective mats or other mats if approved by the Engineer.

(1) Vibration Monitoring Requirements. The Contractor shall be responsible for seismographic monitoring of the vibration due to blasting at foundations adjacent to or nearest the point of removal. The engineering seismograph shall be a Dallas Instrument Company Model ST-4 or approved equal and shall be operated by qualified personnel.

Foundations shall include garage, shed, house and pool slab footings and foundation walls.

Monitoring measurements shall be taken within three (3') feet of the nearest adjacent structure foundation at the nearest point to blasting. The transducer will be buried six inches (6") to one foot (1') below the surface.

If vibration exceeds the allowable maximum limits, the Contractor shall use an alternate method for removal of the rock, provided it complies with the vibration requirements herein.

C. Measurement and Payment. Blasting, monitoring vibrations, and all associated hauling, equipment, labor, materials, and incidentals shall not be measured or paid for directly, but shall be subsidiary to other items of the Contract.

END OF SECTION