**Technical**
**Specifications**

# BIG CREEK INTERCEPTOR SEWER UPSIZING
# LEE'S SUMMIT MIDDLE SCHOOL #4
# LEE'S SUMMIT, MISSOURI
# 2021

**Prepared for Lee's Summit R7 School District**

olsson®

**Olsson Project No. 020-01030**

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**TECHNICAL SPECIFICATIONS**

**SUPPLEMENTAL CONDITIONS TO**
**CITY OF LEE'S SUMMIT, MISSOURI STANDARD SPECIFICATIONS**
**LEE'S SUMMIT, MISSOURI - 2021**

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Work for the City of Lee's Summit shall follow City of Lee's Summit Standard Specifications, except as modified below. The following additions and/or alterations to the City of Lee's Summit provided below shall apply to execution of the various parts of the work performed on this project.

**Remove the first paragraph of 2102.4.I.6 Trench Backfill LS Section 2100, and Replace with the following paragraph:**
The backfill material shall be placed in layers not exceeding 8-inches in loose thickness and be compacted to at least 95% of maximum dry density. A minimum of one compaction test shall be taken every 100 to 150 linear feet for each lift of backfill.

**Remove section O. Casing Pipe from section LS 3501**

**Add the following Section to LS 3500:**

C. 4. PVC Large Diameter Gravity Sewer Pipe and Fittings; Pipe and fittings shall conform to ASTM F679, except as otherwise specified herein.
   a. Material: The pipe shall be made of PVC plastic having a cell classification of 12454B or 12364B as defined in ASTM D 1784. The fittings shall be made of PVC plastic having a cell classification of 12454B or 13343B as defined in ASTM D1784.
   b. Design: Pipe shall have an integral wall bell and spigot joint and a minimum wall thickness complying with PS 115. Fitting shall have a minimum wall thickness complying with PS 115.
   c. Joints: Joints shall conform to ASTM D 3212. Joints shall be push-on type only with bell-end grooved to receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F477. Natural rubber gaskets shall not be accepted.
   d. Fittings:
      i. Fittings defined as wye connections shall be bell-end with a minimum wall thickness complying with PS 115 and shall be furnished by the pipe manufacturer.
      ii. Fittings shall be clearly marked with SDR 26. The markings shall be applied to the fittings in such a manner that they remain legible after installation and inspection has been completed.

**Manhole steps will not be installed as a part of this project.**

**Remove section P. 8. Manhole Steps from LS Section 3500**

**Remove the sentence of section D.3.c (from LS Section 3500)** stating "Sections shall be placed so that steps are aligned but without rotation or damage to sealant integrity."

**Remove section D. 9. Steps from LS Section 3502**

**Add the following to section LS 3502. A.:**

7. Contractor to coordinate construction work with property owners prior to entry.

**Add the following sentence to section B. Sanitary Sewer Installation 10. Removal of water from LS Section 3502.**

Contractor shall take all means and methods necessary to design, furnish, install, and maintain a dewatering system that provides a dry, stable, and safe working environment necessary for completion of work.

**Remove the sentence of section C. 1. b. from section 3502 stating** "In general, testing for sanitary sewers shall begin at least 30 days after the completion of all sanitary sewer."

**Add the following to section C.2.a. i. LS 3502**:

The following table is calculated from ASTM F679 and shall be followed for this project.

| Mandrel Sizing | | | | |
|---|---|---|---|---|
| Nom. Size | Class | Avg. Inside Diameter | Base Inside Diameter | 5% Deflection Mandrel (in) |
| 24 | PS 115 | 22.918 | 22.102 | 20.997 |
| 30 | PS 115 | 29.566 | 28.523 | 27.097 |

Mandrel Diameter = (100% - Deflection Percentage Limit) * Base Inside Diameter

**Remove the following sentence from section C. 3. b. in LS 3502 stating** "The required air pressure and/or exfiltration testing shall be successfully performed on the carrier conduits prior to sealing of the ends of the casing conduits. "

**Add the following sections:**
**Section 3504. Trenchless Installation of Utility Piping**

GENERAL

A. Summary

1. Casing Pipe.

   a. Steel tunnel liner.
   b. Carrier pipe.
   c. Excavation for approach trenches and pits.

2. Related Requirements:

a. APWA Section 2100 – Grading and Site Preparation.
b. City of Lee's Summit Section 3500 – Sanitary Sewers.

3. American Association of State Highway and Transportation Officials:

   a. AASHTO HB-17 - Standard Specifications for Highway Bridges.
   b. AASHTO M133 - Standard Specification for Preservatives and Pressure Treatment Processes for Timber.
   c. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

4. American Railway Engineering and Maintenance-of-Way Association:

   a. AREMA - Manual for Railway Engineering.

5. American Welding Society:

   a. AWS D1.1/ (D1.1M - Structural Welding Code œ Steel).

6. ASTM International:

   a. ASTM A36/A (36M - Standard Specification for Carbon Structural Steel).
   b. ASTM A53/ (A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless).
   c. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
   d. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
   e. ASTM A1011/ (A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength).
   f. ASTM C33/ (C33M - Standard Specification for Concrete Aggregates).
   g. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   h. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
   i. ASTM C150/ (C150M - Standard Specification for Portland Cement).
   j. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   k. ASTM C361M - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (Metric).
   l. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
   m. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
   n. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).

o. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
p. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
q. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

7. National Utility Contractors Association:

a. NUCA - Guide to Pipe Jacking and Microtunneling Design.

B. Coordination

1. Coordinate Work of this Section with city of Lee's Summit Water Utilities, Union Pacific Railroad (UPRR), and other utilities within construction area. UPRR requires track monitoring and will need to be coordinated with their representative.

C. Preinstallation Meetings

1. Convene minimum two weeks prior to commencing Work of this Section.

D. Submittals

1. Requirements for submittals.

a. All submittals shall be submitted a minimum of 14 days before the casing pipe installation begins.

b. Product Data: Submit manufacturer information regarding tunnel liner plate, showing sizes, shapes, methods of attachment, connection details, and details of grout holes.

c. Shop Drawings:

i. Indicate details of casing, jacking head, sheeting, and other falsework for trenches and pits, field sketches, UPRR site specific requirements, and other details to complete Work.
ii. Indicate relationship of proposed installation to natural features over installation, angle of installation, right-of-way lines, and general layout of built facilities.
iii. Indicate cross-section(s) from field survey, showing installation in relation to actual profile of ground.
iv. Indicate entry and exit seal materials and construction.

v. Submit description of proposed construction plan, dewatering plan, and plan to establish and maintain vertical and horizontal alignments.
vi. Indicate a grouting plan to seal the space between the casing pipe and the ground.
vii. Submit a track and ground monitoring plan as described by UPRR Requirements.

d. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

e. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

f. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for casing pipe, and the jacking and receiving pits and all that is required to allow for construction including but not limited to sheeting and shoring, and dewatering.

g. Submit City of Lee's Summit and UPRR occupancy permit for installations along and under public throughways and lands.

h. Submit emergency response procedures to handle situations when conduit is compromised and jeopardizes safety or integrity of installation, including a 24-hour emergency contact.

i. Submit written report results of visual check of the entire length of casing prior to installation of carrier to verify that there are no voids or defective joints.

j. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

k. Qualifications Statements:

i. Submit qualifications for installer and licensed professional.
ii. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.

l. Grouting work plan for the space between the casing pipe and the surrounding earth.

m. Calculations/plans signed and sealed by a Professional Engineer for the following items:

i. Calculations verifying the casing pipe can withstand the loads during the installation.

ii. Calculations and plans for the installation of sheeting, shoring and bracing required for the entry and exit trenches and pits that must follow UPRR Requirements.
iii. Calculations for pressure grouting to prevent frac-out.

E. Closeout Submittals

1. Project Record Documents: Record actual locations of casing pipe, carrier pipe, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

F. Quality Assurance

1. Perform Work according to AREMA, NUCA, and city of Lee's Summit Water Utilities guidelines.

   a. Obtain occupancy permit when boring, jacking, or tunneling under or within rights-of-way of the city of Lee's Summit highways and railroads.
   b. Perform Work according to city of Lee's Summit Water Utilities and UPRR standards.
   c. Maintain two copies of each standard affecting Work of this Section on Site.

G. Qualifications

1. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.
2. Exhibit minimum of 3,000 feet or 10 drives for qualified personnel operating microtunneling or jack and bore equipment similar to Work of this Section.
3. Submit history of previous work completed of equivalent nature and scope.
4. Provide a project superintendent with at least 10 years of tunneling experience who has worked on at least 5 tunnel/pipe jacking projects in similar ground conditions using equipment similar in type and size to the equipment selected for this project.
5. Provide a machine operator and a shift supervisor for each shift with at least 3 years of tunneling experience who has worked on at least 5 tunnel/pipe jacking projects using equipment similar in type and size to the equipment selected for this project.
6. Welders: AWS qualified within previous 12 months for employed weld types.

H. Delivery, Storage, and Handling

1. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

2. Handling: Support casing and carrier pipes with nylon slings during handling.

3. Storage:

    a. Store products according to manufacturer instructions.
    b. Use wooden shipping braces between layers of stacked pipe.
    c. Stack piping lengths no more than three layers high.
    d. Store field joint materials in original shipping containers.

4. Protection:

    a. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
    b. Provide temporary end caps and closures on piping and fittings and maintain in place until installation.
    c. Protect piping from entry of foreign materials and water by installing temporary covers, completing sections of Work, and isolating parts of completed system.
    d. Provide additional protection according to manufacturer instructions.

I. Existing Conditions:

1. Field Measurements:

    a. Verify field measurements and elevations of utilities prior to fabrication, excavation, and installation of casing pipe.
    b. Indicate field measurements on Shop Drawings.

J. Design Responsibilities

1. Design of all equipment, methods, and other systems required to perform the bore and jack operation.
2. Design and support of the bore pits and the trenches including design and detailing of any excavation support systems that are necessary. Must be signed and sealed by a Professional Engineer.
3. Design of the dewatering system.
4. Support of carrier pipe during installation

K. Design Criteria:

1. Internal carrier pipe diameter and invert location and elevations shall conform to those shown in the contract documents.
2. All machinery, equipment, and lighting shall be explosion proof.
3. The walls of the support system shall be designed to resist reaction forces induced by jacking operations adequately and safely.
4. Structural support systems shall be designed in accordance with the standards in this Section.
5. Design of driven support systems shall consider drivability through the subsurface formations possibly in the bore.

6. The design shall include appropriate surcharge loads from construction equipment and other sources. Surcharges shall be applied as a uniform lateral load equal to 75% of the ground pressure applied at the surface by the surcharge source. The uniform load shall be applied across the entire retained height of the system.
7. The main jacking system shall consist of an even number of thrust cylinders arranged symmetrically. Each cylinder shall have individual activation, synchronized activation, and individual thrust control. Cylinders shall not exert force when idle but shall resist displacement. The installed thrust capacity shall equal or exceed the combined reactions from the maximum hydrostatic pressure, soil friction, earth pressure, and cutter forces.

L. Site Protection and restoration:
1. Bore and jack/microtunneling installations shall be designed to avoid impact to the adjacent railroad.
2. Contractor shall not disturb areas outside of the limits of disturbance delineated in the drawings without further discussion and approval from the engineer and City. Contractor shall not encroach onto the railroad tracks vicinity or use the railroad right of way as a staging, stockpiling, or laydown area.
3. Contractor is responsible for protecting the railroad tracks and keeping these areas clear of any obstructions at all times. Contractor shall restore/repair all damage resulting from tunneling related settlement or heave at no additional cost to the owner.
4. Contractor shall monitor railroad tracks during bore and jack installations for differential settlement and/or subsidence. Contractor shall alert the Engineer and Owner immediately if any settlements of subsidence are noted.

PRODUCTS

A. Casing Pipe

1. Manufacturers:

a. Furnish materials according to city of Lee's Summit Water Utilities standards.

2. Steel Casing Pipe:

a. Comply with ASTM A 139, grade B
b. Minimum Yield Strength: 35,000 psi, 241 MPa.
c. Minimum Wall Thickness: 0.625 inches. Greater thickness shall be supplied if required to handle anticipated jacking loads.
d. Welded Joints:

i. Comply with AWS D1.1/D1.1M.
ii. Full circumference.

3. Performance and Design Criteria:

a. Casing Pipe:

i. Leakproof joints.

ii. Design for earth pressure, jacking pressure, other pressure loads, and railway loads.

1. Railways:

a. Comply with AREMA Chapters 1-5- Manual for Railway Engineering.

b. Impact loading according to AREMA guidelines plus 50 percent.

b. Bracing, Backstops, and Jacks: Of sufficient rating for continuous jacking without stopping except to add pipe sections, and to minimize tendency of ground material to freeze around casing pipe. Shoring plan must be developed and submitted for approval by UPRR.

B. Carrier Pipe

1. Sanitary Sewage System Piping: As specified in city of Lee's Summit Section 3500 - Sanitary Sewers

C. Materials

1. Soil Backfill for Trench Approaches and Pits to Finish Grade:

a. Soil Type S1, as specified in APWA 2100.

2. Filling and Sealing Grout

a. Pressures must be controlled for the type of soil being bored to prevent frac-out.
b. Mortar Sand: Comply with ASTM C33/C33M.
c. Portland Cement:
ii. Comply with ASTM C150/C150M.
Type: V Portland Cement

D. ACCESSORIES

1. Steel Supports and Insulators:

a. Bands: 14-gauge (2.9-mm) T-304 stainless steel.
b. Flange Bolts: 5/16-inch (8-mm) T-304 stainless steel.
c. Skids: Ultra high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon.
d. Steel Strapping: Comply with ASTM A36/A36M.

EXECUTION

A. Examination

1. Verify that connection to existing piping system, sizes, locations, and invert elevations are as indicated on Drawings.

2. Perform casing installation to minimize movement of ground in advance of, around, and above the casing. The track monitoring plan approved by UPRR will need to be in place prior to beginning the installation.

B. Preparation

1. Identify required lines, levels, contours, and datum locations.

2. Existing Utilities:

a. Locate and identify utilities indicated to remain and protect from damage.

i. Establish minimum separation from other utilities, sanitary sewage piping as stated in city of Lee's Summit, Section 3500.
ii. Establish elevations of casing as shown on the drawings.

C. Installation

1. Dewatering:

As specified in APWA Section 2100 and as follows:

a. Contractor shall take all means and methods necessary to design, furnish, install, and maintain a dewatering system that provides a dry, stable, and safe working environment necessary for completion of work.
b. Intercept and divert surface drainage precipitation and ground water away from excavation through use of dikes, curb walls, ditches, pipes, sumps, or other methods.
c. Develop substantially dry subgrade for subsequent operations.
d. Comply with requirements of local and state authorities for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.
e. Develop a 24-hour monitoring plan including emergency contact information.

2. Pits or Approach Trenches:

a. Excavate approach trenches or pits to allow for working clearances.
b. Location of pits shall be as indicated on the drawings.
c. Support soil, pavement, utilities, or structures existing outside excavation.
d. Construct pits to limit intrusion of ground water.

e. Ensure that casing entrance faces as near perpendicular in alignment as conditions permit.
f. Establish vertical entrance face at least 1 foot above top of casing.
g. Install excavation supports as specified in APWA Section 2100, UPRR Requirements, and OSHA safety requirements.
h. Thrust Restraints:
    i. Construct thrust blocks or thrust walls for intended jacking loads as required.
    ii. Do not apply jacking loads until concrete has achieved required design strength.
i. If concrete is placed within pits to prevent inflow of ground water, construct thickness equal to 1.5 times hydrostatic uplift, in addition to requirements for transfer of thrusts from jacking frame.

3. Casing Pipe:

Boring and Jacking:

a. Push pipe into ground with boring auger rotating within pipe to remove soil.
b. Do not advance cutting head ahead of casing pipe, except for distance necessary to permit cutting teeth to maintain clearance for pipe.
c. Arrange machine bore and cutting head to be removable from within pipe.
d. Arrange face of cutting head to provide barrier to free flow of soft material.
e. If unstable soil is encountered during boring, retract cutting head into casing to permit balance between pushing pressure and ratio of pipe advancement to quantity of soil.
f. Grout to fill voids if voids develop greater than OD of pipe by approximately 1 inch (25 mm).
g. If boring is obstructed, relocate jack or tunnel as directed by Engineer.
h. Dispose of excavated material from tunnel or pit offsite, at regular intervals. Stockpiling of materials is not permitted.

Microtunnel Boring Machine:

a. Cutting anticipated materials or structures in bore.
b. Providing positive face support regardless of MTBM type.
c. Steering in both vertical and horizontal directions to the tolerances mentioned in this section.
d. Functions controlled from surface control unit.
e. Rotation controlled by using bidirectional drive on cutter head or antiroll fins or grippers.
f. Heave and settlement controlled by proper operation to acceptable tolerances.
g. Grouting to fill voids if voids develop greater than the OD of the pipe by approximately 1 inch (25 mm).
h. If boring is obstructed, relocate tunnel as directed by Engineer. Retrievement shafts will not be permitted on this project.

4. Pressure Grouting: Pressure-grout annular space between casing pipe and surrounding earth. Contractor needs to provide calculations signed and sealed by a Professional Engineer showing soil pressures to minimize frac-out.

5. Carrier Pipe: Clean, inspect, and handle pipe as specified in city of Lee's Summit Section 3500

6. Placement: Place carrier pipe as specified in city of Lee's Summit Section 3500

    a. Prevent damage to pipe joints as carrier pipe is placed in casing.

7. Supports:

    a. Support pipeline within casing such that no external loads are transmitted to carrier pipe.
    b. Attach supports to barrel of carrier pipe; do not rest carrier pipe on bells.
    c. Install end seal provided by casing pipe manufacturer to cap casing.

D. Tolerances

Quality Requirements: Requirements for tolerances.

1. Excavation: Do not overcut excavation by more than 1 inch greater than OD of casing pipe.

2. Casing Pipe Vertical and Horizontal Alignment: Plus or minus 3 inches prior to installation of carrier pipe.

3. Pipe Bells: Minimum 1/2-inch clearance to casing.

E. Field Quality Control

Requirements for inspecting and testing.

1. Compaction Testing:

    a. Comply with ASTM D698, APWA 2100, city of Lee's Summit Section 2100.

    b. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

    c. Testing Frequency: every 100-150 lineal feet for each lift of backfill.

    d. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section. Time on Site will be based on how long the casing takes to install. Manufacturer's

representative shall be on Site for technical assistance during following periods of casing installation:

e. Unloading of casing materials and components.

f. Prior to commencing excavation and during excavation.

g. Installation of casing

F. Protection
1. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities and landscape in immediate or adjacent areas.
2. Coordination with surrounding businesses and property owners will need to take place.
3. Protect plant life, lawns, and other features of final landscaping.
4. Protect benchmarks, survey control points, and existing structures from excavating equipment and vehicular traffic.
5. Any items damaged during construction will need to be repaired or replaced at no further cost to the Owner.

G. Buried Electrical:
1. Provide drilling equipment with permanent inherent alarm system capable of detecting electrical equipment.
2. Provide audible alarm to warn operator when drill head nears electrified cable.
3. Equip personnel with grounded safety mats and grounding cables.

H. Precautions for Ventilation:
1. Provide ventilation for jacking and receiving pits, access pits, intermediate structure, and casing.
2. Conduct air monitoring on a continuous basis.
3. Gas Concentration Threshold Limits:
a. Carbon Monoxide: Maximum 0.005 percent
b. Methane: Maximum 0.25 percent
c. Hydrogen Sulfide: Maximum 0.001 percent
d. Oxygen: Minimum 20 percent

I. Barricades
1. Pits, Shafts, and Open Excavations shall be barricaded as required to provide safety to anyone or thing on the jobsite.
2. When not in operation, isolate or cover open pits and shafts.
3. Remove equipment from vehicular and pedestrian roads and pathways to permit access.

J. Temporary Facilities
1. Erosion and Sediment control shall be as specified in Section 2150.
2. Maintain existing stormwater flow patterns.

3. Noise control will need to be considered and implemented as necessary.

K.

**Add the following section:**
**Section 3505. PUMPING AND BYPASSING**

GENERAL

A. Summary

1. Section Includes:

a. Setting up of temporary pumping equipment
b. Temporary pumping of wastewater around work area
c. Removing of temporary pumping equipment

B. Related Requirements:

1. Lee's Summit Section 3500

C. Coordination

1. Coordinate work for this Section with the city of Lee's Summit Water Utilities and UPRR.

D. Preinstallation Meetings

1. Convene minimum one week prior to commencing work for this section.

E. Scheduling

1. Finish work schedule for periods of time when sewer piping section is out of service.

2. Schedule work for this section to coincide with sanitary sewer interceptor installation.

F. Submittals

1. Detailed Bypass Pumping Plan - Contractor shall submit detailed design plans and descriptions outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. The pumping system must be designed to provide adequate capacity for peak flows.
2. Bypass pumping phasing plan with exhibits and description for each phase, including a schedule for installation and maintenance of bypass pumping system and staging area for pumps.
3. Bypass pump sizes, capacity, number of each size to be onsite and power requirements for each pump.

4. Size, length, material, location, and method of installation for suction and discharge piping.
5. Road crossing details
6. Method of noise control for each pump or generator.
7. Calculation of available time between pump failure and flooding, backups, etc.
8. A 24-hour emergency contact information including a name, and phone number if the need should arise.

G. Qualifications

1. Company specializing in performing Work of this Section with minimum three years' documented experience.

PRODUCTS

A. General

1. Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary pumping system for the purpose of diverting the existing flow around the work area for the duration of the Project.
2. The design, installation, and operation of the temporary bypass pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.
3. When directed by the City of Lee's Summit Water Utilities, the Contractor shall put the affected sanitary sewer line back into service at the end of each working day.
4. All unmanned bypass pumping operations shall be fitted with an auto-dialer feature to monitor the operation of the pump and notify the Contractor in the event of a pump failure or overflow situation.
5. At the discretion of the City of Lee's Summit Water Utilities, the temporary bypass pumping system may be required to operate 24 hours per day.

B. Equipment

1. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric or diesel powered. All pumps used must be constructed to allow dry running for long periods of time to account for the cyclical nature of effluent flows.

2. Contractor shall provide the necessary stop/start controls for each pump.

3. Contractor shall include one stand-by pump for each size to be maintained on site. Back-up pumps shall be on-line, isolated from the primary system by a valve.

4. Discharge and suction piping sizing shall be determined according to flow calculations and system operating calculations.

5. High Density Polyethylene (HDPE) - Piping shall be homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, or other deleterious faults. Pipe shall be assembled and joined on site using couplings, flanges or butt-fusion method to provide leak proof joint. Thread or solvent joints are not acceptable. Pipe fusion shall be carried out by personnel certified as fusion technicians by manufacturer of HDPE pipe and/or fusing equipment. Butt-fusion joints shall be true alignment and uniform roll- back beads resulting from use of proper temperature and pressure.

6. Flexible Hoses and Associated Couplings and Connectors - Flexible hose and couplings shall be abrasive resistant and suitable for the intended services (i.e., fire hoses are not permitted). They shall be rated for external and internal loads anticipated including test pressure. External load design shall incorporate anticipated traffic loadings, including traffic impact loading where applicable. When subjected to traffic loading, the system shall be composed of traffic ramps and covers maintaining an H-20 loading requirement while in use or as directed by MOAW.

7. All rigid or hard piping shall be constructed with positive restrained joints.

8. Under no circumstance will aluminum irrigation type piping or glued PVC pipe be allowed.

C. Design Requirements

1. Bypass pumping systems shall have sufficient capacity to pump the peak flow required. The Contractor shall provide all pipeline plugs, pumps of adequate size to handle peak flow, and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the section to be removed and replaced. Bypass pumping system may be required to be operated 24 hours a day. Contractor shall provide all necessary monitoring devices to notify the Contractor of any pump failure.

2. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each pump size utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

3. Bypass pumping system shall be capable of bypassing flow around the Work area and of releasing any amount of flow up to the full available flow into the work area as necessary for satisfactory performance of the Work.

4. The Contractor shall make all arrangements for bypass pumping during the time when the main is shut down for any reason. The system must overcome any existing force main pressure on discharge.

D. Performance Requirements

1. It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage throughout the duration of the project. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with work, carry it past the work area, and return it to the existing sewer downstream of the work area.

2. The design, installation, and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all local, State, and Federal codes and regulations.

3. Contractor shall provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the main flows under any circumstances.

4. The Contractor shall maintain sewer flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers, and that will protect public and private property from damage and flooding.

5. The Contractor shall protect water resources, wetlands, and other natural resources.

EXECUTION

A. Field Quality Control And Maintenance

1. Test – Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The city of Lee's Summit Water Utilities Project Representative to be given 48 hours' notice prior to testing.

2. Inspection - Contractor shall inspect bypass pumping system every four hours to ensure that the system is working properly.

3. Maintenance Service - Contractor shall insure that the temporary pumping system is properly maintained, and a responsible operator shall be on hand at all times when pump(s) is(are) operating.

4. Extra Materials:

   a. Spare parts for pumps and piping shall be kept on site.

   b. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

B. Preparation

1. Precautions

   a. Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the city of Lee's Summit Water Utilities Project Representative. All costs associated with relocating utilities and obtaining approvals shall be the responsibility of the Contractor.

   b. During all bypass pumping operation, the Contractor shall protect the sewer main and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for any physical damage to the sewer main and all local sewer lines caused by human or mechanical failure.

C. Installation And Removal

1. Contractor shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only at the access location indicated in the bypass pumping plan as submitted by the Contractor and as may be required to provide suction conduit.

2. Plugging or blocking of sewage flows shall incorporate primary and secondary plugging devices. When plugging or blocking is no longer needed for performance and acceptance of Work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging, or causing other major disturbances downstream.

3. When working inside a manhole, the Contractor shall exercise caution and comply with all OSHA and city of Lee's Summit requirements for working in the presence of sewer gases, combustible oxygen-deficient atmospheres, and confined spaces.

4. The installation of bypass pipelines is prohibited in all saltmarsh/wetland areas.

5. The pipeline must be located off streets, sidewalks, and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, where roadway ramps cannot be used, the Contractor must place the bypass line in trenches and cover with temporary pavement or plates.

6. Upon completion of the bypass pumping operations, the Contractor shall remove all piping, restore all property to pre-construction condition, and restore all pavement and roadways. The Contractor is responsible for obtaining any approvals for placement of temporary pipelines from local agencies.

## SECTION 2100 - GRADING AND SITE PREPARATION

## CITY OF LEE'S SUMMIT, MISSOURI
## STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2100 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2100 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2102.3.J Blasting: DELETE "permitted by the Engineer" and REPLACE with "permitted by the City"

2102.3.K No Blasting Areas: DELETE "permitted by the Engineer" and REPLACE with "permitted by the City"

2102.4.I.6 Trench Backfill: DELETE paragraph and REPLACE with the following

The backfill material shall be place in layers not exceeding 8-inches in loose thickness and be compacted to at least 95% of maximum density. A minimum of one compaction test shall be taken every 100 to 150 linear feet for each lift of backfill.

Testing shall be performed by a qualified testing lab hired by the Contractor and approved by the Owner.

Laboratory compaction test and index property test results for each material used on site shall be submitted to the Engineer prior to construction. Any work by Contractor prior to test submittals and subsequent Owner review and approval shall be work done at the Contractor's risk.

Field Density Test reports shall be submitted to the City daily. The reports shall clearly indicate the location of all tests by street name, station and/or lot number, type of backfill material, utility type, and depth of test. The reports shall include the results of all tests (pass or fail) and all re-tests.

2102.4.J.2 Trench Backfilling in Street or Alley Right of Way and under Pavement

ADD "***untreated compacted aggregate meeting APWA 2203.3.A"*** to list material allowed for dense, well-graded aggregate base materials suitable for trenches between 24 to 48 inches wide.

2102.6.E Consolidated Rock Embankment

ADD the following:

***The upper layer of rock shall be filled with a 6-inch thick layer of 3/4-inch choker stone prior to placing soil material.***
***(standard APWA detail changed to require 95%)***

## SECTION 2150 – EROSION AND SEDIMENT CONTROL

## CITY OF LEE'S SUMMIT, MISSOURI
## STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2150 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2150 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2154.5.A (Silt Fence) Materials, Construction Requirements, and Maintenance:

ADD the following:

1. ***Silt fence typically should not be used in swales, drainage-ways, channels and other conduits of concentrated stormwater flow and will only be considered on a case by case basis.***
2. ***Silt fence typically should not be used to direct or divert water and will only be considered on a case by case basis.***

## SECTION 2300 - INCIDENTAL CONSTRUCTION

## CITY OF LEE'S SUMMIT, MISSOURI
## STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2300 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2300 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2301.3 Materials

2301.3.A Concrete:

***Concrete shall be a currently approved KCMMB 4k mix.***

2301.3 Materials
ADD the following:

***F. ADA Detectable Warning Surfaces: The material used to provide contrast shall be an integral part of the walking surface. The material for detectable surface shall be:***

***1. Grouted-in-Place Clay Pavers***

***a. Paving brick shall be 2 ¼" x 3 5/8" x 7 5/8" and shall meet the requirements of ASTM C902 for Class SX, Type 1 brick and ASTM C1272.***

***b. The bricks shall be placed in a Soldier Course pattern on type A and Type M ramps, or in the Herringbone or Soldier Course pattern on Type B ramps.***

***c. The bricks shall be saw cut only and any brick shall not be less than 25% of a full brick.***

***d. Type M mortar shall be used for the setting bed and grouted joints in accordance with ASTM C270, Table 1 (Masonry Cement Type only).***

***2. Cast-in-Place Tiles: Acceptable products include ceramic composites, composites, reinforced concrete, or materials of strength and durability similar to that of the concrete walking surface. Proposed materials shall be approved by the City prior to installation.***

3. ***Color for all surfaces options shall be 'brick red'. Any color variation to meet contrast requirements must be approved by the City.***

4. ***Surface applied retrofit tiles shall not be allowed.***

2302 Asphalt Sidewalks, Driveways, and Bicycle/Pedestrian Paths

ADD the following statement to Paragraph 2302.1

Scope: ***Asphalt shall not be allowed for sidewalks, driveways and bicycle/pedestrian paths within the public right-of-way.***

Section 2304 Concrete Paver Stones (for Median Treatment)

2304.3 Material: ADD the following1.3.A Concrete:

***Stamped and colored concrete shall be used for medians and edge treatments along arterial streets. Interlocking paver stones will not be allowed for such use along arterial streets.***

2305 Maintenance of Traffic: Delete APWA section in its entirety (replace with LS Section 3000 – Traffic Control, Marking and Signing)

2306 Pavement Markings: Delete APWA section in its entirety (replace with LS Section 3000 – Traffic Control, Marking and Signing).

# SECTION 2400 – SEEDING AND SODDING

## CITY OF LEE'S SUMMIT, MISSOURI
## STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2400 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition**.**

# SECTION 3500 - SANITARY SEWERS

# CITY OF LEE'S SUMMIT, MISSOURI
# STANDARD SPECIFICATIONS

## 3501 MATERIALS

A. General: All materials shall conform to the latest revision of the reference standard applying to that particular material.

B. Pipe and Fittings for Sanitary Sewers

1. Allowable Materials: Pipe and fitting materials used in the construction of sanitary sewers shall be:

   a. Ductile Iron (DI) special thickness Class 50
   b. Polyvinyl Chloride (PVC)
   c. High Density Polyethylene (HDPE) (for force mains only)

2. Requirements: The pipe manufacturer shall furnish pipe of materials, joint types, sizes, and strength classes indicated and specified. The Contractor shall furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures, and appurtenances.

3. Manufacturer's Experience: The Manufacturer shall be experienced in the design, manufacture, and commercial supplying of the specified material.

4. Inspection and Testing: Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards.

5. Markings: Each pipe or fitting shall have the following information plainly and permanently marked by indenting in the outside surface of the pipe or painted thereon with waterproof paint:

   a. Pipe size and class or designation.
   b. Date manufactured and lot number.
   c. Manufacturer's name or trademark.
   d. For ductile iron pipe, in lieu of the above listed markings, the information may be provided on an adhesive bar code labeling system that complies with AWWA Standards. The adhesive label shall be provided on the outside surface near the bell.

6. Handling: The Manufacturer and Contractor/Developer shall use equipment and methods adequate to protect the pipe and joint elements and to prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water-tightness shall be rejected.

7. On-Site Inspection: All pipe and appurtenances shall be inspected by the Inspector prior to installation, and all damaged pieces, as well as any pieces not complying with

the City of Lee's Summit Standard Specifications, shall be immediately removed from the job site and replaced by pipe and appurtenances as may be acceptable to the Inspector at the expense of the Contractor/Developer.

8. Certification: Suppliers shall submit certifications with their material delivery. These certifications shall be given to the Inspector.

C. PVC Sewer Pipe and Fittings

1. Type PSM PVC Sewer Pipe and Fittings (4-inch through 15-inch diameters only): Pipe and fittings shall conform to ASTM D 3034 and F1336, except as otherwise specified herein.

   a. Material: The pipe shall be made of PVC plastic having a cell classification of 12454B or 12364B as defined in ASTM D 1784. The fittings shall be made of PVC plastic having a cell classification of 12454B or 13343B as defined in ASTM D1784.

   b. Design: Pipe shall have an integral wall bell and spigot joint and a minimum wall thickness complying with SDR 26. Fittings shall have a minimum wall thickness complying with SDR 26.

   c. Joints: Joints shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

   d. Fittings:

      i. Fittings defined as wye connections suitable for assembly to 4- or 6-inch building sewers shall be bell-end with a minimum wall thickness complying with SDR 26 and shall be furnished by the pipe manufacturer.

      ii. Fittings shall be clearly marked with their SDR number. The markings shall be applied to the fittings in such a manner that they remain legible after installation and inspection has been completed.

2. PVC Pressure-Rated Pipe (SDR Series): Pipe shall conform to ASTM D 2241 except as otherwise specified herein.

   a. Material: The pipe shall be made of PVC plastic having a cell class of 12454B or 14333B, as defined in ASTM D 1784.

   b. Design: Pipe shall have an integral wall bell and spigot joint. Pipe shall have a minimum wall thickness complying with Table 2 in ASTM D 2241.

   c. Joints: Joints shall conform to ASTM D 3212 for gravity lines and ASTM D 3139 for pressure lines. Joints shall be push-on type only with the bell-end grooved to

receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

d. Fittings: Fittings shall be DI and shall conform to the requirements of Paragraph 3501.D.

3. PVC Plastic Pipe, Schedule 40: Pipe and fittings shall conform to ASTM D 1785 and ASTM D 2466, respectively, except as otherwise specified herein.

a. Material: The pipe and fittings shall be made of PVC plastic having a cell class of 12454B, as defined in ASTM D 1784.

b. Design: Pipe shall have an integral wall bell and spigot joint. Pipe shall have a minimum wall thickness complying with Table 2 in ASTM D 1785. Fittings shall have a minimum wall thickness complying with Table 1 in ASTM D 2466.

c. Joints: Joints shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

d. Fittings:

i. Fittings shall be bell-end with a minimum wall thickness complying with Schedule 40 and shall be furnished by the pipe manufacturer.

ii. Fittings shall be clearly marked with their schedule number. The markings shall be applied to the fittings in such a manner that they remain legible after installation and inspection has been completed.

D. Ductile Iron Pipe (DIP) and Fittings: Pipe and fittings shall conform to ANSI/AWWA C151/A21.51, ANSI/AWWA C110/A21.10, and ANSI/AWWA C153/A21.53 except as otherwise specified herein.

1. Design: All DIP shall meet the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51. The minimum thickness shall be Special Thickness Class 50.

2. Joints: Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI/AWWA C111/A21.11. Natural rubber gaskets shall not be accepted.

3. Restrained Joint Pipe and Fittings: Restrained joint pipe and fittings shall be per the pipe manufacturer's recommendation. American Flex-Ring, US Pipe TR Flex, Griffen Snap-Lok, Griffen Bolt-Lok and McWane TR Flex are considered restrained joints.

4. Coatings: The pipe exterior shall be coated with a layer of arc-sprayed zinc per ISO 8179 with a mass of 200 g/m2. Pipe markings shall include the word "ZINC". The

zinc shall be covered with a standard thickness exterior bituminous coating complying with ANSI/AWWA C151/A21.51.

5. Linings: Pipe and fittings shall have a hydrogen sulfide resistant ceramic quartz filled amine cured novalac epoxy interior lining, 40 mil nominal thickness. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

6. Polyethylene Encasement: All ductile iron pipe and fittings shall be installed with a polyethylene tube encasement having a thickness of 0.008 inches (8 mils) and complying with Section 4.1.1. of ANSI/AWWA C105/A21.5.

E. HDPE Pipe and Fittings: Pipe and fittings shall conform to ANSI/AWWA C901 and ANSI/AWWA C906 except as otherwise specified herein.

1. Material: The pipe and fittings shall be made of polyethylene (PE) plastic having a grade if PE34 with a minimum cell classification of 345464C, as defined in ASTM D 3350.

2. Design: All HDPE pipe and fittings shall meet the requirements of ANSI/AWWA C901 and ANSI/AWWA C906. Pipe shall have a minimum wall thickness complying with DR 11. The pressure class shall be 1.5 times the working pressure plus 100 psi surge allowance.

3. Fittings: HDPE fittings shall comply with ANSI/AWWA C906 and the requirements of ASTM D 2683 for socket-type fittings, ASTM D 3261 for butt heat fusion fittings, and ASTM F 1055 for electrofusion type fittings.

F. Concrete: Concrete shall be a MCIB mix with a design strength of 4500 psi, unless otherwise shown on plans. Mix shall meet MCIB Specifications November 2007 as listed on the Concrete Promotional Group Website www.concretepromotion.com.

G. Granular Bedding Aggregate Material: See Section 2100.

H. Backfill: See Section 2100.

I. Flowable Backfill: Flowable backfill shall consist of Controlled Low Strength Material (CLSM) complying with the requirements of Section 2100, Mix Design Type A.

J. Trench Checks: Trench checks shall consist of flowable backfill as specified in Paragraph 3501.I.

K. Pipe Encasement: Concrete used for pipe encasement shall be a 4500 psi MCIB mix. Reinforcing steel shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

L. Pipe Collars: Concrete, whether reinforced or non-reinforced, used for pipe collars shall be a 4500 psi MCIB mix. Reinforcing steel, when required, shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

M. Pipe Anchors: Concrete, whether reinforced or non-reinforced, used for pipe anchors shall be a 4500 psi MCIB mix. Reinforcing steel, when required, shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

N. Building Sewer Stubs: Building sewer stubs shall be SDR 26 (minimum) PVC.

O. Casing pipe

1. Pipe

a. The casing pipe shall be made of steel, meeting the requirements of ASTM A 139, grade B, with a minimum yield strength of 35,000 psi.

b. The minimum wall thicknesses required are shown in the following table:

c.

| Casing Diameter (inch) | Minimum Wall Thickness |
|---|---|
| 10, 12, 14, 16 | 0.188" (3/16") |
| 18, 20, 22 | 0.250" (1/4") |
| 24, 26 | 0.281" (9/32") |
| 28, 30, 32, 34 | 0.312" (5/16") |
| 36, 38, 40, 48 | 0.344" (11/32") |

2. Pipe Supports:

a. Casing Spacers: Casing spacer shall be a two-piece shell or band made from T-304 stainless steel of a minimum 14 gauge thickness. The shell/band shall have risers made of 10 gauge T-304 stainless steel and have a PVC liner. The bearing surface (skid or runner) shall be made of an ultra high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon. The shell/band shall be bolted together with T-304 stainless steel bolts. The configuration of the carrier pipe in the casing pipe shall be centered. End seals shall be made by the same manufacturer as the casing spacers and shall use stainless steel bands to hold end seals to pipes.

b. Wood Skids:

i. Wood skids shall be made of 4-inch by 4-inch pressure treated lumber, 3 feet long.

ii. Skids shall be attached to sewer pipe with two stainless steel bands.

iii. When woods skids are used, sand shall be blown into the annular space between the sewer and casing pipes.

iv. Skids shall be spaced at 120° intervals around the circumference of the pipe. Two skids shall be used on each end of the pipe joint.

3. Ends of the Casing Pipe: The ends of the casing pipe shall be closed with one of the following (see the Standard Drawings):

    a. Manufactured end seal.
    b. Concrete plug with allowances for water flow.

P. Manholes

1. Precast Sections: Precast concrete manholes shall conform to ASTM C 478 with the following modifications.

    a. Wall thickness not less than one-twelfth of inside diameter, or 4 inches, whichever is greater, shall be used.

    b. Cement, fine aggregate, coarse aggregate and water used in the manufacture of precast manholes shall be as specified in MCIB, Section No. 1 (Materials).

    c. Integral cast bases shall be used unless prior approval is obtained from the City Engineer. The diameter of the base pad shall be 8 inches greater than outside diameter of the manhole.

    d. Pipe penetrations shall be fitted with a flexible pipe-to-manhole connector. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

    e. The minimum distance from the invert of the downstream pipe to the top surface of the base shall be 3 inches.

    f. Riser Rings

        i. Concrete: Precast riser rings shall be 4 inches or 6 inches in thickness. The use of lightweight concrete with fiber reinforcement is recommended. Reinforcing shall conform to ASTM C 478. Tongue and groove joints shall be used.

        ii. HDPE: Injection-molded HDPE adjusting rings as manufactured by Ladtech, Inc.

2. Cast-In-Place-Concrete: Concrete shall comply the requirements of a 4500 psi MCIB mix.

3. Reinforcing Steel: Reinforcing steel shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

4. Joint Sealant

    a. Between Precast Sections: Joints between precast manhole pipe sections and between the manhole casting frame and precast manhole pipe sections shall be sealed with preformed butyl joint sealants meeting the requirements of ASTM C 990. The minimum bead dimension shall be 1 square inch. The butyl component

of the preformed joint sealant shall consist of 60 percent (minimum) butyl rubber. Preformed joint sealants shall remain flexible at temperatures as low as 0° F. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

b. Exterior of Joints: The exterior of all joints including the joint between the manhole casting frame and the precast manhole pipe sections shall be sealed with one of the following:

   i. Press-Seal EZ-Wrap Butyl joint wrap with rubber backing, 6-inch wide, or an approved equal: The butyl component of the tape shall consist of 50 percent (minimum) butyl rubber, shall contain 2 percent or less volatile matter, and shall be 0.030 inches thick. The backing component shall be EPDM rubber. A release paper may be utilized. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

   ii. Heat-shrinkable joint wrap complying with ANSI/AWWA C216: The wrap system shall consist of a two-part material (backing + adhesive) with a closure system and a compatible primer. It shall consist of an irradiated and cross-linked polyolefin sheeting, pre-coated with a layer of anti-corrosion adhesive. The backing shall have a minimum recovery of 22%. The adhesive shall be a mastic-type, specially formulated to become fluid at temperatures achieved during installation and maintain flexibility in cold climates with installation temperatures down to -40°F. Upon cooling the adhesive shall form a tough, elastomeric protective layer. The wrap shall employ a closure seal to allow sealing of the overlap area. The overall thickness of an applied sleeve shall nominally measure 0.100 inches (2.5 mm). Refer to the Water Utilities List of Acceptable Manufacturers and Models.

   iii. The casting shall be sealed to the structure with an external sealing system. The seal shall be a continuous band, made of EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 65 mils. Each unit shall have a 2" wide mastic strip on the top and bottom edge rubber band. The mastic shall be non-hardening butyl rubber sealant, with a minimum thickness of ¼", and shall seal to the cone/top of the manhole and over the lip of the casting. Refer to the Water Utilities List of Acceptable Manufacturers and Models. Prior to placement of the mastic against the manhole or casting, the surfaces shall be coated with a primer capable of enhancing the mastic adhesion. The primer coat shall cover the entire surface area where the mastic is intended to adhere. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

5. Non-Shrink Grout: Non-shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C 827 and shall develop compressive strength not less than 3,000 pounds per square inch with a trowelable mix within 24 hours per ASTM C 109. The placement time shall be not less than 45 minutes based on initial set per ASTM C 191.

6. Gasket: Pipe openings shall contain flexible gaskets complying with the requirements of ASTM C 923. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

7. Waterproofing: All precast sections shall be waterproofed prior to shipment to the project site. Waterproofing shall be accomplished using one of the following coatings:

    a. When a sewage force main terminates in a manhole, the internal surface of the first two receiving manholes shall be lightly sandblasted and coated with a total dry film thickness of not less than 8.0 mils of Tnemec Series 69 Hi-Build Epoxiline II or approved equal.

    b. Exterior manhole surfaces shall be coated with one of the following materials:

        i. A total dry film thickness of not less than 14.0 mils of bituminous coating.

        ii. A total dry film thickness of not less than 4.0 mils of Tnemec Series 66 Hi-Build Epoxiline or approved equal.

8. Manhole Steps: Steel core plastic coated steps shall meet the following minimum requirements:

    a. The standard plastic coated step shall be as referenced in the Water Utilities List of Acceptable Manufacturers and Models.

    b. The plastic coating shall be a copolymer polypropylene complying with ASTM D 4101 with a classification of PP0344B33534Z02 or better.

    c. The steel core shall be a minimum of ½ inch in diameter and shall conform to ASTM A 615, grade 60.

9. Manhole Castings

    a. Material for all iron castings shall comply with the requirements of "Drainage Structure Castings," AASHTO M306, Section 3, except if cast iron is used, it shall be ASTM A48/AASHTO M105, Class 30B or better.

    b. Workmanship and Finish: Manhole castings shall comply with the requirements of AASHTO M306, Paragraphs 4.1 and 5.1. All castings shall be manufactured true to pattern and component parts shall fit together in a satisfactory manner.

    c. Seating and Bearing Surfaces: All horizontal-bearing surfaces shall be machined. Castings shall conform to the requirements of AASHTO M306, Paragraph 4.3.

    d. Rating: Castings shall be heavy duty and capable of handling loads of at least 40,000 pounds. Proof-load testing shall conform to the requirements of AASHTO M306, Section 7. Proof-load testing is not required for the adapters (Lee's Summit ID Nos. LS106A-D, LS107A-D).

e. Markings:

i. Imported castings shall meet the country-of-origin markings as required in Title 19, Code of Federal Regulations, Part 134 (19 CFR 134).

Lettering for country-of-origin marking shall not exceed 1 ½ inches.

ii. Castings shall conform to the requirements of AASHTO M306, Section 11. Julian heat date shall be cast, not stamped, into the castings.

f. Dimensional Tolerances: The dimensions of all castings shall be within the permissible variations specified in AASHTO M306, Paragraph 4.2, except 4.2.4 shall be replaced with the following: No casting shall weigh less than 95 percent of the specified weight shown on the Standard Drawings.

g. Frames and Covers: Frames and covers shall meet the following minimum requirements:

i. Critical dimensions and Lee's Summit part numbers shown in the Standard Drawings.

ii. All manhole frames (except the slab bolt-down manhole frame) shall be designed and delivered with a full mud ring. Partial projections shall not be accepted.

iii. All covers shall have two concealed pickholes that meets the manufacturer's requirements.

iv. All covers shall have the "City of Lee's Summit" and "Sewer" cast into the piece in 1 ½-inch and 3-inch letters, respectively.

v. Castings shall be fully interchangeable in the field with the equivalent Clay & Bailey models indicated in Paragraph 3501.P.9.h.vi.below.

vi. All parts shall have a Lee's Summit part number cast into the piece in 1-inch letters. Location of the part number shall be such that when the part is installed, part number shall be readily visible without excavation of adjacent material. Part numbers shall be as shown below:

| Part No. | Description |
|---|---|
| LS101A | Standard 24" Manhole Frame (Clay & Bailey 2007MR)<br>- Matching cover is LS101B |
| LS101B | Standard 24" Manhole Cover (Clay & Bailey 2007)<br>- Matching frame is LS101A |
| LS102A | Bolt-down Manhole Frame (Clay & Bailey 2014OR)<br>- Matching cover is LS102B |
| LS102B | Bolt-down Manhole Frame Cover (Clay & Bailey 2014OR) |

| | |
|---|---|
| | - Matching frame is LS102A |
| LS103A | Slab Manhole Frame (Clay & Bailey 2002)<br>- Matching cover is LS103B |
| LS103B | Slab Manhole Cover (Clay & Bailey 2007)<br>- Matching frame is LS103A |
| LS104A | Slab Bolt-down Manhole Frame (Clay & Bailey KCMO R4)<br>- Matching cover is LS104B |
| LS104B | Slab Bolt-down Manhole Cover (Clay & Bailey KCMO R4)<br>- Matching frame is LS104A |

vii. Covers marked with other cities' names and/or logos shall not be accepted.

viii. Covers located in the street right-of-way or adjacent utility easement shall be hot-dipped asphalt coated.

ix. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

10. Epoxy Manhole Liner: Epoxy manhole liners shall be installed inside the first two receiving manholes downstream of force main sanitary sewer system and shall meet the following minimum requirements:

a. Epoxy Manhole Liner for Manholes: The epoxy manhole liner shall be chemical resistant (below a pH of 2.0), VOC compliant, moisture tolerant, 100% solids, two (2) component epoxy system with the following properties:

| | |
|---|---|
| Flexural Strength [ASTM D-790]: | >10,000 psi |
| Compressive Strength [ASTM D-695]: | >10,000 psi |
| Tensile Strength [ASTM D-638]: | >7,000 psi |
| Adhesion: | Concrete Substrate Failure |

b. Refer to the Water Utilities List of Acceptable Manufacturers and Models.

Q. Utility Markers:

1. Utility marker tape shall be minimum 2 inches wide, 4-mil thick green plastic tape with the word "SEWER" lettered in permanent black graphics.

2. In addition to utility marker tape, PVC and HDPE force main shall have a tracer wire installed along the top of the pipe. The wire shall be insulated, no smaller than 12 gauge, and for underground applications.

3. Splices in wiring shall be made with epoxy/silicon splice connector.

4. Tracer wire shall be installed along the top of service laterals. The wire shall have HDPE insulation, be no smaller than 12 gauge, and intended for underground applications. The tracer wire shall be green in color. Tracer wires shall terminate at

the ground surface inside a tracer box. Tracer box lids shall be green in color. Tracer wire shall be grounded to a minimum one pound magnesium anode at the sewer line.

## 3502 CONSTRUCTION AND INSTALLATION

A. General

1. Notification

a. Disruption of Sanitary Sewer Service:

i. When a disruption of sanitary sewer service will occur, the Contractor shall notify Water Utilities Operations at least 48 hours in advance to make the necessary arrangements.

ii. It shall be the Contractor's responsibility to place door hangers on the affected premises at least 24 hours in advance of the disruption. The door hanger shall indicate the date and time of the disruption and its anticipated length.

b. The Contractor's work shall be scheduled in a manner to accommodate the schedules of the City and the affected customers.

2. Protection of Existing Water Mains, Sewers, Structures, or Utilities

a. Where new lines approach, cross, connect to, or run parallel to existing water or sewer mains, the Contractor shall be held completely responsible for protecting, preserving, and otherwise maintaining existing line during construction of new line. Any damage inflicted to water and sanitary sewer mains or structures must be promptly reported to Water Utilities Operations and arrangement made for the repair. Any damage inflicted to storm sewer lines or structures must be reported promptly to the Public Works Operations Division and arrangement made for repair. Any damage inflicted to any other utility must be reported promptly to the respective utility and arrangement made for the repair.

b. Where new construction interferes with operation of existing mains, Contractor shall provide bypass lines or other temporary connections are required to maintain continuous service.

c. The Contractor shall protect all existing structures, utilities, and work of any kind against damage or interruption of service that may result from the operations of the Contractor. Damage or interruption of service resulting from failure to do so shall be repaired or restored promptly at the expense of the Contractor.

d. The Contractor shall give reasonable notice to utility companies and to other owners of property when such property is liable to damage or injury could result from the execution of the Work, so that the owners of such utility or property may take precautionary measures.

e. The Contractor shall be responsible to adjust to finish grade any existing utility/appurtenances (i.e. valves, meter wells, sanitary sewer manhole, storm junction box etc.) that is affected by construction.

3. Handling and Storage

a. Handle pipe materials and fittings in a manner to assure installation in sound and undamaged condition. Use slings, lifting bags, hooks, and other devices designed to protect pipe, joint elements, and coatings. In handling plastic pipe of 10 feet long or greater, a double sling will be required.

b. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.

c. Pipe shall be handled in a manner that minimizes the damage to the coating. Damaged coating shall be repaired in a manner complying with the pipe manufacturer's recommendations.

4. Inspection of Materials: All pipe, fittings, and accessories shall be examined by the Inspector prior to installation for soundness and specification compliance. Rejected materials shall be marked and removed from the project site, and replaced with approved materials.

5. Alignment: Pipe shall be laid to the lines and grades as shown on the approved Engineering Plans.

6. Cleaning: All pipe, fittings, and accessories shall be kept clean of foreign matter while being handled or stored. During installation, foreign matter shall not enter the pipe or appurtenances. At the end of each working day, a temporary plug shall be installed at the termination of the pipeline.

B. Sanitary Sewer Installation

1. Installation Standards: All pipes shall be installed in accordance with the following standards:

a. DIP - ANSI/AWWA C 600.

b. PVC Pipe - ASTM D 2321.

c. HDPE Pipe - Plastics Pipe Institute, "Underground Installation of Polyethylene Pipe".

2. Installation

a. Governmental Requirements: Sanitary sewer main installation shall comply with applicable local, State, and Federal requirements.

b. Trench Dewatering: See Section 2100.

c. Drainage Course Crossings: See Section 2100.

d. Trench Widths

i. Minimum Widths: Trench widths and pipe clearances shall be not less than those shown in the following table.

| MINIMUM TRENCH WIDTHS AND PIPE CLEARANCES (in) | | | |
|---|---|---|---|
| **Nominal Pipe Diameter** | **Trench Width[1]** | **Pipe Side Clearance[2] (Soil/Rock)** | **Pipe Bottom Clearance (Soil/Rock)** |
| 6 | 22 | 6/6 | 6/6 |
| 8 | 22 | 6/6 | 6/6 |
| 10 | 24 | 6/6 | 6/6 |
| 12 | 27 | 6/6 | 6/6 |
| 15 | 30 | 6/6 | 6/6 |
| 18 | 34 | 6/6 | 6/6 |
| 21 | 39 | 7/9 | 6/9 |
| 24 | 43 | 7/9 | 6/9 |
| 27 | 48 | 8/9 | 6/9 |
| 30 | 54 | 8/9 | 6/9 |

[1] Measured below a horizontal plane 6 inches above the top of the pipeline.

[2] Measured from the outside face of pipe barrel to inside face of trench.

ii. Maximum Widths

(a) Maximum trench widths shall not exceed the manufacturer's recommendations.

(b) The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and 6 inches above the top of the pipe.

(c) The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded, the Contractor shall provide appropriate embedment as indicated by the Design Engineer and the City Engineer.

iii. Trench Slope: See Section 2100.

iv. Trench Shields: See Section 2100.

e. Compacted Fill: See Section 2100.

f. Pipe Embedment: All pipe shall be bedded in bedding material with a minimum thickness beneath the pipe as specified in Paragraph 3502.B.2.d. See Section 2100.

g. Bedding Installation: See Section 2100.

3. Backfill: See Section 2100.

4. Utility Marker Tape: Install utility marker tape above the centerline of each sewer line. Bury marker tape 18 to 24 inches below finished grade, along the full length of the sewer line. When tracer wire is required, the tracer wire shall be installed along the top of the pipe on all mains and services so that the wire is in relatively continuous contact with the pipe and shall be for underground applications. The wire shall be accessible at every manhole, vault or tracer box. Marker tape and tracer wire shall be inspected by the public works inspector prior to backfill. All tracer wires shall be tested before acceptance. Any tracer wire broken during installation shall be repaired by the Contractor.

5. Wyes and Building Sewer Stubs: Wyes and building sewer stubs shall be installed as shown on the Engineering Plans or specified herein.

   a. Building sewer stubs shall be adequately plugged to prevent foreign matter from entering the pipe during construction.

   b. Wyes shall be installed at a maximum of 45 degrees and not less than 30 degrees with pipe spring-line, for pipe sizes 8- through 16-inch diameters. Wyes shall not be installed in pipe sizes equal to or greater than 18 inches in diameter.

   c. When the building sewer stub grade exceeds 20 percent, pipeline anchors shall be installed as required under Paragraph 6501.E.7 with the first anchor not more than 12 or less than 5 feet upstream of the wye.

   d. All building sewer stubs shall be constructed bell to spigot.

   e. For new construction, where a wye has been provided for a private building sewer, a second wye shall not be provided (cut-in by the builder).

   f. The Contractor shall maintain an accurate record for submittal to the Design Engineer of location, size, and direction of each wye and insertable fitting and the elevation, location, size, and length of each building sewer stub. Locations shall use the pipeline stationing as shown on the Engineering Plans.

6. Gravity Sewers: All gravity sewers shall be installed to the alignment, elevation, slope, and with pipe embedment as specified and/or shown on the Engineering Plans.

7. Pipe Encasement, Collars, Anchors, and Trench Checks

   a. Concrete construction shall comply with ACI 301, Specifications for Structural Concrete.

b. Total or partial encasement of pipe in concrete shall be used where the required safe supporting strength of the pipe cannot be obtained by other bedding methods. Concrete encasement shall also be provided at locations to protect public water supplies or where there exists the possibility that standard bedding may be eroded by currents of water under and around the pipe.

c. Concrete encasement shall be constructed at locations indicated and in accordance with details as shown on the Engineering Plans and in the Standard Drawings. Start and terminate encasement at a pipe joint. Adequately support and block the pipe to maintain position and prevent flotation. Form to dimensions indicated or construct full width of a trench.

   i. Longitudinal reinforcement shall be continuous.

   ii. Concrete encasement shall be protected and cured so as to prevent excessive evaporation of moisture or freezing. Backfilling will not be considered as a suitable method of curing the encasement.

   iii. Backfill trench only after concrete encasement has obtained a minimum of 2000 psi. All backfilling shall be done in accordance with Section 2100.

d. Collars shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the Standard Drawings.

e. Anchors shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the Standard Drawings.

f. Trench Checks: Trench checks shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the standard drawings. They shall consist of flowable backfill and extend 12 inches below the bottom of the pipe. Length shall be a minimum of 12 inches and width shall be the width of the trench. The height of the trench check shall extend to 12 inches above the top of the pipe.

8. Pipe Laying: All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

   a. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Design Engineer for approval a better bedding for the pipe or pipe of sufficient strength to provide safe supporting strength.

   b. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.

   c. Pipe and fittings rejected by the Inspector shall be marked and removed from the project site. All pipe and fittings shall be examined for soundness and

specification compliance prior to placement in the trench and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.

d. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer. Keep lubricants and applicators clean.

e. Pipe laying shall begin at the lowest point. The Contractor will not be allowed to lay any pipe if manholes are not on the project site. The pipe laying upstream of a manhole shall not proceed until the base of the manhole has been placed and leveled.

f. Unless otherwise required, lay all pipe straight between manholes. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.

g. The alignment of all pipelines between adjacent manholes shall be true to line and grade. The pipeline from manhole to manhole shall reflect the full bore of the pipe. The pipe shall be truly centered into the abutting pipe.

h. The grade lines shown on the profile drawings extend from the centerline of the top manhole to the centerline of the bottom manhole. The pipes and appurtenances shall be truly laid to line and grade throughout, all junctions and other pieces required shall be properly excavated for and laid as shown on the Engineering Plans, and the following tolerances from true horizontal alignment and vertical grade shall be maintained:

| | |
|---|---|
| Horizontal Alignment: | $\pm$12 inches |
| Vertical Grade: | $\pm$ 0.1 feet |

Pipe installed but not meeting these tolerances shall be ordered removed and replaced at the Contractor's expense.

i. The sewer trench shall be excavated to sufficient depth to allow embedment to be placed in the bottom of all trenches. At the pipe joints, the trench shall be excavated to an additional depth so that the bell will not rest on the bottom of the trench, and all the weight of the pipe shall be evenly distributed along the entire length of the barrel of the pipe.

j. The sewer must be made watertight at all points; any leaks or other defects discovered at any time before the final acceptance of the Work shall be immediately repaired or that portion of the sewer shall be rebuilt if necessary.

k. In all cases, full length sticks of pipe shall be used, except in making closures.

l. Clean interior of all pipe, fittings, and joints prior to installation. To exclude entrance of foreign matter during discontinuance of installation, close open ends of

pipe with snug fitting closures. Take reasonable precautions to not let water fill the open trench, and include provisions to prevent pipe flotation. Remove water, sand, mud, and other undesirable backfill materials from trench before removal of end cap.

m. In forming joints, each length of pipe shall be carefully aligned in such manner as to form an accurate concentric joint, thus providing a uniform circular pipe opening. Each length of pipe shall thrust into the bell and shall be securely held in position until the next length of pipe has been placed. Insofar as possible, commence laying of downstream end of line and install pipe with spigot or tongue end downstream.

n. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joints shall be made under water.

o. Joints:

i. Joints shall in general be made in accordance with the manufacturer's recommendations and as specified herein. All joints to be welded or fused shall be performed by a technician certified by the manufacturer.

ii. Clean and lubricate all joint and gasket surfaces with lubricant recommended by pipe manufacturer.

iii. Care shall be exercised by the Contractor to insure against damage to joint material in storage, handling, or placing operations.

iv. No damaged joint material shall be permitted to be used, and the same shall be removed from the job site.

v. All pipe joints shall be completed by insuring that the ends of the pipe to be joined are in contact and completely shoved into "home" position.

p. Pipe shall be cut in a neat workmanlike manner without damage to pipe. Cutting of pipe with a torch is not permitted. Smooth cut by power grinding to remove burrs and sharp edges. Repair the lining as required and approved by the Inspector.

q. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of storm water or other foreign matter.

r. When a sanitary sewer line crosses an existing pipeline (water lines and storm), and the clearance is less than 18 inches, concrete encasement shall be required in a manner approved by the City’s on-site representative.

9. Temporary Plugs

a. Provide and install plugs as manufactured by pipe supplier or as fabricated by Contractor if approved. Plugs shall be watertight against hydraulic heads up to 20 feet. Secure plugs in place in a manner that facilitates removal when required to connect pipe.

b. Plugs shall be installed as specified or where shown on Engineering Plans. Also the open end of the sewer shall be plugged at the end of the work day with a suitable mechanical plug to prevent entry of foreign material until work is resumed.

10. Removal of Water: The Contractor shall provide dewatering as specified in Section 2100. Damaged pipe or structures of any kind resulting from insufficient dewatering facilities or similar lack of proper conduct of the work shall be replaced by the Contractor at their own expense. No structure or pipes shall be laid in water, and no water shall be allowed to run into or over any concrete work or pipe, or into or through any pipe.

11. Sewer Main Connections to Existing Pipelines and Structures

    a. General: Connect pipe to existing structures and pipelines where indicated.

    b. Tying a Sewer Main to an Existing Manhole: Prepare structure by making an opening with manufacturer's recommended clearance all around fitting to be inserted. The concrete structure shall be core drilled, and a flexible pipe-to-manhole connector/gasket shall be installed in such a manner that a watertight condition will result. Refer to the Water Utilities list of Acceptable Manufacturers and Models for flexible pipe-to-manhole connectors/gaskets.

    c. Adding a Manhole onto an Existing Sewer Main:

        i. The Contractor shall cut the existing sewer main, set a pre-cast base onto a 6-inch thick (minimum) crushed rock bedding layer, and insert sewer pipe through the manhole to connect the existing ends of the sewer main. The ends may be connected to the existing sewer through the use of rigid couplings if a bell(s) is (are) not available. The inverts may be formed using non-calcium chloride high-early strength concrete.

        ii. Any portion of the existing sewer damaged by the Contractor shall be repaired or replaced. Any damaged vitrified clay pipe shall be replaced with PVC pipe, as a minimum, or DIP if required by its location.

        iii. Bypass pumping shall be required and shall be coordinated with Public Works Inspections.

    d. Pipe Connecting to a Structure: Pipe connecting to a structure shall be supported with bedding aggregate as specified in Section 2100.

12. Connection of Pipes of Dissimilar Materials:

a. General: The connection of pipes of different materials shall be made using approved transition couplings, and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.

b. Pipe Diameters less than 15 Inches: Connections between different pipe materials less than 15 inches in diameter shall be made using a Maxadaptor coupling or approved equal unless otherwise specified on the Engineering Plans.

c. Pipe Diameters Greater than or Equal to 15 Inches: Connections between different pipe materials greater than or equal to 15 inches in diameter shall be made using a Fernco Strong Back coupling. The coupling shall be encased in MCIB/KCMMB 4000 psi concrete mix to a level 6 inches above the top of the pipe material unless otherwise specified on the Engineering Plans.

13. Abandonment of Building Sewer Stubs

a. Building Sewer Stubs shall be disconnected from the sewer main when buildings are demolished and future reuse of the sewer stub is not anticipated or the sewer stub is not compliant with the applicable codes and standards in effect at the time.

b. Building sewer stubs shall be disconnected from the sewer main when property that contains sewer stubs is re-platted and those sewer stubs are no longer necessary for future development.

c. A building sewer stub may be left in place and reused for future development if the stub and the connection to the main are complaint with the codes and standards in effect at the time, if it is capped with a water tight seal at or near the edge of the right-of-way and it is marked by vertically burying a 2”x4” with a steel spike from the end of the sewer stub to the surface of the ground.

d. Building sewer stubs being disconnected from the sewer main shall be disconnected by the Water Utilities Department, after the contractor has provided access to the sewer main via an OSHA compliant excavation with proper shoring as necessary. Water Utilities staff reserve the right to not enter any trench determined to be unsafe.

14. Abandonment of Sewer Mains

a. Prior to abandonment of a sewer main, the Contractor shall contact the Water Utilities Department to verify that no existing services will be affected. Building sewer stubs shall be properly abandoned prior to abandoning the sewer main.

b. Sewer mains shall be abandoned by plugging each end of the line segment with a 1- foot thick plug of non-shrink grout sealed with Portland Cement Grout, or removed, backfilled and restored as directed by the Water Utilities Department.

15. Protection of Water Supplies

a. There shall be no physical connection between a public or private potable water supply system and a sewer, or an appurtenance thereto, that would permit the passage of any wastewater or polluted water into the potable water supply.

b. Sewer mains, i.e., house connections, building sewers, trunk lines, interceptors, force mains, etc., shall not be constructed within a 100-foot radius of a public water supply well. Greater separation may be required where soil and drainage conditions indicate the need for greater protection. Sewer mains constructed of DIP may be constructed within 10 feet of a private water supply well. Sewer mains constructed of other materials must be at least 50 feet from a private water supply well.

c. For sewer mains paralleling or crossing water mains, see Paragraph 6501.E.1.c.

d. Water and sewer mains shall not be placed in the same trench or excavation.

C. Acceptance Tests for Completed Sewers

1. General

a. The Contractor shall furnish all labor, equipment, water, materials, and reports for the required acceptance tests. All pipelines, including building sewer stubs, shall undergo and pass all required tests to determine soundness and workmanship. Pipelines that do not comply with the City of Lee's Summit Standard Specifications shall be repaired and/or replaced and shall be retested until the pipeline meets said specifications.

b. No testing shall be performed before backfill and compaction operations have been completed unless otherwise approved by the Inspector. In general, testing for sanitary sewers shall begin at least 30 days after completion of all sanitary sewer.

c. After backfilling has been completed, the Contractor shall conduct all testing in the presence of the Inspector.

d. Each reach of sewer shall meet the requirements of the acceptance tests. All defects shall be repaired to the satisfaction of the Inspector.

e. The Contractor shall clean and flush with clear water the pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.

2. Sewer Pipe Alignment and Grade Testing: Alignment, grade and visible defects shall be checked as follows:

a. Sewer Pipe Deflection Testing: Flexible pipelines (i.e., PVC pipe) shall be tested for deflection by pulling a mandrel through the entire length thereof.

i. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine evenly-spaced arms or prongs. Mandrels with fewer arms will be

rejected as not sufficiently accurate. The dimensions of the mandrel shall be as listed in the table below. The mandrel diameter dimension shall carry a tolerance of ±0.01 inch. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the mandrel diameter dimension but shall be counted in as part of the 5 percent or lesser deflection allowance. Contact length shall be measured between points of contact on the mandrel arm. The length shall not be less than as shown in the table below.

| **Nominal Diameter (in)** | **Mandrel Length (in)** | **Mandrel Diameter (in)[1]** | |
|---|---|---|---|
| | | **SDR 26[2]** | **SDR 21[3]** |
| 8 | 8 | 7.37 | 7.41 |
| 10 | 9 | 9.21 | 9.21 |
| 12 | 10 | 10.96 | 10.96 |
| 15 | 12 | 13.42 | N/A |
| 18 | 15 | N/A | 15.47 |
| 21 | 16 | N/A | N/A |
| 24 | 18 | N/A | 20.63 |
| 27 | 27 | N/A | N/A |

[1] Mandrel diameter = [avg. outside diameter - 2*(min. wall thickness)]*0.95

[2] Calculated using values from ASTM D3034.

[3] Calculated using values from ASTM D2241.

ii. The Inspector shall be responsible for approving the mandrel. In the event the Contractor provides the mandrel, he/she shall provide proving rings to verify this. No mandrel testing will be witnessed or approved by the Inspector without completion of the aforementioned verification of the mandrel size for the Work.

iii. The mandrel shall be hand-pulled by the Contractor through all sections of PVC sewer mains. Any sections of sewer not passing the mandrel test shall be uncovered, and the Contractor shall re-round or replace the sewer to the satisfaction of the Inspector. These repaired sections shall be retested.

iv. Sections of DIP sewer main shall be visually checked for deflection, i.e., not deflection tested with the mandrel due to the potential for damaging the cement mortar lining.

b. Television/Video Inspection: Sewer mains installed as part of the Work are subject to inspection by closed circuit television prior to 1) issuing a Certificate of Substantial Completion and 2) the end of the correction period. Television / video inspection will be done twice by the City at the City's expense. If more than two television / video inspections are necessary, they shall be performed by the

contractor and the television / video and inspection report submitted to the City for its review. Any deficiencies noted shall be repaired at the expense of the Contractor.

3. Exfiltration-Infiltration Testing

   a. General

      i. Air pressure or hydrostatic tests shall be conducted on sewers before acceptance by the City. The exfiltration-infiltration shall not exceed 50 gallons per day per inch of nominal diameter per mile of sewer main for any section of the Work.

      ii. Immediately prior to conducting a test, the groundwater level shall be determined by augering a vertical hole adjacent to the pipe and measuring the distance to the water level. Exfiltration head and air test pressures shall be adjusted for groundwater elevations over the top of the pipe.

   b. Sewer Pipe Exfiltration Testing: Exfiltration tests shall be performed by the Contractor using one or a combination of the methods as set forth below. The required air pressure and/or exfiltration testing shall be successfully performed on carrier conduits prior to sealing of the ends of the casing conduits. PVC gravity sewer pipe shall be air tested.

      i. Air Testing for PVC and DIP Gravity Sewer Mains

         (a) The Contractor may perform air tests for all pipe sizes.

         (b) Furnish all facilities required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulators to avoid over pressurization, and all miscellaneous items required.

         (c) Each section of gravity pipeline between manholes and/or structures shall be tested after backfilling as outlined below and in accordance with ASTM F 1417. The time-pressure drop method specified in 8.2.2 of ASTM F 1417 shall be used.

         (d) If the groundwater level is 2 feet or more above the top of the upstream end or if the test pressure required for the test is more than 9 psig, air testing should not be used.

         (e) The pipe plug for introducing air to the sewer main shall be equipped with two taps. One tap will be used to introduce air into the line being tested through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. Additional valves and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The

pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer main.

(f) The pressure test gauge shall meet the following minimum specifications:

| | |
|---|---|
| Size (diameter) | 4-1/2 inches |
| Pressure Range | 0-15 psi |
| Figure Intervals | 1 psi increments |
| Minor Subdivisions | 0.05 psi |
| Pressure Tube | Bourdon Tube or diaphragm |
| Accuracy | +/-0.25% of maximum scale reading |
| Dial | White coated aluminum with black lettering, 270$^{o}$ arc and mirror edge |
| Pipe Connection | Low male ½-inch N.P.T. |

Calibration data not more than one year old shall be supplied with all pressure test gauges. Certification of pressure test gauges will be required from the gauge manufacturer. This certification and calibration data shall be given to the Inspector prior to the performance of any air tests conducted for the Work.

(g) Plug ends of line and cap or plug all connections to withstand internal pressure. Due to safety considerations, the Contractor must take care to brace both the end of the pipe and plug before introducing test pressure into the system. The Contractor can then connect the air control equipment to the air hose and begin to pressurize the system. During the pressurization process, the Contractor shall monitor the air pressure of the system so that internal pressure does not exceed 5.0 pounds per square inch gauge (psig). After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least 2 minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the pressure begins to slowly drop from 3.5 psig and if the total time, in seconds, for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

| **Pipe Size (in)** | **Minimum Time (min:s)** | **Length for Minimum Time (ft)** | **Time for Longer Length (s) L = Total Length** |
|---|---|---|---|
| 8 | 7:34 | 298 | 1.520 L |
| 10 | 9:26 | 239 | 2.374 L |
| 12 | 11:20 | 199 | 3.418 L |
| 15 | 14:10 | 159 | 5.342 L |
| 18 | 17:00 | 133 | 7.692 L |

| | | | |
|---|---|---|---|
| 21 | 19:50 | 114 | 10.470 L |
| 24 | 22:40 | 99 | 13.674 L |
| 27 | 25:30 | 88 | 17.306 L |
| 30 | 28:20 | 80 | 21.366 L |

If air test fails to meet above requirements, repeat the test as necessary after all leaks and defects have been repaired and backfilled.

ii. Hydrostatic Tests for Gravity Systems:

(a) Test section shall be filled with water not less than 12 hours prior to testing. Refill the test section of pipe prior to performing the test.

(b) Perform at depths of water as measured above center line of pipe of not less than 4 feet or more than 10 feet (consideration shall be given for a water table above said centerline). Maintain the test as necessary to locate all leaks but not less than two hours.

(c) The Design Engineer shall determine the maximum allowable exfiltration rate for a given test section and then field verify that the maximum exfiltration rate has not been exceeded for that section. The maximum allowable exfiltration rate shall be approved by the City Engineer prior to testing.

c. Sewer Pipe Infiltration Testing: Where sewers are laid within the groundwater table, infiltration testing shall be conducted. Where the Inspector discovers evidence of infiltration, the Design Engineer and the City Engineer shall be contacted. The Contractor shall install weirs or other suitable flow rate measuring devices adequate to determine to the satisfaction of the City Engineer that the specified infiltration limit is not exceeded for that reach of gravity sewer. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective reach of the pipeline. Following repair of the pipeline, the Contractor shall re-measure infiltration flow rates and make additional repairs until an acceptable infiltration flow rate is achieved.

D. Manhole Installation:

1. Bases

a. Integral cast bases shall be reinforced in accordance with ASTM C 478. Precast integral cast bases shall be installed on a maximum of 6 inches of bedding aggregate. Depths exceeding this amount shall be filled with MCIB/KCMMB 4000 psi concrete mix.

b. If integral cast bases cannot be used, cast-in-place concrete bases shall be used with the approval of the City Engineer. Cast-in-place bases shall be MCIB/KCMMB 4000 psi concrete mix and have a minimum thickness of 12 inches. The bottom wall sections shall be embedded in the base section a

minimum of 4 inches. The bottom precast wall section shall not be set upon a previously poured base. Wood shall not be used for supporting or leveling the wall section prior to pouring the base.

2. Inside Dimensions: The minimum horizontal clear distance in the barrel of the manholes shall not be less than 4 feet.

3. Precast

   a. Delivery: Precast concrete components shall not be delivered to the job until representative concrete control cylinders have attained at least 80 percent of the specified minimum design strength.

   b. Inspection: Precast concrete shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C 478.

   c. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal wall and cone joints with a minimum of two beads of preformed butyl joint sealant. Seal the joints between the top of the cone, adjustment or riser rings and the manhole frame with a double bead of preformed butyl joint sealant. Sections shall be placed so that steps are aligned but without rotation or damage to sealant integrity. Lift holes in excess of 2 inches in depth shall be patched with non-shrink grout.

4. Cast-in-Place:

   a. Wall Thickness: Wall thickness shall conform to the dimensions as shown on the Engineering Plans.

   b. Construction: Reinforcement steel shall be placed as shown on the Engineering Plans. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where required, shall be installed as shown on the Engineering Plans. Water stops shall be installed at the wall and slab connection and shall be of the size, thickness, and material shown on the Engineering Plans.

   c. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications. Application shall conform to the manufacturer's recommendation.

5. Sealants. A double bead of preformed butyl joint sealer shall be applied to all joints. For the minimum bead dimension, see Paragraph 3501.P.44. The vertical spacing between manhole sections shall not exceed 1/4 inch. Joint sealants shall not be applied on damp or dirty surfaces.

6. Joint Wraps: The exterior of all joints, including the frame and cover assembly, shall be sealed with a 6-inch wide butyl joint wrap with rubber backing. Refer to the Water Utilities List of Acceptable Manufacturers and Models. The tape shall be overlapped

at least twice its width. The tape shall not be stretched during application. Primer and/or adhesive, as recommended by the tape supplier, shall be employed for adverse, critical, or other applications.

7. Epoxy Manhole Liner: Installation of epoxy manhole liner shall consist of: cleaning the entire manhole interior surface, preparation of the manhole interior surface, frame seal, grade adjustment, cone/wall joint, pipe seals, bench and invert as required, and lining the manhole interior surface with a two component, 100% solids epoxy coating system which provides a durable, high strength, monolithic lining, at an average thickness of 125 mils with a minimum thickness of 120 mils. The first two manholes downstream of a force main entering the system shall be lined along with any other manholes identified on the Engineering Plans.

8. Gaskets. When gaskets are used, two gasket clamps shall be utilized at each pipe-to-gasket connection with the take-up screws for the gasket clamps being positioned a minimum of 90° apart.

9. Steps: Steps shall be aligned vertically below the casting and spaced at 16-inch centers. The top step shall be not more than 1 foot below the top of the cone. The lowest step shall be not more than 1 foot above the invert bench. Field drilled step holes are not permitted in precast concrete manholes unless approved by the Inspector.

10. Castings:

    a. Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed butyl joint sealant.

    b. Bolt-down castings shall be held in place as shown on the Engineering Plans.

    c. Bolt-down castings shall be bolted to the manhole, not to the adjusting ring.

11. Top Slabs: Thickness shall conform to the dimensions and reinforcement steel shall be placed as shown on the Engineering Plans.

12. Inverts: Inverts shall be at least MCIB/KCMMB 4000 psi concrete mix and steel-troweled to produce a dense, smooth finish. The invert channel shall be "U" shaped in cross section and extend upward three-fourths of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation, and bends. The invert bench shall be sloped to drain. In no case shall the inverts extend into the pipe or create areas that will allow for the accumulation of debris or interfere with flow through the manhole. Manholes with precast inverts shall not be used, except as allowed in Paragraph 6501.H.10.a.

13. Top Elevation: The finish top elevation of manhole castings shall conform to the following unless otherwise shown on the Engineering Plans or directed by the Inspector.

a. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.

b. In non-pavement areas, the top of the casting shall be at the elevation shown on the Engineering Plans or as directed by the Inspector.

14. Manhole Adjustment: All new manholes will be provided with an adjustment ring(s) underneath the casting as shown on Engineering Plans. A maximum of two 6-inch or three 4-inch riser rings shall be installed on top of the cone section. Minimize the number of riser rings used. The joints shall be sealed with a double bead of preformed butyl joint sealant. If the top of an existing manhole is required to be raised to an elevation that will exceed 12 inches, or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.

15. Manhole Backfilling: Manhole backfilling shall be governed by Section 2100. Any damage to the exterior manhole waterproofing shall be coated with 14.0 mils of bituminous coating prior to backfilling.

E. Acceptance Testing for Completed Manholes

1. General: All manholes and other structures installed or otherwise disturbed during construction shall be tested for infiltration-exfiltration by the method described herein. Infiltration-exfiltration testing shall be performed in the presence of the Inspector. The Contractor shall notify the Inspector 2 working days prior to beginning manhole testing. All visible leaks shall be repaired by the Contractor prior to testing and during the correction period.

2. Infiltration-Exfiltration Testing:

a. For new manholes, lift holes penetrating the manhole wall in excess of 2 inches in depth shall be plugged with an approved non-shrink grout prior to testing. All pipes entering the manhole shall be plugged at least 8 inches into the sewer pipe. The plug shall be inflated at a location beyond the manhole/pipe. The plug and pipe shall be braced securely to prevent either item from being drawn into the manhole.

b. Test Method: The vacuum test apparatus shall be placed inside or on top of the casting and the seal inflated according to manufacturer's directions as appropriate. A vacuum of 10 inches of mercury shall be drawn, and then the vacuum pump shall be shut off. With valves closed and hoses removed, the time shall be measured for the vacuum to drop to 9 inches of mercury. The manhole shall be acceptable if the time for the vacuum to drop from 10 inches to 9 inches is as follows:

| **Manhole Depth** | **Time (min)** |
|---|---|
| 10 feet or less | 2.0 |
| 10.1 to 15.0 feet | 2.5 |

| | |
|---|---|
| 15.1 to 25 feet | 3.0 |
| 25.1 feet or greater | 3.5 |

c. Resealing, repairs, and retesting shall be allowed at the discretion of the Inspector.

d. If the manhole fails the initial test, necessary repairs shall be made with a water reactive elastomeric chemical grout, such as 3M Scotch Seal Chemical Grout 5600, or a water reactive polymer solution, such as Avanti AV-202, or equivalent. Resealing and retesting shall be performed until the manhole passes the test.

## 3503 ACCEPTABLE MANUFACTURERS AND MODELS

A. General: A list of acceptable manufacturers and models for various materials will be maintained by the City Engineer and updated on a regular basis. An approved list of materials can be found on the City's web site www.cityofls.net. Go to Development, then Development Regulations, then Design and Construction Manual.

# APPENDIX A

Geotechnical Report

# GEOTECHNICAL EXPLORATION AND RECOMMENDATIONS

**LEE'S SUMMIT MS#4 SEWER EXTENSION**
**Lee's Summit, MO**
CFS Project No. 20-1074-003

***Prepared For***
Lee's Summit R7 School District
301 NE Tudor Road
Lee's Summit, MO 64086

June 24, 2021

Prepared by:
Cook, Flatt & Strobel Engineers, P.A.
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103
913.627.9040

*One Vision. One Team. One Call.*

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# Geotechnical Exploration and Foundation Recommendations

## LEE'S SUMMIT MIDDLE SCHOOL #4 – SEWER EXTENSION

## LEE'S SUMMIT, MISSOURI

Project Number: 20-1074
June 24, 2021

# 1 INTRODUCTION

## 1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at the proposed Lee's Summit Middle School #4 sewer line extension project site.

This report includes geotechnical recommendations and considerations pertaining to site development, earthwork, construction, and drainage considerations associated with the proposed project.

# 2 PROJECT DESCRIPTION

CFS Engineers understands the planned project consists of constructing a new sewer line which will extend from the new Middle School #4 structure in Lee's Summit, Missouri to the existing sewer line located to the southwest of the school. The existing sewer line generally flows south from the existing residential development on SE Bailey Road to Greenwood, Missouri. The project will also include the removal and replacement of this section of sewer line.

Currently, the planned site consists of agricultural fields, wooded areas with creeks and water ditches throughout, a landfill, and residential properties. The new sewer extension will intercept the existing line at the south end of the field (Boring B5).

## 2.1 SITE GEOLOGY

Jackson County is located in the Central Lowland province of the Interior Plains and is near the middle of an approximate 150 mile-wide, north-south trending band of Pennsylvanian-Age Rocks that is located in western Missouri and eastern Kansas. Generally, the rock beds exhibit a subtle prevailing dip to the west-northwest of about 10 feet per mile. The region is underlain by rock units of the Pennsylvanian System, Missourian Series (Kansas City Group, Lansing Group, and Pleasanton Group) in the Time Stratigraphic Unit age classification.

# 3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

## 3.1 SCOPE OF WORK

This geotechnical exploration consisted of drilling 21 borings to auger refusal along the planned sewer line. Additionally, select borings were continued beyond auger refusal by means of standard core barrel techniques. The boring locations were laid out in the field by Cook, Flatt & Strobel Engineers using Google Earth.

*Please note, the original boring layout included 27 borings, however, certain borings could not be drilled due to access restrictions. This is the reason for skipped boring numbers on the boring logs.*

## 3.2 SUBSURFACE CONDITIONS

The following table presents a general summary of the major strata encountered during this subsurface exploration. Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report.

*Table 1: Elevations*

| Bore Hole ID | Existing Elevation | Bottom of Manhole | Manhole Depth | Depth to Top of Limestone |
|---|---|---|---|---|
| B1 | 983.9 | 972.3 | 11.6 | 10.5 |
| B2 | 981.5 | 967.5 | 14.0 | 6.5 |
| B3 | 972.2 | 964.2 | 8.0 | 7.0 |
| B4 | 970.0 | 961.5 | 8.5 | 7.0 |
| B5 | 969.0 | 959.0 | 10.0 | 7.0 |
| B6 | 967.3 | 955.4 | 11.9 | 6.0 |
| B7 | 966.5 | 953.4 | 13.1 | 12.0 |
| B8 | 964.4 | 951.3 | 13.1 | 10.5 |
| B9 | 964.7 | 949.4 | 15.3 | 13.0 |
| B12 | 962.2 | 944.8 | 17.4 | 10.5 |
| B13 | 958.0 | 942.6 | 15.4 | 3.0 |
| B14 | 955.6 | 940.4 | 15.2 | 15.0 |
| B15 | NA | NA | NA | NA |
| B16 | 956.9 | 936.1 | 14.0 | 19.5 |
| B17 | 950.4 | 934.6 | 15.8 | 13.0 |
| B18 | 946.1 | 932.7 | 13.4 | 12.5 |
| N19 | NA | NA | NA | NA |
| B20 | NA | NA | NA | NA |
| B21 | NA | NA | NA | NA |
| B22 | 937.2 | 925.1 | 12.1 | 6.5 |
| B23 | 942.1 | 924.3 | 17.8 | 11.5 |
| B24 | 941.8 | 923.3 | 18.5 | 12.0 |
| B25 | 937.8 | 922.4 | 15.4 | 12.5 |
| B26 | 945.8 | 921.4 | 24.4 | 13.5 |

| | | | | |
|---|---|---|---|---|
| B27 | 929.6 | 920.4 | 9.2 | NA |
| Please note that shale bedrock was penetrated prior to limestone in many of the borings. Reference the logs for more information. | | | | |

### 3.2.1 Overburden Material

Approximately twelve (12) inches of topsoil was encountered at the surface of the borings. The topsoil was generally underlain by gray-brown and gray fat clay (CH) with consistencies ranging from medium stiff to stiff. The fat clay material continued to the refusal material, occasionally taking on a shaley characteristic.

### 3.2.2 Refusal Materials

Auger refusal on highly weathered to slightly weathered limestone was encountered throughout the borings below the soil overburden. Please note, some highly weathered limestone was consistently encountered and penetrated prior to refusal. Please reference the logs for more information.

## 3.3 GROUNDWATER CONDITIONS

Free water was encountered during drilling in some of the borings prior to refusal. Often, groundwater travels along and is perched atop restrictive bedrock layers, such as the limestone encountered during this exploration. Please reference the logs for groundwater depths.

Please note, the reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

# 4 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, Project Description of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

1. *Shallow Bedrock*: CFS encountered shallow limestone and shale bedrock throughout this exploration. The bedrock was fairly weathered, but a hydraulic breaker may be needed to excavate the limestone and/or subsequent shale material.

## 4.1 SITE PREPARATION

CFS understands the new sewer line will be excavated in sections during installation. Once the excavations have reached the planned flow depths and prior to the placement of any clean rock or engineered fill, the exposed subgrade at these depths should be stable and suitable for support of the planned sewer and backfill materials.

Any topsoil and grass at the surface should be stripped from all structural fill areas and be stockpiles for later use in landscape areas or it should be wasted.

## 4.2 GRADING

### 4.2.1 Suitable Fill Material

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement or athletic track without being treated with cement as outlined later in this report.

### 4.2.2 Unsuitable Fill Material

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

### 4.2.3 Fill Placement

In general, fill placement should conform to APWA specifications. Additionally, fill should be placed in eight (8) inch loose lifts in utility trenches and behind walls.

A representative of the Geotechnical Engineer should monitor back filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 below for required testing frequency.

*Table 2: Density Testing Frequency*

| Location or Area | Standard Proctor Density (ASTM D 698) | Testing Frequency One per lift per … |
|---|---|---|
| Trenches under Roadway (minimum 3 tests/lift) | 95% | 100 lf |
| Utility Trenches – General (minimum 3 tests/lift) | 95% | 300 lf |

## 4.3 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site are *expected* to be made in "Type B" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances.

Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -3% to +3% of the optimum moisture content.

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D 698. No backfill should be deposited or compacted in standing water.

Precautions should be taken by the contractor to avoid undermining the newly constructed foundations/ rammed aggregate piers. Shoring and excavations supports may need to be designed to account for the existing building loads.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

## 4.4 DRAINAGE AND DEWATERING

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff.

## 4.5 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient.

*Table 3: Earth Pressure and Friction Coefficients*

| Material | Active ($K_a$) | Passive ($K_p$) | At-Rest ($K_o$) | Allowable Base Friction | Unit Weight (pcf) |
|---|---|---|---|---|---|
| Open-graded crushed limestone | 0.27 | 3.69 | 0.43 | 0.47 | 130-140 |
| In-situ lean clay soils | 0.40 | 2.5 | 0.68 | 0.32 | 95-115 |
| In-situ fat clay soils | 0.49 | 2.04 | 0.66 | 0.24 | 90-110 |
| Lean clay – conditioned and compacted | 0.32 | 3.12 | 0.48 | 0.35 | 95-115 |
| Fat clay – conditioned and compacted | 0.45 | 2.2 | 0.63 | 0.27 | 90-110 |

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied

upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

# 5 GENERAL COMMENTS

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

Respectfully submitted,

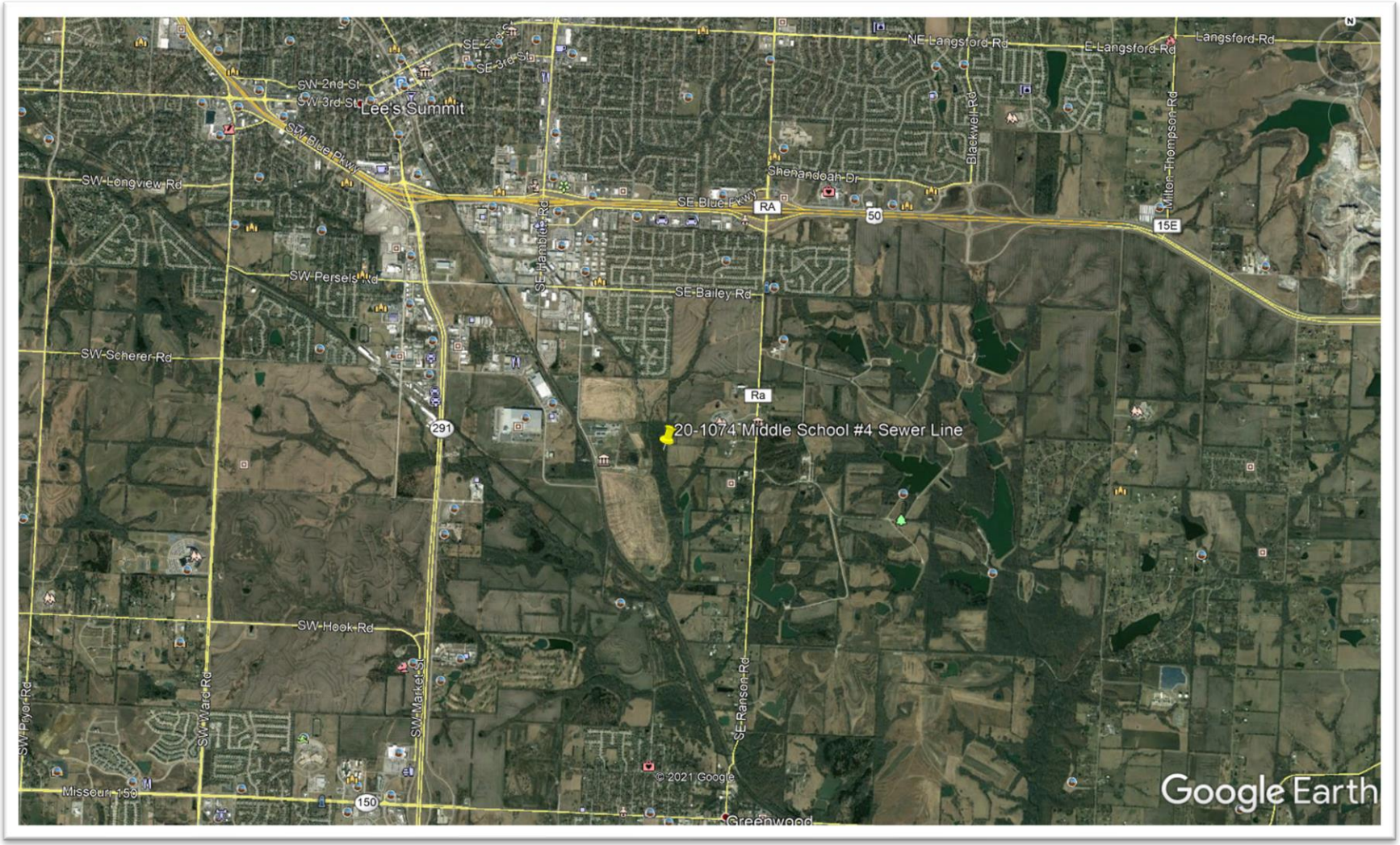
COOK, FLATT & STROBEL ENGINEERS, P.A.

STATE OF MISSOURI
JACOB PHILLIP ENGLER
NUMBER PE-2017018964
4/24/21
PROFESSIONAL ENGINEER

Jacob Engler, P.E.
Geotechnical Engineer

Adam McEachron, P.E.
Senior Geotechnical Engineer

# **Appendix A:** Figures

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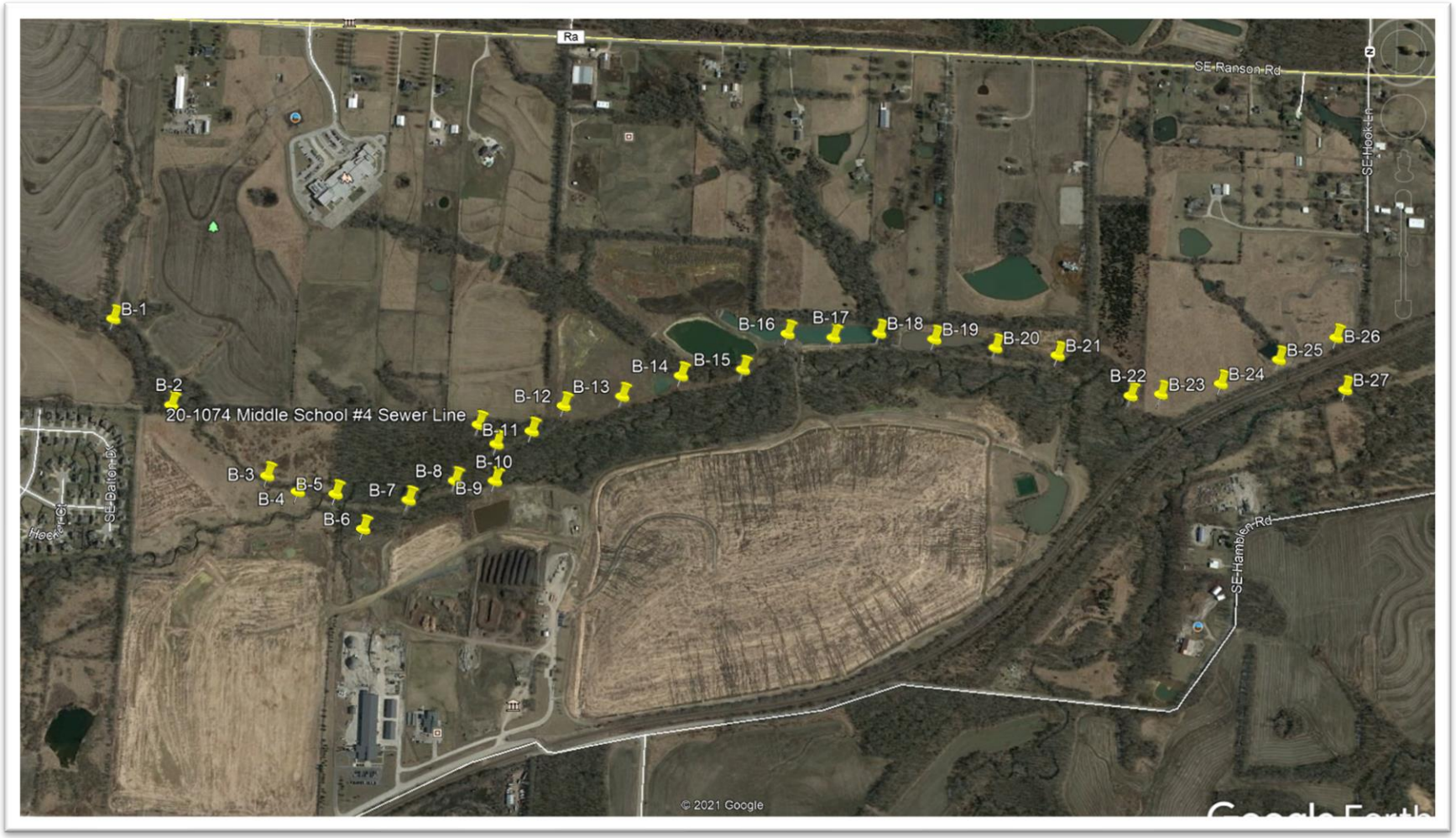
| | | | |
|---|---|---|---|
| Project: **MS#4 SEWER** | | Project #: 20-1074 | Figure 1: **SITE LOCATION PLAN** |
| Project Location: | Lee's Summit, MO | Comments: | |
| Client: | Lee's Summit R7 District | | |
| Date: | 4/20/2021 | | |

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| | | | |
|---|---|---|---|
| Project: **Lee's Summit MS#4 Sewer line** | | Project #: 20-1074 | Figure 2: **BORING LOCATION PLAN** |
| Project Location: | Lee's Summit, MO | Comments: | |
| Client: | LS R7 School district | | |
| Date: | 6/24/2021 | | |

## BORING B3


| Boring Elevation: | | 972.2 |
|---|---|---|
| RUN #: | DEPTH (FT): | MATERIAL |
| 1 | 10-Jul | LIMESTONE |

## BORING B5

| Boring Elevation: | | 969 |
|---|---|---|
| RUN #: | DEPTH (FT): | MATERIAL |
| 1 | 9.5-14.5 | LIMESTONE |


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| Project: | **Lee's Summit MS#4 Sewer** | Figure 3: | **Rock Core Photos** |
|---|---|---|---|
| Project Location: | Lee's Summit, MO | Project # | 20-1074 |
| Client: | Lee's Summit R-7 School District | Date: | 4/20/2021 |
| Comments: | | | |

## BORING B8

| Boring Elevation: | | 964.4 |
|---|---|---|
| RUN #: | DEPTH (FT): | MATERIAL |
| 1 | 11.5-16 | LIMESTONE/ SHALE |

## BORING B9

| Boring Elevation: | | 964.7 |
|---|---|---|
| RUN #: | DEPTH (FT): | MATERIAL |
| 1 | 13.5-18 | LIMESTONE |


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| Project: | **Lee's Summit MS#4 Sewer** | Figure 4: | **Rock Core Photos** |
|---|---|---|---|
| Project Location: | Lee's Summit, MO | Project # | 20-1074 |
| Client: | Lee's Summit R-7 School District | Date: | 4/20/2021 |
| Comments: | | | |

## BORING B26

| Boring Elevation: | | 945.8 |
|---|---|---|
| RUN #: | DEPTH (FT): | MATERIAL |
| 1 | 15-20 | LIMESTONE & SHALE |
| 2 | 20-25 | SHALE |
| 3 | 25-27 | LIMESTONE & SHALE |

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| | | | |
|---|---|---|---|
| Project: | **Lee's Summit MS#4 Sewer** | Figure 6: | **Rock Core Photos** |
| Project Location: | Lee's Summit, MO | Project # | 20-1074 |
| Client: | Lee's Summit R-7 School District | Date: | 4/20/2021 |
| Comments: | | | |

# **Appendix B:** Boring Logs

CFS Engineers, Inc
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# BORING NUMBER B1



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/07/21 **COMPLETED** 05/07/21
**GROUND ELEVATION** 983.9 ft **HOLE SIZE** 3.25 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 3.25-inch Continuous Flight
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, wet, (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark brown, moist, medium stiff | SPT 1 | 94 | 0-2-2 (4) | | | | | | | |
| | | (CH) gray and brown, stiff, with iron nodules below 3' | | | | | | | | | | |
| 5 | | | SPT 2 | 138 | 2-4-5/1" | | | | | | | |
| | | SHALE, slightly weathered, dark gray | SPT 3 | 100 | 6-20-31 (51) | | | | | | | |
| 10 | | LIMESTONE | | | | | | | | | | |

Refusal at 11.2 feet.
Bottom of borehole at 11.2 feet.

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# BORING NUMBER B2



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/14/21 **COMPLETED** 04/14/21
**GROUND ELEVATION** 981.5 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
▽ **AT TIME OF DRILLING** 15.00 ft / Elev 966.50 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- Not Recorded
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) grayish brown, moist, stiff, with highly weathered limestone fragments | SPT 1 | 100 | 0-4-6 (10) | | | | | | | |
| 5 | | (CH) light grayish brown below 5' | SPT 2 | 100 | 4-6-50/1" | | | | | | | |
| | | LIMESTONE, highly weathered | | | | | | | | | | |
| | | SHALE, moderately weathered, tan | SPT 3 | 56 | 11-17-26 (43) | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | Gray below 13.5' | SPT 4 | 100 | 25-50/2" | | | | | | | |
| 15 | | ▽ | | | | | | | | | | |
| | | Highly weathered limestone fragments at 16' | GB 5 | 100 | | | | | | | | |

Refusal at 16.0 feet.
Bottom of borehole at 16.0 feet.

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# BORING NUMBER B3



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/15/21 **COMPLETED** 04/15/21
**GROUND ELEVATION** 972.2 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 966.20 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- Not Recorded
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark grayish brown, moist, medium stiff | SPT 1 | 69 | 1-3-4 (7) | | | | | | | |
| | | (CH) highly weathered limestone fragments encountered at 2' | | | | | | | | | | |
| 5 | | (CH) brown, wet, below 5' ▽ | SPT 2 | 100 | 1-2-50/5" | | | | | | | |
| | | LIMESTONE, highly weathered to slightly weathered | RC 3 | 100 (78) | | | | | | | | |
| 10 | | | | | | | | | | | | |

Refusal at 7.0 feet.
Bottom of borehole at 10.0 feet.

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# BORING NUMBER B4



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/15/21 **COMPLETED** 04/15/21
**GROUND ELEVATION** 970 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
▽ **AT TIME OF DRILLING** 7.00 ft / Elev 963.00 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- Not Recorded
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark grayish brown, moist, stiff, with gravel | SPT 1 | 72 | 1-3-5 (8) | | | | | | | |
| 5 | | | SPT 2 | 11 | 4-4-5 (9) | | | | | | | |
| | | ▽ LIMESTONE, highly weathered to slightly weathered | | | | | | | | | | |

Refusal at 7.5 feet.
Bottom of borehole at 7.5 feet.

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# BORING NUMBER B5



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/16/21 **COMPLETED** 04/16/21
**GROUND ELEVATION** 969 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark brown, moist | | | | | | | | | | |
| | | (CH) wet, soft, below 3' | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| | | LIMESTONE, highly weathered, with clay seams | | | | | | | | | | |
| 10 | | LIMESTONE, slightly weathered | RC 1 | 100 (92) | | | | | | | | |

Refusal at 9.5 feet.
Bottom of borehole at 14.5 feet.

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# BORING NUMBER B6



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/05/21 **COMPLETED** 05/05/21
**GROUND ELEVATION** 967.3 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** ---
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | LEAN CLAY, SANDY, (CL) light brown, dry, with highly weathered limestone fragments (FILL) | SPT 1 | 89 | 7-15-5 (20) | | | | | | | |
| | | SHALE, moderately weathered, light brown and olive | | | | | | | | | | |
| 5 | | | SPT 2 | 100 | 10-13-18 (31) | | | | | | | |
| | | LIMESTONE, moderately weathered | | | | | | | | | | |

Refusal at 6.5 feet.
Bottom of borehole at 6.5 feet.

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# BORING NUMBER B7



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/19/21 **COMPLETED** 04/19/21
**GROUND ELEVATION** 966.5 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | LEAN CLAY, (CL) dark brown, moist, with gravel (FILL) | | | | | | | | | | |
| | | | SPT 1 | 94 | 9-7-9 (16) | | | | | | | |
| 5 | | | SPT 2 | 89 | 5-4-5 (9) | | | | | | | |
| | | | SPT 3 | 89 | 4-3-3 (6) | | | | | | | |
| 10 | | LIMESTONE, moderately weathered | | | | | | | | | | |

Refusal at 12.0 feet.
Bottom of borehole at 12.0 feet.

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# BORING NUMBER B8



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/19/21 **COMPLETED** 04/19/21
**GROUND ELEVATION** 964.4 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | LEAN CLAY, (CL) dark brown and brown, moist, medium stiff to very dense, with gravel and organics (FILL) | SPT 1 | 100 | 7-7-11 (18) | | | | | | | |
| 5 | | | SPT 2 | 78 | 2-3-4 (7) | | | | | | | |
| 10 | | | SPT 3 | 39 | 3-3-3 (6) | | | | | | | |
| | | LIMESTONE, slightly weathered | RC 4 | 93 (74) | | | | | | | | |
| 15 | | SHALE, moderately weathered<br>LIMESTONE, slightly weathered | | | | | | | | | | |

Refusal at 11.5 feet.
Bottom of borehole at 16.0 feet.

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# BORING NUMBER B9



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/15/21 **COMPLETED** 04/15/21
**GROUND ELEVATION** 964.7 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
▽ **AT TIME OF DRILLING** 12.50 ft / Elev 952.20 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- Not Recorded
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | LEAN CLAY, (CL) dark brown, moist, stiff, with gravel and organics (FILL) | | | | | | 24 | | | | |
| | | | SPT 1 | 67 | 4-5-6 (11) | | | 21 | | | | |
| 5 | | FAT CLAY, (CH) grayish brown and black, moist, stiff, with iron nodules | SPT 2 | 89 | 5-5-6 (11) | | | 28 | | | | |
| | | (CH) medium stiff below 8' | SPT 3 | 94 | 3-3-4 (7) | | | | | | | |
| 10 | | ▽ | | | | | | | | | | |
| | | LIMESTONE, highly weathered, with clay seams | | | | | | | | | | |
| | | LIMESTONE, moderately weathered to slightly weathered | | | | | | | | | | |
| 15 | | | RC 4 | 91 (70) | | | | | | | | |

Refusal at 13.5 feet.
Bottom of borehole at 18.0 feet.

# BORING NUMBER B12



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**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/05/21 **COMPLETED** 05/05/21
**GROUND ELEVATION** 962.2 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** ---
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) grayish brown and gray, moist, medium stiff to stiff | SPT 1 | 61 | 2-2-3 (5) | | | | | | | |
| 5 | | | SPT 2 | 94 | 2-3-5 (8) | | | | | | | |
| | | | SPT 3 | 50 | 1-7-7 (14) | | | | | | | |
| 10 | | (CH) highly weathered limestone fragments below 9.5' | | | | | | | | | | |
| | | LIMESTONE, slightly weathered | RC 4 | 100 (81) | | | | | | | | |
| | | SHALE, moderately weathered, gray | | | | | | | | | | |
| 15 | | LIMESTONE, slightly weathered | | | | | | | | | | |
| | | SHALE, gray, limey | RC 5 | 100 (55) | | | | | | | | |
| 20 | | | | | | | | | | | | |

Refusal at 11.5 feet.
Bottom of borehole at 20.0 feet.

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# BORING NUMBER B13



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/05/21 **COMPLETED** 05/05/21
**GROUND ELEVATION** 958 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** ---
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FAT CLAY, (CH) grayish brown, dry, stiff, with gravel (FILL) | SPT 1 | 67 | 5-5-4 (9) | | | | | | | |
| | | LIMESTONE, highly weathered | | | | | | | | | | |

Refusal at 3.5 feet.
Bottom of borehole at 3.5 feet.

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# BORING NUMBER B14



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/07/21 **COMPLETED** 05/07/21
**GROUND ELEVATION** 955.6 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, moist, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark grayish brown, moist, stiff | SPT 1 | 83 | 2-5-5 (10) | | | | | | | |
| | | (CH) tan and gray below 3' | | | | | | | | | | |
| 5 | | | SPT 2 | 123 | 2-4-5/1" | | | | | | | |
| | | SHALE, moderately weathered, gray | | | | | | | | | | |
| | | | SPT 3 | 100 | 22-37-50/5" | | | | | | | |
| 10 | | | | | | | | | | | | |
| 15 | | LIMESTONE | | | | | | | | | | |

Refusal at 15.0 feet.
Bottom of borehole at 15.0 feet.

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# BORING NUMBER B16



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/19/21 **COMPLETED** 04/19/21
**GROUND ELEVATION** 956.9 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | LEAN CLAY, (CL) dark brown and brown, moist, with gravel, shale fragments and organics (FILL) | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | FAT CLAY, (CH) dark gray, moist, shaley (Decomposed Shale) | | | | | | | | | | |
| | | SHALE, gray | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 20 | | LIMESTONE, moderately weathered | | | | | | | | | | |

Refusal at 20.0 feet.
Bottom of borehole at 20.0 feet.

# BORING NUMBER B17



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**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/30/21 **COMPLETED** 04/30/21
**GROUND ELEVATION** 950.4 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FAT CLAY, (CH) dark brown and brown, moist, medium stiff to stiff, with gravel and wood debris (FILL) | SPT 1 | 72 | 2-4-4 (8) | | | | | | | |
| 5 | | | SPT 2 | 83 | 1-2-2 (4) | | | | | | | |
| 10 | | FAT CLAY, (CH) dark brown, moist, very stiff, shaley | SPT 3 | 100 | 5-9-12 (21) | | | | | | | |
| | | SHALE, slightly weathered, gray | | | | | | | | | | |
| | | LIMESTONE, highly weathered | | | | | | | | | | |

Refusal at 13.5 feet.
Bottom of borehole at 13.5 feet.

# BORING NUMBER B18



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**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 04/30/21 **COMPLETED** 04/30/21
**GROUND ELEVATION** 946.1 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** 12.50 ft / Elev 933.60 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** 12.00 ft / Elev 934.10 ft
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FAT CLAY, (CH) dark brown and brown, moist, medium stiff to stiff, with gravel and wood debris (FILL) | SPT 1 | 50 | 5-3-4 (7) | | | | | | | |
| 5 | | | SPT 2 | 11 | 3-4-6 (10) | | | | | | | |
| 10 | | | SPT 3 | 56 | 1-3-3 (6) | | | | | | | |
| | | LIMESTONE, highly weathered to slightly weathered, with clay seams | | | | | | | | | | |
| 15 | | | | | | | | | | | | |

Refusal at 15.5 feet.
Bottom of borehole at 15.5 feet.

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# BORING NUMBER B22



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/08/21 **COMPLETED** 05/08/21
**GROUND ELEVATION** 937.2 ft **HOLE SIZE** 3.25 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hand Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, moist, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) brown and gray, moist | | | | | | | | | | |
| 5 | | (CH) highly weathered limestone fragments below 6' | | | | | | | | | | |
| | | LIMESTONE, hand auger refusal | | | | | | | | | | |

Refusal at 7.0 feet.
Bottom of borehole at 7.0 feet.

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# BORING NUMBER B23



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/08/21 **COMPLETED** 05/08/21
**GROUND ELEVATION** 942.1 ft **HOLE SIZE** 3.25 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 3.25-inch Continuous Flight
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, moist, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) brown and grayish brown, moist | | | | | | | | | | |
| 5 | | (CH) trace of highly weathered limestone fragments at 5' | | | | | | | | | | |
| 10 | | LIMESTONE, highly weathered | | | | | | | | | | |
| | | LIMESTONE | RC 1 | 100 (69) | | | | | | | | |
| 15 | | | RC 2 | 100 (71) | | | | | | | | |
| 20 | | | | | | | | | | | | |

Refusal at 13.0 feet.
Bottom of borehole at 20.0 feet.

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# BORING NUMBER B24



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/07/21 **COMPLETED** 05/07/21
**GROUND ELEVATION** 941.8 ft **HOLE SIZE** 3.25 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 3.25-inch Continuous Flight
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, moist, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark brown, moist | | | | | | | | | | |
| | | (CH) grayish brown, below 3' | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 10 | | (CH) highly weathered limestone fragments below 10' | | | | | | | | | | |
| | | LIMESTONE, highly weathered | | | | | | | | | | |

Refusal at 13.5 feet.
Bottom of borehole at 13.5 feet.

# BORING NUMBER B25



CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/08/21 **COMPLETED** 05/08/21
**GROUND ELEVATION** 937.8 ft **HOLE SIZE** 3.25 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 3.25-inch Continuous Flight
**AT TIME OF DRILLING** ---
**LOGGED BY** DA **CHECKED BY** JE
**AT END OF DRILLING** ---
**NOTES**
**AFTER DRILLING** ---

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, moist, with roots (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark brown | | | | | | | | | | |
| 5 | | (CH) brown and grayish brown below 3' | | | | | | | | | | |
| | | SHALE, highly weathered, gray | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | LIMESTONE, highly weathered, with clay and shale seams | | | | | | | | | | |
| 15 | | | | | | | | | | | | |

Bottom of borehole at 15.0 feet.

# BORING NUMBER B26



CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/03/21 **COMPLETED** 05/03/21
**GROUND ELEVATION** 945.8 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
▽ **AT TIME OF DRILLING** 13.50 ft / Elev 932.30 ft
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- Not Recorded
**NOTES**
**AFTER DRILLING** --- Not Recorded

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, with organics (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) grayish brown and brown, moist, medium stiff to stiff | SPT 1 | | 1-2-3 (5) | | | 35 | | | | |
| | | | | | | | | 27 | | | | |
| 5 | | | SPT 2 | | 2-3-4 (7) | | | 28 | | | | |
| | | | SPT 3 | | 2-3-5 (8) | | | 17 | | | | |
| 10 | | | | | | | | | | | | |
| | | ▽ LIMESTONE, highly weathered, with clay seams | | | | | | | | | | |
| 15 | | LIMESTONE, slightly weathered | | | | | | | | | | |
| | | SHALE, slightly weathered, dark gray | RC 4 | 100 (53) | | | | | | | | |
| 20 | | | RC 5 | 100 (75) | | | | | | | | |
| 25 | | | RC 6 | 100 (58) | | | | | | | | |
| | | LIMESTONE, moderately weathered | | | | | | | | | | |

Refusal at 15.0 feet.
Bottom of borehole at 27.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

# BORING NUMBER B27



**CLIENT** Lee's Summit R7 District
**PROJECT NAME** Lee's Summit MS #4 Sewer Line
**PROJECT NUMBER** 20-1074
**PROJECT LOCATION** Lee's Summit, MO
**DATE STARTED** 05/03/21 **COMPLETED** 05/03/21
**GROUND ELEVATION** 929.6 ft **HOLE SIZE** 6 inches
**DRILLING CONTRACTOR** CFS Engineers
**GROUND WATER LEVELS:**
**DRILLING METHOD** 6-inch Hollow Stem
**AT TIME OF DRILLING** --- No Free Water Encountered
**LOGGED BY** KK **CHECKED BY** JE
**AT END OF DRILLING** --- No Free Water Encountered
**NOTES**
**AFTER DRILLING** --- No Free Water Encountered

| DEPTH (ft) | GRAPHIC LOG | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT | ATTERBERG LIMITS: PLASTIC LIMIT | ATTERBERG LIMITS: PLASTICITY INDEX | FINES CONTENT (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | ORGANIC SOIL, (OL) dark brown, dry, with organics (TOPSOIL) | | | | | | | | | | |
| | | FAT CLAY, (CH) dark grayish brown, moist, medium stiff to stiff | SPT 1 | 100 | 0-2-3 (5) | | | | | | | |
| 5 | | | SPT 2 | 89 | 2-4-5 (9) | | | | | | | |
| | | SHALE, moderately weathered to slightly weathered, dark gray | SPT 3 | 100 | 15-33-50/3" | | | | | | | |
| 10 | | | | | | | | | | | | |
| | | | SPT 4 | 20 | 50/5" | | | | | | | |

Refusal at 14.0 feet.
Bottom of borehole at 14.0 feet.

# APPENDIX B

Union Pacific Railroad Standards and Specifications

Appendix B.1.

# Union Pacific Railroad

## GUIDELINES FOR ABANDONMENT & REMOVAL OF SUBSURFACE UTILITY STRUCTURES

CALL BEFORE YOU DIG
1-800-336-9193

# Contents

**For pipelines, tunnels and other similar structures that are scheduled for abandonment or removal on the Union Pacific Railroad right-of-way, the following guidelines apply.**

# 1. Abandonment Procedures

## A. Hazardous material testing & notification

1. Prior to either removal or abandon in-place of existing Facilities, testing for ACM, PACM, LBP and PCBs shall be completed and the results reported to the Railroad.
    i. ACM or PACM – Asbestos Containing Materials or Presumed Asbestos Containing Materials
    ii. LBP – Lead Based Paint
    iii. PCBs – PolyChlorinated Biphenyls
2. Testing results shall be emailed to asbestos@up.com (file size limit / email is 10mb) with one of the following subject lines:
    i. Action Required – Priority Project
    ii. Action Required – Request for Information/Question
    iii. Reporting – Test Results
3. The Railroad may require removal or consider abandon in-place of the existing Facilities upon review of the testing results.

## B. Removal

1. At the time of abandonment, Facilities within Zone B shall be removed at the cost of the owner. See Figure 2-1 for Zone identification.
2. The following additional Zone requirements apply.
    i. Zone A – Designed shoring systems are required per Section 3. Track & ground monitoring is required per Section 2.
    ii. Zone B – Sloped or stepped excavations are acceptable.

## C. Abandon in-place

1. The Facility shall be filled with CLSM (Controlled Low-Strength Material). This process is designed to help avoid future subsidence as the line deteriorates after abandonment. The use of low strength CLSM also allows the future removal of CLSM at a later date if deemed necessary.
2. CLSM Design
    i. The CLSM material shall have an unconfined compressive strength 300psi. This provides strength while allowing future removal if necessary.
    ii. The mixture shall consist of water, Portland cement, fly ash, and sound fine or coarse aggregate or both.
    iii. The mix design shall allow adequate flowability without segregation of aggregates.
    iv. Hardening time is of prime importance and CLSM should develop 50psi in about one hour.
    v. The maximum layer of thickness for CLSM shall be 3 feet.
    vi. Additional layers shall not be placed until the CLSM has lost sufficient moisture.
    vii. For pipelines or structures with a depth greater than 3 feet, CLSM shall be placed in lifts.
    viii. Contractor should verify no voids will be present after filling the structure.
    ix. Access to fill pipelines shall be from off the UPRR right-of-way if possible. If excavation is required for the fill procedure, excavations shall meet requirements in Section 3.

# 2. Track and Ground Monitoring

## A. General track and ground monitoring requirements

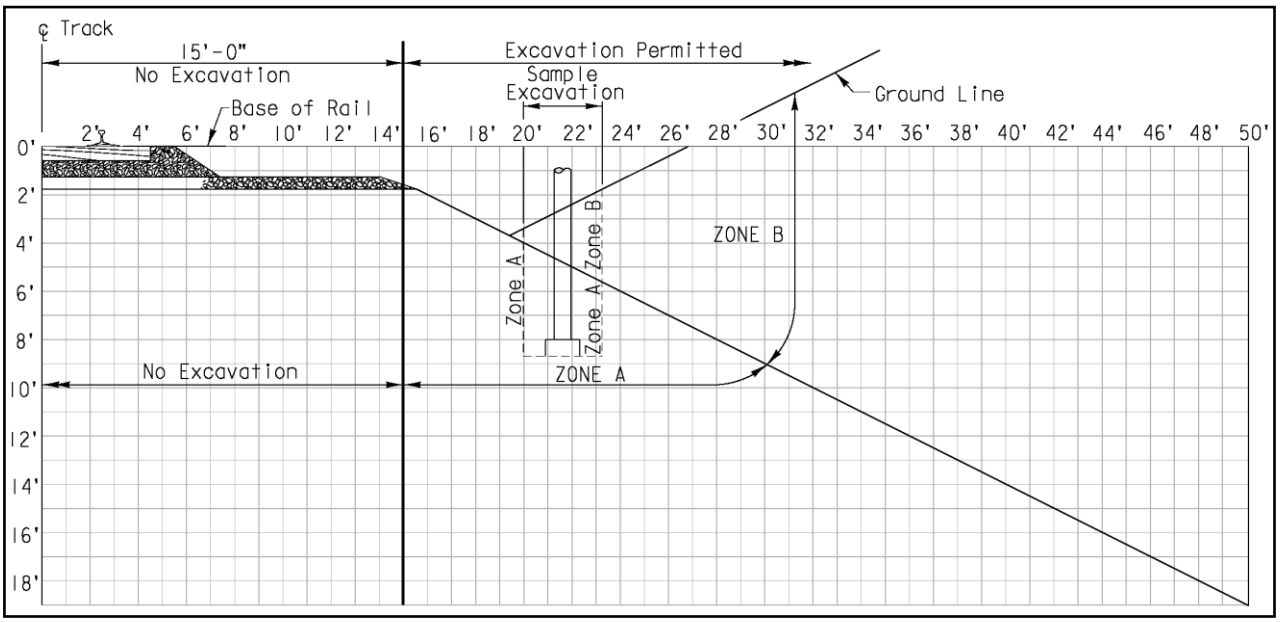
1. General requirement
   - i. Temporary lighting may also be required by the Railroad to identify tripping hazards to train crewmen and other Railroad personnel.
   - ii. Any excavation, holes or trenches on the Railroad property shall be covered, guarded and/or protected. Handrails, fence, or other barrier methods must meet OSHA and FRA requirements.
2. Track and ground monitoring are required as follows:
   - i. For crossings with pipe diameter and depth (below base of rail) as shown below in Table 2-1.
   - ii. For shoring within Zone A of any track, as shown below in Figure 2-1.
   - iii. Additional monitoring may be required by the Railroad on a case by case basis.
3. Monitoring schedule
   - i. Monitoring shall commence once any construction activity is within Zone A. See Figure 2-1.
   - ii. Monitoring shall continue, after installation is complete, for 7 days or as required by the Railroad.
     - a. For large and/or shallow pipeline installations monitoring may be required for up to 30 days.

**Table 2-1**

| Depth, feet (below base of rail) | <=6 | <=12 | <=18 | <=24 | <=30 | <=36 | <=42 | <=48 | <=54 | <=60 | >60 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| <=5 | X | X | X | X | X | X | X | X | X | X | X |
| <=10 | X | X | X | X | X | X | X | X | X | X | X |
| <=15 | X | X | X | X | X | X | X | X | X | X | X |
| <=20 | | | X | X | X | X | X | X | X | X | X |
| <=25 | | | | | X | X | X | X | X | X | X |
| <=30 | | | | | | | | X | X | X | X |
| >30 | | | | | | | | | | X | X |

X = Monitoring is required

**Figure 2-1**



**B. Track Monitoring**

1. Track Deflection Limits
    i. The top of rail shall not permanently deflect more than ¼ inch vertical or horizontal.
2. Targets
    i. Track monitoring shall not require track access other than to place the track monitoring targets.
    ii. Monitoring targets should be placed such that monitoring is possible when a train is present. However, monitoring during the passing of a train is not required as the train will temporarily deflect the track.
    iii. Adhesive backed reflective targets may be attached to the side of the rail temporarily. Targets should be removed once monitoring phase is complete.
3. Monitoring Plan
    i. If the top of rail does deflect more than 1/4 inch, all operations shall stop until the matter is resolved.
    ii. Provide established contingency plan, See Section 2.D, in the event of ground loss and/or the rail deviates ¼ inch vertical or horizontal.
    iii. Establish a bench mark in the vicinity of the construction. Establish locations for shooting elevations on the top of rail at each area of construction.
        a. Example locations for shooting rail elevations would be at:
        - At the centerline of an under track crossing.
        - At both outside edges of the crossing. ie. For a wide excavation.
        - At multiple locations from the crossing/excavation edge but no less than 10, 20, 30, 40 and 50 feet from the crossing.
    iv. Monitoring shall be continuous and recorded in a field log book dedicated for this purpose. Copies of these field log entries can be made available to all concerned parties upon request at any time during construction.

**C. Ground Monitoring**

1. Provide means for monitoring ground settlement. Submit monitoring plan for Railroad review.
2. Ground monitoring points should be in alignment above the proposed construction activities.

**D. Contingency Plans**

1. The Contractor shall supply Contingency Plan(s), which anticipate reaching the Threshold and Shutdown values, for all construction activities which may result in horizontal and/or vertical track deflection.
    i. Track monitoring values:
        a. Threshold value = 1/8 inch permanent vertical or horizontal deflection
        b. Shutdown value = 1/4 inch permanent vertical or horizontal deflection
2. The Contingency Plans shall provide means and methods, with options if necessary.
3. The Contractor should anticipate the need to implement each Contingency Plan with required materials, equipment and personnel.
    i. Once the Threshold value is met, the contractor shall determine the appropriate Contingency Plan(s) and immediately discuss this plan with, and receive approval confirmation from, the Railroad.
    ii. Once the Shutdown value is exceeded all project work shall stop and the chosen Contingency Plan shall commence.
        a. The Railroad may choose to allow and/or require the immediate implementation of specific approved Contingency Plans, submitted by the Contractor, once the Shutdown value is exceeded.

# 3. Excavation Requirements

## A. Shoring Design

1. For temporary earth retention design requirements on the Right-of-Way, see the Railroad Guidelines for Temporary Shoring.
   http://www.up.com/real_estate/roadxing/industry/index.htm

## B. Excavation Safety

1. Guardrails
   i. Guardrails shall be provided to surround unattended excavations on Railroad Right-of-Way per OSHA Standard Number 1926.502 as follows:
      a. The guardrail height shall be at least 42 inches above the walking surface.
      b. The smallest dimension for openings in the guardrail shall be no greater than 19 inches.
      c. Guardrail systems shall be capable of withstanding, without failure, a force of at least 200 pounds applied within 2 inches of the top edge, in any outward or downward direction, at any point along the top edge of the guardrail.

# 4. Glossary

**Call Before You Dig:** A Union Pacific Railroad 24-hr by 7-day communication center to assist in protecting, documenting and notifying callers of other utilities installed within the Railroad right-of-way. **1-800-336-9193**

**Crossing:** Refers to a Utility which is crossing the Railroad track(s).

**Carrier Pipe:** Pipe used to transport the product.

**Casing Pipe:** Pipe through which the carrier pipe is installed.

**Cover:** Distance from either the base of rail or finished grade to the top of Pipeline or Wireline.

**Encroachment:** Utilities on Railroad right-of-way which are generally oriented parallel with Railroad right-of-way and/or track.

**Centerline of Track:** An imaginary line, that runs down the center of the two rails of a track.

**Construction Documents:** Design plans and calculations, project and/or standard specifications, geotechnical report and drainage report.

**Construction Window:** A timeframe in which construction or maintenance can be performed by the Contractor with the required presence of a Flagman.

**Contractor:** The individual, partnership, corporation or joint venture and all principals and representatives (including Applicant's subcontractors) with whom the contract is made by the Applicant for the construction of the Grade Separation Project.

**Facility:** Refers to the Applicant's pipeline, wireline, poles, manholes, handholes, splice boxes, storage tanks and other such structures which exist as part of the Applicant's infrastructure.

**Flagman (Flagging):** A qualified employee of the Railroad providing protection to and from Railroad operations per Railroad requirements.

**Guidelines:** Information contained in this document.

**Industry Track:** A secondary track designed to allow access to industries along the main track.

**Main Track:** A principle track, designated by Timetable or special instructions, upon which train movements are generally authorized and controlled by the train dispatcher. Main Track must not be occupied without proper authority.

**Railroad Load:** Cooper E-80 loading.

**Railroad:** Refers to Union Pacific Railroad.

**Railroad Manager of Track Maintenance (MTM):** Railroad representative responsible for maintenance of the track and supporting subgrade.

**Right-of-Entry Agreement**: An agreement between the Railroad and an Applicant or a Contractor allowing access to Railroad property.

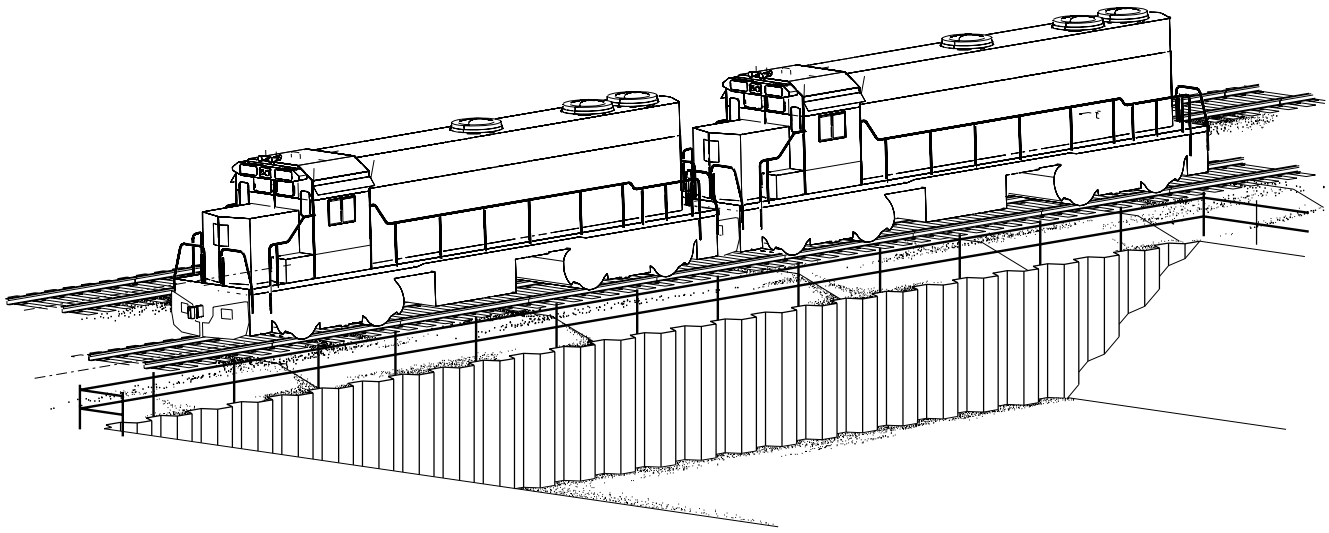
**Right-of-Way**: The private property limits owned by the Railroad.

**Tracks:** The rails, ties and ballast and roadbed that compose the traveling surface used by trains.

**Utility:** Refers to a pipeline or wireline.

**Wireline:** Refers to electric power and communication utility systems including, but not limited to, all associated conductors, cables, support structures, and equipment.

# GUIDELINES FOR TEMPORARY SHORING



Burlington Northern Santa Fe Railway

"CALL BEFORE YOU DIG!"
1-800-533-2891

ASSISTANT DIRECTOR STRUCTURE DESIGN
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## INDEX

# GUIDELINES FOR TEMPORARY SHORING

## 1. SCOPE

The scope of these guidelines is to inform public agencies, design engineers, contractors and inspectors of current Railroad standards and requirements concerning design and construction of temporary shoring.

1. The term **Railroad** refers to the Burlington Northern & Santa Fe Railway (BNSF) and/or the Union Pacific Railroad (UPRR). The term **Contractor** is defined as any party gaining access to work on Railroad right-of-way or other Railroad operating locations.

2. These guidelines are provided as a reference and may not be taken as authority to construct without prior review and written approval of the Railroad. These guidelines supersede all previous guidelines for temporary shoring and are subject to revision without notice.

3. These guidelines supplement the current, American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Recommended Practice. The 2002 AREMA Manual was utilized in developing this guideline. The AREMA Manual is available from:

   American Railway Engineering and Maintenance-of-Way Association
   8201 Corporate Drive, Suite 1125
   Landover, MD 20785-2230
   Phone: (301) 459-3200
   FAX: (301) 459-8077
   www.arema.org

4. The specific requirements for temporary shoring addressed in this document shall be followed for all locations where the Railroad operates, regardless of track ownership.

5. Any items not covered specifically herein shall be in accordance with the AREMA Manual and subject to the review and approval of the Railroad. Where conflicts exist, the most stringent specification should be applied.

6. All excavations shall also be governed by Railroad requirements, Federal, State and Local laws, rules, and regulations concerning construction safety.

7. Safe rail operations shall be required for the duration of the project. All personnel, railroad tracks and property shall be protected at all times.

8. To expedite the review process of the temporary shoring plans, drawings submitted by the Contractors are required to adhere to the project specifications, AREMA and other Railroad requirements.

## 2. GENERAL CRITERIA

The Contractor must not begin construction of any component of the shoring system affecting the Railroad right-of-way until written Railroad approval has been received.

1. All excavations shall be in compliance with applicable OSHA regulations and shall be shored where there is any danger to tracks, structures or personnel regardless of depth.

2. The Contractor is responsible for planning and executing all procedures necessary to construct, maintain and remove the temporary shoring system in a safe and controlled manner.

3. Emergency Railroad phone numbers are to be obtained from the Railroad representative in charge of the project prior to the start of any work and shall be posted at the job site.

4. The Contractor must obtain a valid right of entry permit from the Railroad and comply with all Railroad requirements when working on Railroad property.

5. The Contractor is required to meet minimum safety standards as defined by the Railroad.

6. All temporary shoring systems that support or impact the Railroad's tracks or operations shall be designed and constructed to provide safe and adequate rigidity.

7. The Railroad requirements, construction submittal review times and review criteria should be discussed at the pre-construction meeting with the Contractor.

8. A flagman is required when any work is performed within 25 feet of track centerline. If the Railroad provides flagging or other services, the Contractor shall not be relieved of any responsibilities or liabilities as set forth in any document authorizing the work. No work is allowed within 50 feet of track centerline when a train passes the work site and all personnel must clear the area within 25 feet of track centerline and secure all equipment when trains are present.

9. Appropriate measures for the installation and protection of fiber optic cables shall be addressed in the plans and contract documents. For specific Railroad requirements and additional information refer to:

   www.bnsf.com or call 1-800-533-2891.

   www.uprr.com, call 1-800-336-9193 or refer to UPRR Fiber Optic Engineering, Construction and Maintenance Standards.

10. Relocation of utilities or communication lines not owned by the Railroad shall be coordinated with the utility owners. The utility relocation plans must then be submitted to the Railroad utility representative for approval. The shoring plans must include the correct contact for the Railroad, State or Local utility locating service provider. The Railroad will not be responsible for cost associated with any utility, signal, or communication line relocation or adjustments.

## 3. CONTRACTOR RESPONSIBILITIES

The Contractor shall be solely responsible for the design, construction and performance of the temporary structure. **(AREMA 8.28.1.3)**

1. The Contractor's work shall in no way impede the train operations of the Railroad and must be coordinated with the local Railroad operating department.

2. The Contractor shall develop a work plan that enables the track(s) to remain open to train traffic at all times.

3. The Contractor shall comply with all State and Federal Laws, county or municipal ordinances and regulations which in any manner affect the work.

4. All removed soils will become the responsibility of the Contractor and shall be disposed of outside the Railroad right-of-way according to the applicable Federal, State and Local regulations.

5. The Project Engineer and the Contractor shall evaluate the quality of materials furnished and work performed.

6. The Contractor is responsible to protect the Railroad ballast and subballast from contamination.

7. The Contractor must monitor and record top of rail elevations and track alignment for the duration of the project. The movement shall be within the limits defined in **Table 1, Deflection Criteria** on page 10. Displacements exceeding the limits defined in **Table 1** must be immediately reported to the Railroad. All work on the project must stop and the Railroad may take any action necessary to ensure safe passage of trains. The Contractor must immediately submit a corrective action plan to the Railroad for review and approval. The Railroad must review and approve the proposed repair procedure. The repair must be inspected by the Railroad before the track can be placed back in service.

8. Any damage to Railroad property such as track, signal equipment or structure could result in a train derailment. All damage must be reported immediately to the Railroad representative in charge of the project and to the Railroad Manager of Track Maintenance (MTM).

## 4. INFORMATION REQUIRED

Plans and calculations shall be submitted, signed and stamped by a Registered Professional Engineer familiar with Railroad loadings and who is licensed in the state where the shoring system is intended for use. Shoring design plans and calculations shall be in English units. If Metric units are used, all controlling dimensions, elevations, design criteria assumptions, and material stresses shall be expressed in dual units, with English units to be in parentheses. Information shall be assembled concerning right-of-way boundary, clearances, proposed grades of tracks and roads, and all other factors that may influence the controlling dimensions of the proposed shoring system. See section 10 for additional requirements.

1. Field Survey.

   Sufficient information shall be shown on the plans in the form of profiles, cross sections and topographical maps to determine general design and structural requirements. Field survey information of critical or key dimensions shall be referenced to the centerline of track(s) and top of rail elevations. Existing and proposed grades and alignment of tracks and roads shall be indicated together with a record of controlling elevation of water surfaces or ground water. Show the location of existing/proposed utilities and construction history of the area which might hamper proper installation of the piling, soldier beams, or ground anchors.

2. Geotechnical Report shall provide:
   a. Elevation and location of soil boring in reference to the track(s) centerline and top of rail elevations.
   b. Classification of all soils encountered.
   c. Internal angle of soil friction.
   d. Dry and wet unit weights of soil.
   e. Active and passive soil coefficients, pressure diagram for multiple soil strata.
   f. Bearing capacity and unconfined compression strength of soil.
   g. Backfill and compaction recommendations.
   h. Optimum moisture content of fill material.
   i. Maximum density of fill material.
   j. Minimum recommended factor of safety.
   k. Water table elevation on both sides of the shoring system.
   l. Dewatering wells and proposed flownets or zones of influence.
   m. In seismic areas, evaluation of liquefaction potential of various soil strata.

3. Loads.

All design criteria, temporary and permanent loading must be clearly stated in the design calculations and on the contract and record plans. Temporary loads include, but are not limited to: construction equipment, construction materials and lower water levels adjoining the bulkhead causing unbalanced hydrostatic pressure. Permanent loads include, but are not limited to: future grading and paving, Railroads or highways, structures, material storage piles, snow and earthquake. The allowable live load after construction should be clearly shown in the plans and painted on the pavements behind the bulkheads or shown on signs at the site and also recorded on the record plans. Some of the loads are:

a. Live load pressure due to E80 loading for track parallel to shoring system.
b. Live load pressure due to E80 loading for track at right angle to shoring system.
c. Other live loads.
d. Active earth pressure due to soil.
e. Passive earth pressure due to soil.
f. Active earth pressure due to surcharge loads.
g. Active pressure due to sloped embankment.
h. Dead load.
i. Buoyancy.
j. Longitudinal force from live load.
k. Centrifugal forces.
l. Shrinkage.
m. Temperature.
n. Earthquake.
o. Stream flow pressure.
p. Ice pressure.

4. Drainage. **(AREMA 8.20.2.4)**

   a. The drainage pattern of the site before and after construction should be analyzed and adequate drainage provisions should be incorporated into the plans and specifications. Consideration should be given to groundwater as well as surface drainage.

   b. Drainage provisions for backfill should be compatible with the assumed water conditions in design.

5. Structural design calculations.

   a. List all assumptions used to design the temporary shoring system.

   b. Determine E80 live load lateral pressure using the Boussinesq strip load equation. See **Figure 2** which illustrates Plan Number **710001 "LIVE LOAD PRESSURE DUE TO COOPER E80**".

   c. Computerized calculations and programs must clearly indicate the input and output data. List all equations used in determining the output.

   d. Example calculations with values must be provided to support computerized output and match the calculated computer result.

   e. Provide a simple free body diagram showing all controlling dimensions and applied loads on the temporary shoring system.

   f. Calculated lateral deflections of the shoring and effects to the rail system must be included. See section 8, Part 6. Include the elastic deflection of the wall as well as the deflection due to the passive deflection of the resisting soil mass.

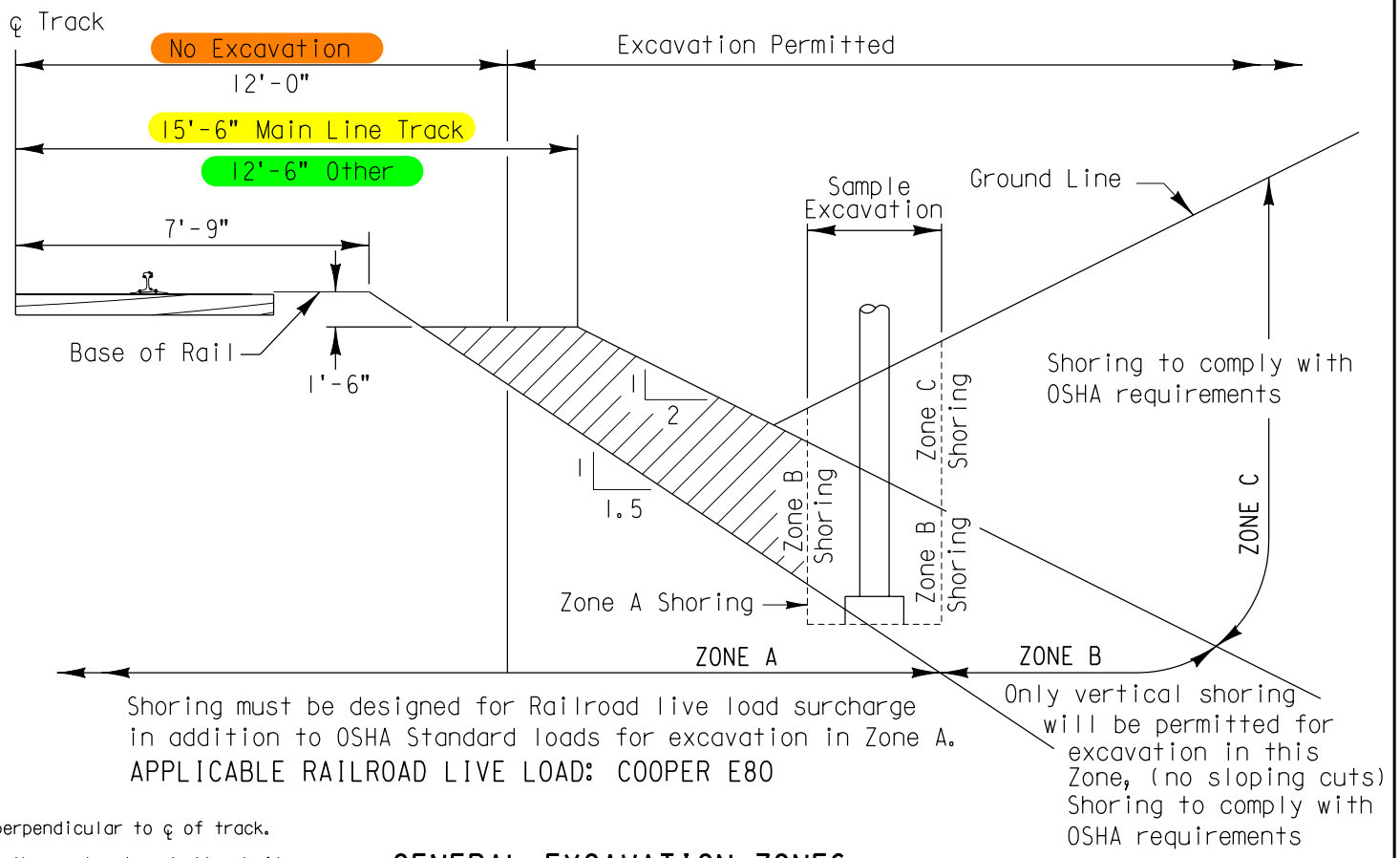
   g. Documents and manufacturer's recommendations which support the design assumptions must be included with the calculations.

## 5. TYPES OF TEMPORARY SHORING

1. A shoring box is a prefabricated shoring system which is installed as the excavation progresses. This shoring system is not accepted by the Railroad. This system is allowed in special applications only, typically where Railroad live load surcharge is not present. The shoring box is moved down into the excavation by gravity or by applying vertical loading from excavation equipment.
2. Anchored systems with tiebacks are discouraged. The tiebacks will be an obstruction to future utility installations and may also damage existing utilities. Tiebacks must be removed per Railroad direction. Removal of tieback assemblies is problematic.
3. An anchored sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded and the tensile resistance of the anchors.
    a. For purposes of these guidelines, ground anchors shall be cement-grouted tiebacks designed, furnished, installed, tested and stressed in accordance with the project specifications and AREMA requirements.
4. An anchored soldier beam with lagging wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded and from the tensile resistance of the ground anchors.
    a. Anchored soldier beam with lagging walls are generally designed as flexible structures which have sufficient lateral movement to mobilize active earth pressures and a portion of the passive pressure.
    b. For purposes of these specifications, soldier beams include steel H-piles, wide flange sections or other fabricated sections that are driven or set in drilled holes. Lagging refers to the members spanning between soldier beams.
5. A cantilever sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded. If cantilever sheet pile is used for shoring adjacent to an operating track, the shoring system shall be at least 12’-0” away from the centerline of track. Cantilever sheet pile walls shall be used only in granular soils or stiff clays.
6. A cantilever soldier beam with lagging wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded.
7. A braced excavation is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the vertical members are embedded and from the structural capacity of the bracing members.
    a. For purposes of these guidelines, the vertical members of the braced excavation system include steel sheet piling or soldier beams comprised of steel H-piles, wide flange sections, or other fabricated sections that are driven or installed in drilled holes. Wales are horizontal structural members designed to transfer lateral loads from the vertical members to the struts. Struts are structural compression members that support the lateral loads from the wales.
8. A cofferdam is an enclosed temporary structure used to keep water and soil out of an excavation for a permanent structure such as a bridge pier or abutment or similar structure. Cofferdams may be constructed of timber, steel, concrete or a combination of these. These guidelines consider cofferdams primarily constructed with steel sheet piles.

## 6. GENERAL SHORING REQUIREMENTS

For general shoring requirements and specific applications of the following items refer to **Figure 1** on the next page which illustrates Plan Number **710000 “GENERAL SHORING REQUIREMENTS**”.




## GENERAL NOTES:

All dimensions are measured perpendicular to ℄ of track.

Prior to commencing any work, the contractor shall submit for approval by the Railroad detailed plans indicating the nature and extent of the track protection shoring proposed. The contractor shall install the temporary shoring system per the approved plans. Design of the temporary shoring system to comply with **GUIDELINES FOR TEMPORARY SHORING.**

For excavations which encroach into zone A or B, shoring plans shall be accompanied by design calculations. Plans and calculations must be signed and stamped by a Professional Engineer registered in the state where the work will be performed.

## GENERAL EXCAVATION ZONES

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DESIGN BY: PGP | DRAWN BY: JFS | CHECKED BY: AA

APPROVED:

K.H. Jennison
BNSF - ASSISTANT DIRECTOR STRUCTURES DESIGN

Hugo J. Myra 9-1-04
UPRR - MGR SPECIAL PROJECTS STRUCTURES DESIGN

BURLINGTON NORTHERN SANTA FE RAILWAY — BRIDGE STANDARDS — UNION PACIFIC

**GENERAL SHORING REQUIREMENTS**

FILE OWNER: UPRR | DATE: 5-6-03
PLAN NO.: 710000 1 | SHEET: 1 OF 1

PLOTTED: $$$$DATE$$$ $TIME

**Figure 1**

1. No excavation shall be permitted closer than 12'-0" measured at a right angle from the centerline of track to the trackside of shoring system. If existing conditions preclude the installation of shoring at the required minimum distance, the shifting of tracks or temporary removal of tracks shall be investigated prior to any approval. All costs associated with track shifting or traffic interruption shall be at Contractor's expense.

2. Evaluate slope and stability conditions to ensure the Railroad embankment will not be adversely affected. Local and global stability conditions must also be evaluated.

3. All shoring within the limits of Zone A or Zone B must be placed prior to the start of excavation.

4. Lateral clearances must provide sufficient space for construction of the required ditches parallel to the standard roadbed section. The size of ditches will vary depending upon the flow and terrain and should be designed accordingly.

5. The shoring system must be designed to support the theoretical embankment shown for zones A and B.

6. Any excavation, holes or trenches on the Railroad property shall be covered, guarded and/or protected. Handrails, fence, or other barrier methods must meet OSHA and FRA requirements. Temporary lighting may also be required by the Railroad to identify tripping hazards to train crewmen and other Railroad personnel.

7. The most stringent project specifications of the Public Utilities Commission Orders, Department of Industrial Safety, OSHA, FRA, AREMA, BNSF, UPRR or other governmental agencies shall be used.

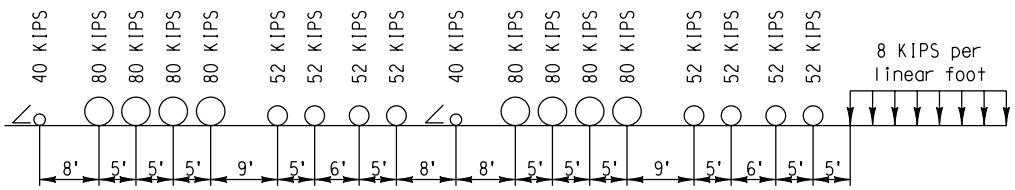
8. Secondhand material is not acceptable unless the Engineer of Record submits a full inspection report which verifies the material properties and condition of the secondhand material. The report must be signed and sealed by the Engineer of Record.

9. All components of the shoring system are to be removed when the shoring is no longer needed. All voids must be filled and drainage facilities restored. See compaction requirements section 9, Part 4.

10. Slurry type materials are not acceptable as fill for soldier piles in drilled holes. Concrete and flowable backfill may prevent removal of the shoring system. Use compacted peagravel material.

## 7. COMPUTATION OF APPLIED FORCES

1. Railroad live load and lateral forces.
   a. For specific applications of the Coopers E80 live load refer to **Figure 2** on the next page which illustrates Plan Number **710001 "LIVE LOAD PRESSURE DUE TO COOPER E80**". Supplemental information and sample calculations are provided in the Appendix pages A-1 through A-4.
2. Dead load.
   a. Spoil pile: must be included assuming a minimum height of two feet of soil adjacent to the excavation.
   b. Track: use 200 lbs/linear ft for rails, inside guardrails and fasteners.
   c. Roadbed: ballast, including track ties, use 120 lb per cubic foot.




**COOPER E80 LOAD**
SCALE: (NOT TO SCALE)

Vertical pressure q shall be based on a distribution width Ld.
Ld is the length of tie plus $H_1$.
$H_1$ is the height from the bottom of tie to the top of shoring.
$H_2$ is the depth of point being evaluated with the Boussinesq equation.
S is a distance perpendicular from centerline of track to the face of shoring.
D is from top of shoring to one foot below dredge line.
Zp is the minimum embedment depth.
Length of tie is 9 feet
q is the intensity of strip load due to E80 Railroad live load
and shall be calculated as follows:

For $H_1 = 0$ Ld = length of tie; therefore, $q = \frac{80{,}000 \text{ lb}}{(5 \text{ feet})(9 \text{ feet})} = 1{,}778 \text{ psf}$

For $H_1 > 0$ Ld = length of tie + $H_1$; therefore, $q = \frac{80{,}000 \text{ lb}}{(5 \text{ feet})(Ld)}$

CASE 1: Lateral live load pressure Ps, due to E80 loading for track **parallel** to shoring system is calculated using the Boussinesq Strip Load Equation.

$$Ps = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

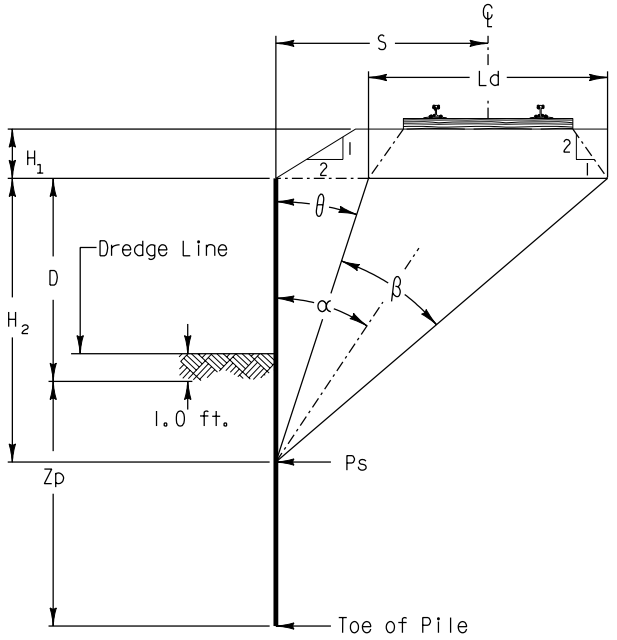
The above equation can be simplified into the following equivalent form:

$$Ps = \frac{2q}{\pi}[\beta - \sin\beta \cos(2\alpha)]$$

$\alpha$ and $\beta$ are angles measured in radians, $\alpha = \theta + \frac{\beta}{2}$

CASE 2: Live load pressure due to E80 loading for track at a **right angle** to the shoring system can be calcuated using the following equation.

$Ps = K_A q$
where $K_A = \tan^2(45 - \frac{\phi}{2})$
$\phi$ is the angle of internal friction in degrees




**PLAN**
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DESIGN BY: PGP | DRAWN BY: JFS | CHECKED BY: AA

APPROVED:

K.H. Jennison
BNSF - ASSISTANT DIRECTOR STRUCTURES DESIGN

George J. Myers 9-1-04
UPRR - MGR SPECIAL PROJECTS STRUCTURES DESIGN

**BRIDGE SHORING STANDARDS**

**LIVE LOAD PRESSURE DUE TO COOPER E80**

FILE OWNER: UPRR | DATE:
PLAN NO.: 710001 | SHEET: 1 OF 1

PLOTTED: $$$$DATE$$$ $TIME

**Figure 2**

3. Active earth pressure.

   a. The active earth pressure due to the soil may be computed by the Coulomb Theory or other approved method.

   b. The active earth pressure at depth "$z_a$" is:

      $P_A = K_A \gamma z_a$ , where $K_A = \tan^2(45 - \frac{\phi}{2})$

      $z_a$ = depth of soil influencing the active pressure.

4. Active earth pressure due to unbalanced water pressure.

   a. When bulkheads are used for waterfront construction, the bulkhead is subjected to a maximum earth pressure at the low water stage. During a rainstorm or a rapidly receding high water, the water level behind the bulkhead may be several feet higher than in front of the bulkhead.

   b. Drained conditions in backfill apply when clean sand or clean sand and gravel are used and adequate permanent drainage outlets are provided. Where drained conditions exist, the design water level may be assumed at the drainage outlet elevation.

5. Active earth pressure due to surcharge load.

   The active earth pressure due to surcharge load q':

   $P_U = K_A q'$, where $K_A = \tan^2(45 - \frac{\phi}{2})$

6. Passive earth pressure.

   The passive earth pressure, $P_{p,}$ in front of the bulkhead may also be computed by the Coulomb Theory.

   $P_p = K_p \gamma z_{p,}$ where $K_P = \tan^2(45 + \frac{\phi}{2})$

   $z_p$ = vertical distance beginning one foot below dredge line but not to exceed embedment depth

7. Pressure due to embankment surcharges.

   Conventional analysis (Rankine, Coulomb, or Log-Spiral) should be used to determine the additional surcharge from embankment slopes.

8. Additional analysis for centrifugal force calculations as described in **AREMA Chapter 15, Part 1, Section 1.3, Article 1.3.6** Centrifugal Loads are required where track curvature exceeds three degrees.

9. Include and compute all other loads that are impacting the shoring system such as a typical Railroad service vehicle (HS-20 truck).

## 8. STRUCTURAL INTEGRITY

Structures and structural members shall be designed to have design strengths at all sections at least equal to the required strengths calculated for the loads and forces in such combinations as stipulated in **AREMA Chapter 8 Part 2 Article 2.2.4b**, which represents various combinations of loads and forces to which a structure may be subjected. Each part of the structure shall be proportioned for the group loads that are applicable, and the maximum design required shall be used.

**1.** Embedment depth.

   **a.** Calculated depth of embedment is the embedment depth required to maintain static equilibrium.

b. Minimum depth of embedment is the total depth of embedment required to provide static equilibrium plus additional embedment due to the minimum factor of safety.

1. Embedment depth factor of safety for well-defined loading conditions and thoroughly determined soil parameters is generally 1.3 for most temporary shoring systems. (See **AREMA 8.20.4.1.c**)

2. All anchored shoring systems require a minimum embedment depth of 1.5 times the calculated depth of embedment. Shallow penetration into strong soil layers is not acceptable. (See **AREMA 8.20.5.1**)

2. The allowable stresses based on AREMA requirements are as follows:

Structural Steel: 0.55Fy for Compression in extreme fiber. **(AREMA Ch.15 Table 1-11)**

Structural Steel: 0.35Fy for Shear. **(AREMA Ch.15 Table 1-11)**

Sheet Pile Sections: 2/3 of yield strength for steel. **(AREMA 8.20.5.7)**

Concrete: 1/3 of Compressive strength. **(AREMA 8.20.5.7)**

Anchor Rods: 1/2 of yield strength for steel. **(AREMA 8.20.5.7)**

3. AISC allowances for increasing allowable stress due to temporary loading conditions are not acceptable.

4. Gravity type temporary shoring systems must also be analyzed for overturning, sliding and global stability.

5. The contractor is responsible for providing an approved test method to verify the capacity of anchored or tieback systems. The manufacturers recommendations for testing must be satisfied. Systems which support the Railroad embankment will be considered high risk in determining the percentage of elements to be proof tested.

6. Calculated deflections of temporary shoring system and top of rail elevation shall not exceed the criteria outlined in **Table 1 Deflection Criteria**.

**Table 1 Deflection Criteria**

| Horizontal distance from shoring to track C/L measured at a right angle from track | Maximum horizontal movement of shoring system | Maximum acceptable horizontal or vertical movement of rail |
|---|---|---|
| 12’ < S < 18’ | 3/8” | 1/4” |
| 18’ < S < 24’ | 1/2” | 1/4” |

## 9. SOIL CHARACTERISTICS

1. Subsurface Exploration. **(AREMA 8.5.2.2)**

a. Sufficient borings shall be made along the length of the structure to determine, with a reasonable degree of certainty, the subsurface conditions. Irregularities found during the initial soil boring program may dictate that additional borings be taken.

b. The subsurface investigation shall be made in accordance with the provisions of **AREMA Chapter 8 Part 22, Geotechnical Subsurface Investigation**.

2. Type of backfill.

a. Backfill is defined as material behind the wall, whether undisturbed ground or fill, that contributes to the pressure against the wall.

b. The backfill shall be investigated and classified with reference to the soil types described in **AREMA Table 8-5-1**.

c. Types 4 and 5 backfill shall be used only with the permission of the Engineer. In all cases the wall design shall be based on the type of backfill used.

**Table 8-5-1 (AREMA)** Types of Backfill for Retaining Walls

| Backfill Type | Backfill Description |
|---|---|
| 1 | Coarse-grained soil without admixture of fine soil particles, very free-draining (clean sand, gravel or broken stone). |
| 2 | Coarse-grained soil of low permeability due to admixture of particles of silt size. |
| 3 | Fine silty sand; granular materials with conspicuous clay content; or residual soil with stones. |
| 4 | Soft or very soft clay, organic silt; or soft silty clay. |
| 5 | Medium or stiff clay that may be placed in such a way that a negligible amount of water will enter the spaces between the chunks during floods or heavy rains. |

3. Computation of backfill pressure. **(AREMA 8.5.3.2a)**

a. Values of the unit weight, cohesion, and angle of internal friction of the backfill material shall be determined directly by means of soil tests or, if the expense of such tests is not justifiable, by means of **AREMA Table 8-5-2** referring to the soil types defined in **AREMA Table 8-5-1**. Unless the minimum cohesive strength of the backfill material can be evaluated reliably, the cohesion shall be neglected and only the internal friction considered. See Appendix page A-6 for AREMA generic soil properties.

**Table 8-5-2 (AREMA)** Properties of Backfill Materials

| Type of Backfill | Unit Weight Lb. Per Cu. Ft. | Cohesion "c" | Angle of Internal Friction |
|---|---|---|---|
| 1 | 105 | 0 | 33°-42°(38°for broken stone) |
| 2 | 110 | 0 | 30° |
| 3 | 125 | 0 | 28° |
| 4 | 100 | 0 | 0° |
| 5 | 120 | 240 | 0° |

4. Compaction.

a. The backfill shall preferably be placed in loose layers not to exceed 8 inches in thickness. Each layer shall be compacted before placing the next, but over compaction shall be avoided.

b. It is required that backfill be compacted to no less than 95% of maximum dry density at a moisture content within 2% of optimum and tested using Modified Proctor ASTM D1557.

c. Fill within 100 feet of bridge ends or 20 feet outside culverts shall be placed and compacted to not less than 100% of maximum.

d. No dumping of backfill material shall be permitted in such a way that the successive layers slope downward toward the wall. The layers shall be horizontal or shall slope downward away from the wall.

## 10. PLANS

The shoring plans must completely identify the site constraints and the shoring system. Use the design templates provided in the appendix as an example to show the required information, specifications and drawings. The specific requirements of the plan submittals are as follows:

1. General plan view should show:
    a. Railroad right-of-way and North arrow.
    b. Position of all Railroad tracks and identify each track as mainline, siding, spur, etc.
    c. Spacing between all existing tracks.
    d. Location of all access roadways, drainage ditches and direction of flow.
    e. Footprint of proposed structure, proposed shoring system and any existing structures if applicable.
    f. Proposed horizontal construction clearances. The minimum allowable is 12 feet measured at a right angle from centerline of track.
    g. Location of existing and proposed utilities.
    h. Drawings must be signed and stamped by a Licensed Professional Engineer, registered in the state where the work will be performed.
    i. Railroad and other “CALL BEFORE YOU DIG” numbers.
    j. Detailed view of shoring along with controlling elevations and dimensions.
2. Typical section and elevation should show:
    a. Top of rail elevations for all tracks.
    b. Offset from the face of shoring system to the centerline of all tracks at all changes in horizontal alignment.
    c. All structural components, controlling elevations and dimensions of shoring system.
    d. All drainage ditches and controlling dimensions.
    e. All slopes, existing structures and other facilities which may surcharge the shoring system.
    f. Location of all existing and proposed utilities.
    g. Total depth of shoring system.
3. General criteria
    a. Design loads to be based on the AREMA manual and Cooper E80 loading.
    b. Pressure due to embankment surcharges.
    c. ASTM designation and yield strength for each material.
    d. Maximum allowable bending stress for structural steel is 0.55Fy.
    e. Temporary overstress allowances are not acceptable.
    f. All timber members shall be Douglas Fir grade 2 or better.
    g. Insitu soil classification.
    h. Backfill soil classification.
    i. Internal angle of friction and unit weight of the soil.
    j. Active and passive soil coefficients.
    k. Fill within 100 feet of bridge ends or 20 feet outside culverts shall be placed and compacted to a minimum of 100% of maximum dry density tested per Modified Proctor ASTM D1557.
    l. Slopes without shoring shall not be steeper than 2 horizontal to 1 vertical

m. Dredge line elevation.

n. Shoring deflection to be calculated and meet Railroad requirements.

4. Miscellaneous:

a. Project name, location, GPS coordinates, track owner, Railroad line segment, milepost and subdivision in the title block.

b. Procedure outlining the installation and removal of the temporary shoring system.

c. General notes specifying material requirements, design data, details, dimensions, cross-sections, sequence of construction etc.

d. A description of the tieback installation including drilling, grouting, stressing information and testing procedures, anchor capacity, type of tendon, anchorage hardware, minimum unbonded lengths, minimum anchor lengths, angle of installation, tieback locations and spacing.

e. All details for construction of drainage facilities associated with the shoring system shall be clearly indicated.

f. Details and descriptions of all shoring system members and connection details.

g. Settlement and displacement calculations.

h. Handrail and protective fence details along the excavation.

i. Drawings must be signed and stamped by a Licensed Professional Engineer, registered in the state where the work will be performed.

j. Call before you dig number.

k. Construction clearance diagram.

## 11. SUBMITTALS

The Contractor will be responsible for any and all cost associated with the review of plans by the Railroad. Review of design submittals by the Railroad will require a minimum of four (4) weeks. To avoid impacting the construction schedule, the Contractor must schedule submittals well in advance. Partial, incomplete or inadequate designs will be rejected, thus delaying the approval. Revised submittals will follow the same procedure as the initial submittal until all issues are resolved. Submit a minimum of three sets of shoring plans and two sets of calculations with manufacturers' specifications. Drawings and calculations must be signed and stamped by a Registered Professional Engineer familiar with Railway loadings and who is licensed in the state where the shoring system is intended for use. Drawings accompanying the shoring plans shall be submitted on 11" x 17" or 8½" x 11" sized paper.

1. Contractor review.

   The Contractor must review the temporary shoring plans to ensure that the proposed method of construction is compatible with the existing site and soil conditions. The Contractor's work plan must be developed to allow train traffic to remain in service. Removal of the shoring system must also be addressed.

2. Applicant and or Engineer of Record review.

   The applicant and or Engineer of Record must review and approve the submittal for compliance with the project specifications, AREMA Manual, these guidelines and structural capacity before forwarding the submittal to the Railroad.

3. Review process.

   All design submittals shall be forwarded to the Railroad Representative who will send them to the Structures Design Department. The Structures Design Department shall review or have an outside consultant review said submittals. If a Railroad consultant performs said review, the consultant may reply directly to the applicant or their representative after consultation with the Structures Design Department. A copy of the reply will be mailed to the Railroad Representative. During the review process the Railroad Representative is the point of contact to resolve outstanding issues.

## 12. APPENDIX



## 13. BIBLIOGRAPHY

The following list of references used in these guidelines are placed here in alphabetical order for your convenience.


1. *Manual for Railway Engineering*, 2002 American Railway Engineering and Maintenance-of-Way Association.

2. *TRENCHING AND SHORING MANUAL,* January 1990, Revision 11/12/96. State of California Department of Transportation, Office of Structures Construction.

SAMPLE PROBLEM

**Point in question: S = 12 ft H = 6 ft**

$q = \frac{80{,}000 \text{ lbs}}{(5 \text{ ft})(9 \text{ ft})} = 1778 \text{ psf}$ for E80 loading, axle spacing = 5 ft, tie length b = 9 ft

Solve for $X_1 = S - b/2 = 7.5$ ft

Solve for $X_2 = S + b/2 = 16.5$ ft

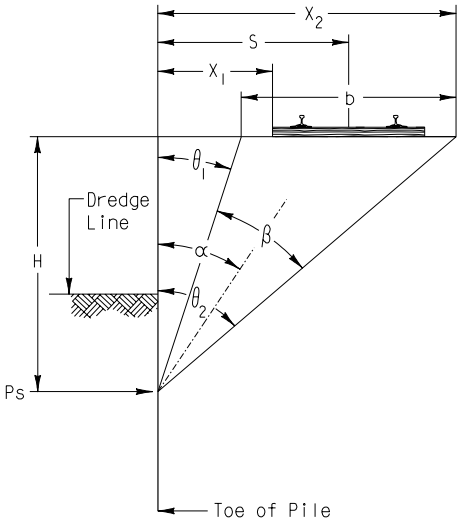
Solve for $\theta_1 = \arctan\left(\frac{X_1}{H}\right) = 0.896$ radians

Solve for $\theta_2 = \arctan\left(\frac{X2}{H}\right) = 1.222$ radians

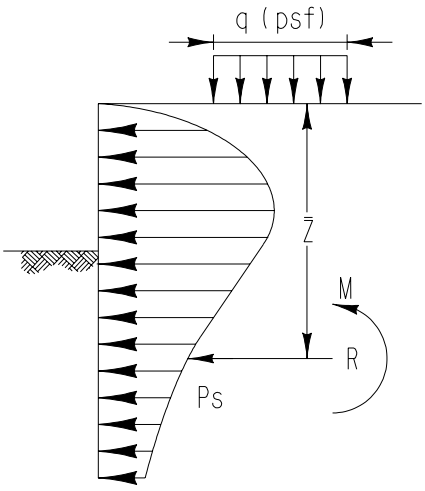
Solve for $\beta = \theta_2 - \theta_1 = 0.326$ radians

Solve for $\alpha = \frac{\theta_1 + \theta_2}{2} = 1.059$ radians

Note: $\tan\alpha \neq \frac{S}{H}$




PRESSURE DISTRIBUTION FOR STRIP LOAD




EQUIVALENT LOADING

- Pressure, Ps due to E80 liveload at the above-identified point:

$$Ps = \frac{2q}{\pi}(\beta - \sin\beta\cos 2\alpha) = \frac{2*1778}{\pi}(0.326 - \sin(0.326)\cos(2*1.059)) = 558.\text{psf}$$

- Shear due to E80 liveload at the above-identified point:

$$R_x = \frac{2qH\beta}{\pi} = \frac{2*1778*6*0.326}{\pi} = 2214.lbs \text{ /ft}$$

- Depth $\bar{z}$ from base of tie:

$$\bar{z} = \frac{H^2\beta - bH + x_2^2\left(\frac{\pi}{2} - \theta_2\right) - x_1^2\left(\frac{\pi}{2} - \theta_1\right)}{2H\beta} = \frac{6^2*0.326 - 9*6 + 16.5^2\left(\frac{\pi}{2} - 1.222\right) - 7.5^2\left(\frac{\pi}{2} - 0.896\right)}{2*6*0.326} = 3.77\text{ft}$$

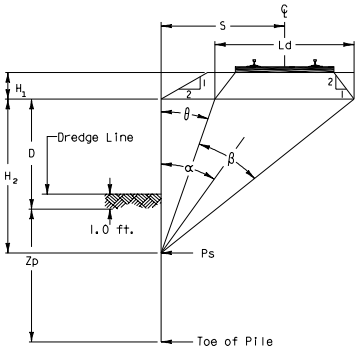
- Moment due to E80 liveload at the above identified point:

$$M = R_x\left(H - \bar{z}\right) = 2214 * \left(6 - 3.77\right) = 4940 \text{ ft-lbs/ft}$$

Use the above equations to determine Ps, M, $R_x$ & $\bar{z}$ due to the E80 liveload along the **entire** depth of the shoring system. Typically the equations are evaluated on 6" increments to determine the maximum values along the depth of the shoring system. The resultants must be combined with other applicable pressures and loads to evaluate the total loading on the shoring system for the entire depth of the system. Determine the minimum embedment depth required and the minimum cross sectional properties of the shoring system based on the allowable stresses and the required factors of safety.

This chart identifies the active pressure and resulting forces due to E80 liveload.
See "SAMPLE PROBLEM" sheet for definitions of variables and equations.

1. Select distance S from track centerline to face of shoring.
2. Select depth $H_2$ below base of tie.
3. Read Ps, M, R and $\bar{z}$ from the table.
4. Use the procedure outlined in the sample problem to determine values at non-tabulated points.




$$Ps = \frac{2q}{\pi}\left[\beta - \sin\beta\cos(2\alpha)\right]$$

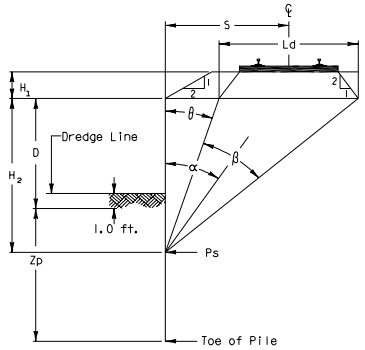
where q = 1778 psf

## Boussinesq surcharge pressure E80 live load for $H_1$=0

| Depth below top of shoring $H_2$ (ft) | Variables | | Horizontal distance (S) from shoring to track CL measured at a right angle | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
| 2 | **Ps** | (psf) | **305** | **220** | **166** | **130** | **105** | **86** | **72** | **61** | **53** | **46** |
| | α | (radians) | 1.38 | 1.41 | 1.44 | 1.45 | 1.47 | 1.48 | 1.48 | 1.49 | 1.50 | 1.50 |
| | β | (radians) | 0.14 | 0.10 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 |
| | $\bar{z}$ | (ft) | 1.32 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 |
| | M | (ft-lbs/ft) | 215 | 152 | 114 | 89 | 71 | 58 | 49 | 41 | 36 | 31 |
| | R | (lbs/ft) | 317 | 226 | 170 | 132 | 106 | 87 | 73 | 62 | 53 | 46 |
| 4 | **Ps** | (psf) | **496** | **381** | **299** | **240** | **197** | **164** | **138** | **118** | **102** | **89** |
| | α | (radians) | 1.21 | 1.27 | 1.31 | 1.34 | 1.36 | 1.38 | 1.40 | 1.41 | 1.43 | 1.44 |
| | β | (radians) | 0.25 | 0.19 | 0.14 | 0.11 | 0.09 | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 |
| | $\bar{z}$ | (ft) | 2.59 | 2.61 | 2.63 | 2.64 | 2.64 | 2.65 | 2.65 | 2.65 | 2.65 | 2.66 |
| | M | (ft-lbs/ft) | 1,609 | 1,165 | 882 | 692 | 557 | 459 | 384 | 327 | 281 | 244 |
| | R | (lbs/ft) | 1,141 | 840 | 643 | 508 | 411 | 339 | 285 | 242 | 209 | 182 |
| 6 | **Ps** | (psf) | **558** | **461** | **381** | **317** | **266** | **225** | **193** | **167** | **146** | **128** |
| | α | (radians) | 1.06 | 1.13 | 1.19 | 1.23 | 1.27 | 1.29 | 1.32 | 1.34 | 1.35 | 1.37 |
| | β | (radians) | 0.33 | 0.25 | 0.20 | 0.16 | 0.13 | 0.11 | 0.09 | 0.08 | 0.07 | 0.06 |
| | $\bar{z}$ | (ft) | 3.77 | 3.83 | 3.88 | 3.90 | 3.92 | 3.94 | 3.95 | 3.96 | 3.96 | 3.97 |
| | M | (ft-lbs/ft) | 4,944 | 3,674 | 2,830 | 2,244 | 1,822 | 1,508 | 1,269 | 1,082 | 933 | 813 |
| | R | (lbs/ft) | 2,214 | 1,696 | 1,332 | 1,070 | 877 | 731 | 618 | 529 | 458 | 400 |
| 8 | **Ps** | (psf) | **535** | **476** | **414** | **358** | **309** | **268** | **234** | **205** | **181** | **160** |
| | α | (radians) | 0.94 | 1.02 | 1.08 | 1.13 | 1.17 | 1.21 | 1.24 | 1.26 | 1.29 | 1.30 |
| | β | (radians) | 0.37 | 0.29 | 0.24 | 0.19 | 0.16 | 0.14 | 0.12 | 0.10 | 0.09 | 0.08 |
| | $\bar{z}$ | (ft) | 4.84 | 4.97 | 5.06 | 5.11 | 5.16 | 5.19 | 5.21 | 5.23 | 5.24 | 5.26 |
| | M | (ft-lbs/ft) | 10,481 | 8,006 | 6,286 | 5,051 | 4,141 | 3,452 | 2,920 | 2,501 | 2,165 | 1,892 |
| | R | (lbs/ft) | 3,316 | 2,641 | 2,134 | 1,751 | 1,456 | 1,228 | 1,047 | 903 | 786 | 689 |
| 10 | **Ps** | (psf) | **474** | **449** | **411** | **370** | **329** | **293** | **260** | **232** | **207** | **186** |
| | α | (radians) | 0.83 | 0.92 | 0.99 | 1.04 | 1.09 | 1.13 | 1.17 | 1.19 | 1.22 | 1.24 |
| | β | (radians) | 0.38 | 0.32 | 0.26 | 0.22 | 0.19 | 0.16 | 0.14 | 0.12 | 0.10 | 0.09 |
| | $\bar{z}$ | (ft) | 5.81 | 6.02 | 6.16 | 6.26 | 6.34 | 6.39 | 6.44 | 6.47 | 6.50 | 6.52 |
| | M | (ft-lbs/ft) | 18,145 | 14,227 | 11,385 | 9,280 | 7,689 | 6,463 | 5,502 | 4,736 | 4,117 | 3,610 |
| | R | (lbs/ft) | 4,328 | 3,571 | 2,964 | 2,482 | 2,099 | 1,792 | 1,544 | 1,341 | 1,175 | 1,037 |
| 12 | **Ps** | (psf) | **404** | **403** | **386** | **360** | **331** | **302** | **274** | **248** | **225** | **204** |
| | α | (radians) | 0.75 | 0.83 | 0.90 | 0.96 | 1.01 | 1.06 | 1.10 | 1.13 | 1.16 | 1.18 |
| | β | (radians) | 0.38 | 0.33 | 0.28 | 0.24 | 0.20 | 0.18 | 0.15 | 0.13 | 0.12 | 0.11 |
| | $\bar{z}$ | (ft) | 6.68 | 6.97 | 7.18 | 7.34 | 7.46 | 7.55 | 7.61 | 7.67 | 7.71 | 7.75 |
| | M | (ft-lbs/ft) | 27,703 | 22,237 | 18,121 | 14,980 | 12,550 | 10,641 | 9,121 | 7,895 | 6,894 | 6,068 |
| | R | (lbs/ft) | 5,207 | 4,424 | 3,763 | 3,214 | 2,762 | 2,389 | 2,080 | 1,823 | 1,608 | 1,427 |
| 14 | **Ps** | (psf) | **338** | **351** | **349** | **337** | **319** | **298** | **276** | **255** | **234** | **215** |
| | α | (radians) | 0.68 | 0.76 | 0.83 | 0.89 | 0.94 | 0.99 | 1.03 | 1.07 | 1.10 | 1.13 |
| | β | (radians) | 0.38 | 0.33 | 0.28 | 0.25 | 0.22 | 0.19 | 0.17 | 0.15 | 0.13 | 0.12 |
| | $\bar{z}$ | (ft) | 7.46 | 7.85 | 8.13 | 8.35 | 8.51 | 8.64 | 8.74 | 8.82 | 8.89 | 8.94 |
| | M | (ft-lbs/ft) | 38,880 | 31,856 | 26,395 | 22,116 | 18,729 | 16,021 | 13,831 | 12,043 | 10,568 | 9,339 |
| | R | (lbs/ft) | 5,948 | 5,178 | 4,499 | 3,913 | 3,414 | 2,990 | 2,631 | 2,327 | 2,068 | 1,847 |
| 16 | **Ps** | (psf) | **280** | **301** | **310** | **308** | **300** | **286** | **271** | **254** | **237** | **220** |
| | α | (radians) | 0.62 | 0.70 | 0.77 | 0.83 | 0.88 | 0.93 | 0.97 | 1.01 | 1.04 | 1.07 |
| | β | (radians) | 0.36 | 0.32 | 0.28 | 0.25 | 0.22 | 0.20 | 0.18 | 0.16 | 0.14 | 0.13 |
| | $\bar{z}$ | (ft) | 8.17 | 8.64 | 9.01 | 9.29 | 9.51 | 9.68 | 9.82 | 9.93 | 10.03 | 10.10 |
| | M | (ft-lbs/ft) | 51,411 | 42,880 | 36,066 | 30,598 | 26,183 | 22,590 | 19,644 | 17,207 | 15,175 | 13,468 |
| | R | (lbs/ft) | 6,563 | 5,829 | 5,158 | 4,560 | 4,034 | 3,576 | 3,179 | 2,837 | 2,540 | 2,284 |

This chart identifies the active pressure and resulting forces due to E80 liveload.
See "SAMPLE PROBLEM" sheet for definitions of variables and equations.

1. Select distance S from track centerline to face of shoring.
2. Select depth $H_2$ below base of tie.
3. Read Ps, M, R and $\bar{z}$ from the table.
4. Use the procedure outlined in the sample problem to determine values at non-tabulated points.




$$Ps = \frac{2q}{\pi}\left[\beta - \sin\beta\cos(2\alpha)\right]$$

where q = 1778 psf

## Boussinesq surcharge pressure E80 live load for $H_1$=0

| Depth below top of shoring $H_2$ (ft) | Variables | | Horizontal distance (S) from shoring to track CL measured at a right angle | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
| 18 | **Ps** | (psf) | **231** | **256** | **271** | **277** | **276** | **269** | **259** | **247** | **234** | **220** |
| | α | (radians) | 0.57 | 0.64 | 0.71 | 0.77 | 0.82 | 0.87 | 0.92 | 0.96 | 0.99 | 1.02 |
| | β | (radians) | 0.35 | 0.31 | 0.28 | 0.25 | 0.23 | 0.20 | 0.18 | 0.16 | 0.15 | 0.13 |
| | $\bar{z}$ | (ft) | 8.80 | 9.37 | 9.81 | 10.16 | 10.44 | 10.67 | 10.85 | 11.00 | 11.12 | 11.22 |
| | M | (ft-lbs/ft) | 65,062 | 55,110 | 46,976 | 40,313 | 34,834 | 30,304 | 26,536 | 23,384 | 20,728 | 18,477 |
| | R | (lbs/ft) | 7,072 | 6,386 | 5,739 | 5,145 | 4,609 | 4,132 | 3,710 | 3,338 | 3,012 | 2,725 |
| 20 | **Ps** | (psf) | **191** | **217** | **236** | **246** | **250** | **249** | **244** | **237** | **227** | **217** |
| | α | (radians) | 0.52 | 0.59 | 0.66 | 0.72 | 0.77 | 0.82 | 0.87 | 0.91 | 0.94 | 0.98 |
| | β | (radians) | 0.33 | 0.30 | 0.28 | 0.25 | 0.23 | 0.21 | 0.19 | 0.17 | 0.15 | 0.14 |
| | $\bar{z}$ | (ft) | 9.37 | 10.03 | 10.56 | 10.98 | 11.32 | 11.59 | 11.82 | 12.01 | 12.16 | 12.30 |
| | M | (ft-lbs/ft) | 79,641 | 68,368 | 58,973 | 51,137 | 44,586 | 39,093 | 34,465 | 30,548 | 27,216 | 24,367 |
| | R | (lbs/ft) | 7,493 | 6,859 | 6,245 | 5,668 | 5,135 | 4,651 | 4,214 | 3,822 | 3,474 | 3,163 |
| 22 | **Ps** | (psf) | **159** | **184** | **204** | **217** | **225** | **228** | **227** | **223** | **217** | **210** |
| | α | (radians) | 0.49 | 0.55 | 0.62 | 0.67 | 0.73 | 0.77 | 0.82 | 0.86 | 0.90 | 0.93 |
| | β | (radians) | 0.31 | 0.29 | 0.27 | 0.25 | 0.23 | 0.21 | 0.19 | 0.17 | 0.16 | 0.14 |
| | $\bar{z}$ | (ft) | 9.89 | 10.64 | 11.24 | 11.73 | 12.14 | 12.47 | 12.74 | 12.97 | 13.17 | 13.33 |
| | M | (ft-lbs/ft) | 94,986 | 82,497 | 71,913 | 62,945 | 55,341 | 48,878 | 43,370 | 38,658 | 34,611 | 31,122 |
| | R | (lbs/ft) | 7,842 | 7,260 | 6,684 | 6,131 | 5,611 | 5,128 | 4,685 | 4,283 | 3,918 | 3,590 |
| 24 | **Ps** | (psf) | **133** | **157** | **176** | **191** | **202** | **207** | **210** | **209** | **206** | **201** |
| | α | (radians) | 0.45 | 0.52 | 0.58 | 0.63 | 0.68 | 0.73 | 0.78 | 0.82 | 0.85 | 0.89 |
| | β | (radians) | 0.30 | 0.28 | 0.26 | 0.24 | 0.22 | 0.20 | 0.19 | 0.17 | 0.16 | 0.15 |
| | $\bar{z}$ | (ft) | 10.35 | 11.19 | 11.87 | 12.44 | 12.90 | 13.29 | 13.62 | 13.89 | 14.13 | 14.32 |
| | M | (ft-lbs/ft) | 110,969 | 97,366 | 85,670 | 75,625 | 66,997 | 59,577 | 53,183 | 47,661 | 42,875 | 38,716 |
| | R | (lbs/ft) | 8,132 | 7,600 | 7,064 | 6,540 | 6,037 | 5,564 | 5,122 | 4,715 | 4,342 | 4,001 |
| 26 | **Ps** | (psf) | **112** | **134** | **153** | **168** | **180** | **188** | **192** | **194** | **193** | **191** |
| | α | (radians) | 0.42 | 0.48 | 0.54 | 0.60 | 0.65 | 0.69 | 0.74 | 0.78 | 0.82 | 0.85 |
| | β | (radians) | 0.28 | 0.27 | 0.25 | 0.23 | 0.22 | 0.20 | 0.19 | 0.17 | 0.16 | 0.15 |
| | $\bar{z}$ | (ft) | 10.78 | 11.69 | 12.45 | 13.09 | 13.62 | 14.07 | 14.44 | 14.77 | 15.04 | 15.28 |
| | M | (ft-lbs/ft) | 127,485 | 112,863 | 100,135 | 89,071 | 79,460 | 71,105 | 63,836 | 57,499 | 51,963 | 47,113 |
| | R | (lbs/ft) | 8,376 | 7,890 | 7,393 | 6,899 | 6,418 | 5,959 | 5,524 | 5,118 | 4,741 | 4,393 |
| 28 | **Ps** | (psf) | **94** | **114** | **132** | **148** | **160** | **169** | **175** | **179** | **180** | **180** |
| | α | (radians) | 0.40 | 0.46 | 0.51 | 0.56 | 0.61 | 0.66 | 0.70 | 0.74 | 0.78 | 0.81 |
| | β | (radians) | 0.27 | 0.26 | 0.24 | 0.23 | 0.21 | 0.20 | 0.19 | 0.17 | 0.16 | 0.15 |
| | $\bar{z}$ | (ft) | 11.17 | 12.16 | 12.99 | 13.70 | 14.29 | 14.80 | 15.23 | 15.60 | 15.91 | 16.19 |
| | M | (ft-lbs/ft) | 144,448 | 128,896 | 115,211 | 103,191 | 92,642 | 83,385 | 75,258 | 68,113 | 61,823 | 56,274 |
| | R | (lbs/ft) | 8,581 | 8,137 | 7,677 | 7,214 | 6,758 | 6,315 | 5,892 | 5,491 | 5,115 | 4,764 |
| 30 | **Ps** | (psf) | **80** | **98** | **115** | **130** | **142** | **152** | **160** | **165** | **167** | **168** |
| | α | (radians) | 0.37 | 0.43 | 0.48 | 0.53 | 0.58 | 0.63 | 0.67 | 0.71 | 0.74 | 0.78 |
| | β | (radians) | 0.26 | 0.25 | 0.23 | 0.22 | 0.21 | 0.20 | 0.18 | 0.17 | 0.16 | 0.15 |
| | $\bar{z}$ | (ft) | 11.52 | 12.59 | 13.49 | 14.26 | 14.92 | 15.48 | 15.97 | 16.38 | 16.75 | 17.06 |
| | M | (ft-lbs/ft) | 161,789 | 145,388 | 130,819 | 117,903 | 106,466 | 96,343 | 87,381 | 79,443 | 72,404 | 66,153 |
| | R | (lbs/ft) | 8,755 | 8,349 | 7,925 | 7,492 | 7,060 | 6,636 | 6,227 | 5,834 | 5,462 | 5,112 |
| 32 | **Ps** | (psf) | **69** | **85** | **101** | **115** | **127** | **137** | **145** | **151** | **155** | **157** |
| | α | (radians) | 0.35 | 0.41 | 0.46 | 0.51 | 0.55 | 0.60 | 0.64 | 0.68 | 0.71 | 0.75 |
| | β | (radians) | 0.25 | 0.24 | 0.22 | 0.21 | 0.20 | 0.19 | 0.18 | 0.17 | 0.16 | 0.15 |
| | $\bar{z}$ | (ft) | 11.85 | 12.98 | 13.95 | 14.79 | 15.51 | 16.13 | 16.67 | 17.13 | 17.54 | 17.89 |
| | M | (ft-lbs/ft) | 179,452 | 162,274 | 146,888 | 133,136 | 120,859 | 109,909 | 100,144 | 91,432 | 83,655 | 76,706 |
| | R | (lbs/ft) | 8,904 | 8,532 | 8,140 | 7,736 | 7,329 | 6,925 | 6,531 | 6,150 | 5,785 | 5,438 |

BNSF guidelines are as follows:

a. Guidelines for Design and Construction of Grade Separation Structures.

UPRR guidelines are as follows:

a. **Underpass Structures** – "Guidelines for Design and Construction of Grade Separation Underpass Structures."
b. **Overhead Grade Separation** – "Guidelines for Design of Highway Separation Structures Over Railroad (Overhead Grade Separation)."
c. **Demolition** – "Guidelines for Preparation of a Bridge Demolition and Removal Plan for Structures Over Railroad."
d. **Shoofly** – "Guidelines for Design and Construction of Shoofly (Detour) Tracks."
e. **Fiber Optic** – "UPRR Fiber Optic Engineering, Construction And Maintenance Standards." 1/1/2002
f. **Pipeline** – "Pipeline Installation" available at www.uprr.com.
g. **Industry Track** – "Technical Specification for Construction of Industrial Tracks"

WEBSITE DIRECTORY:

1. www.astm.org
2. www.arema.org
3. www.bnsf.com
4. www.pilespecs.com
5. www.uprr.com

AREMA Table 8-20-1. Granular Soils

| Descriptive Term for Relative Density | Standard Penetration Test Blows per Foot "N" |
|---|---|
| Very Loose | 0 - 4 |
| Loose | 4 - 10 |
| Medium | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | Over 50 |

AREMA Table 8-20-2. Silt and Clay Soils

| Descriptive Term for Consistency | Unconfined Compressive Strength Tons per Square Foot |
|---|---|
| Very Soft | Less than 0.25 |
| Soft | 0.25 - 0.50 |
| Medium | 0.50 - 1.00 |
| Stiff | 1.00 - 2.00 |
| Very Stiff | 2.00 - 4.00 |
| Hard | Over 4.00 |

AREMA Table 8-20-3. Unit Weights of Soils, and Coefficients of Earth Pressure

| Type of Soil | Unit Weight of Moist Soil, $\gamma$ (Note 1) | | Unit Weight of Submerged Soil, $\gamma'$ (Note 1) | | Coefficient of Active Earth Pressure, $K_A$ | | | | Coefficient of Passive Earth Pressure, Kp | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | For Backfill | For Soils in Place | Friction Angles (Note 2) | | For Soils in Place | Friction Angles (Note 2) | |
| | Minimum | Maximum | Minimum | Maximum | | | $\phi$ | $\delta$ | | $\phi$ | $\delta$ |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Clean Sand: | | | | | | | | | | | |
| Dense | 110 | 140 | 65 | 78 | | 0.20 | 38 | 20 | 9.0 | 38 | 25 |
| Medium | 110 | 130 | 60 | 68 | | 0.25 | 34 | 17 | 7.0 | 34 | 23 |
| Loose | 90 | 125 | 56 | 63 | 0.35 | 0.30 | 30 | 15 | 5.0 | 30 | 20 |
| Silty Sand: | | | | | | | | | | | |
| Dense | 110 | 150 | 70 | 88 | | 0.25 | | | 7.0 | | |
| Medium | 95 | 130 | 60 | 68 | | 0.30 | | | 5.0 | | |
| Loose | 80 | 125 | 50 | 63 | 0.50 | 0.35 | | | 3.0 | | |
| Silt and Clay (Note 3 ) | $\frac{165(1+w)}{1+2.65w}$ | | $\frac{103}{1+2.65w}$ | | 1.00 | $1-\frac{q_u}{p+\gamma\bar{z}}$ | | | $1+\frac{q_u}{p+\gamma\bar{z}}$ | | |

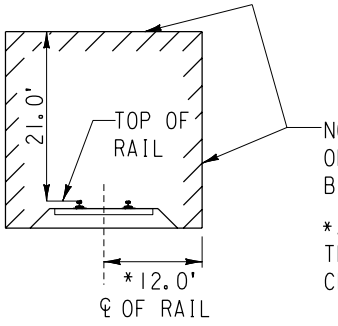
Note 1: In pounds per cubic foot.
Note 2: These angles, expressed in degrees, are $\phi$, the angle of internal friction, and $\delta$, the angle of wall friction, and are used in estimating the coefficients under which they are listed.
Note 3: The symbol $\gamma$ represents $\gamma$ or $\gamma'$, whichever is applicable; P is the effective unit pressure on the top surface of the stratum; $q_u$ is the unconfined compressive strength; w is the natural water content, in percentage of dry weight; and z is the depth below the top surface of the stratum.

General criteria:

a. Design loads to be based on the AREMA manual and Cooper E80 loading.
b. Pressure due to embankment surcharges.
c. ASTM designation and yield strength for each material.
d. Maximum allowable bending stress for steel is 0.55Fy.
e. Temporary overstress allowances are not acceptable.
f. All timber members shall be Douglas Fir Grade 2 or better.
g. Insitu soil classification.
h. Backfill soil classification.
i. Internal angle of friction and unit weight of soil.
j. Active and passive soil coefficients.
k. Backfill compacted to a minimum of 95% Proctor density per ASTM D-1557.
l. Slopes without shoring shall not be steeper than 2 horizontal to 1 vertical.
m. Dredge line elevation.
n. Shoring deflection to be calculated and meet Railroad requirements.

Miscellaneous:

a. Project name, location, GPS coordinates, track owner, Railroad line segment, milepost and subdivision in the title block.
b. Procedure outlining the installation and removal of the temporary shoring system.
c. General notes specifying material requirements, design data, details, dimensions and cross-sections, sequence of construction etc.
d. A description of tieback installation including drilling, grouting, stressing information and testing procedures, anchor capacity, type of tendon, anchorage hardware, minimum unbonded lengths, minimum anchor lengths, angle of installation, tieback locations and spacing.
e. All details for construction of drainage facilities associated with the shoring system shall be clearly indicated.
f. Details and descriptions of all shoring system members and connection details.
g. Settlement and displacement calculations.
h. Handrail and protective fence details along the excavations.
i. Drawings must be signed and stamped by a Licensed Professional Engineer, registered in the state where the work will be performed.
j. Call before you dig number.
k. Construction clearances diagram as shown below.




## MINIMUM CONSTRUCTION CLEARANCES

(NORMAL TO RAILROAD)
Not to scale

| | |
|---|---|
| DESIGN BY: | NAME & LOGO OF ENGINEERING FIRM OR PROJECT OWNER |
| DRAWN BY: | |
| SCALE: | GENERAL CRITERIA AND MISCELLANEOUS |
| DRAWING NO: | |
| SHEET: 1 of 3 | RR M.P. SUBDIVISION |
| DOT#: | CITY COUNTY STATE |
| DATE: | PROJECT NAME & LOCATION |

General plan view should show:

a. Railroad right-of-way and North arrow.
b. Position of all Railroad tracks and identify each track as mainline, siding, spur, etc.
c. Spacing between all existing tracks.
d. Location of all access roadways, drainage ditches and direction of flow.
e. Footprint of proposed structure, proposed shoring system and any existing structures if applicable.
f. Proposed horizontal construction clearances. The minimum allowable is 12 feet measured at a right angle from centerline of track.
g. Location of existing and proposed utilities.
h. Drawings must be signed and stamped by a Licensed Professional Engineer, registered in the state where the work will be performed.
i. Railroad and other "CALL BEFORE YOU DIG" numbers.
j. Detailed view of shoring along with controlling elevations and dimensions.

| | |
|---|---|
| DESIGN BY: | NAME & LOGO OF ENGINEERING FIRM OR PROJECT OWNER |
| DRAWN BY: | |
| SCALE: | GENERAL PLAN VIEW |
| DRAWING NO: | |
| SHEET: 2 OF 3 | RR M.P. SUBDIVISION |
| DOT#: | city COUNTY STATE |
| DATE: | PROJECT NAME & LOCATION |

Typical section and elevation should show:

a. Top of rail elevations for all tracks.
b. Offset from the face of shoring system to the centerline of all tracks at all changes in horizontal alignment.
c. All structural components, controlling elevations and dimensions of shoring system.
d. All drainage ditches and controlling dimensions.
e. All slopes, existing structures and other facilities which may surcharge the shoring system.
f. Location of all existing and proposed utilities.
g. Total depth of shoring system.

| | |
|---|---|
| DESIGN BY: | NAME & LOGO OF ENGINEERING FIRM OR PROJECT OWNER |
| DRAWN BY: | |
| SCALE: | TYPICAL SECTION & ELEVATION VIEW |
| DRAWING NO: | |
| SHEET: 3 of 3 | RR M.P. SUBDIVISION |
| DOT#: | CITY COUNTY STATE |
| DATE: | PROJECT NAME & LOCATION |

# APPENDIX C

City of Lee's Summit Approved Products

# CITY OF LEE'S SUMMIT
# WATER UTILITIES DEPARTMENT

## APPROVED PRODUCTS LIST

This document is provided as a benefit to contractors and suppliers who are performing work in the City of Lee's Summit. The Approved Products List for Water Utilities shall not be used as a substitute for catalog cuts, certifications or shop drawings. This list is updated periodically. The products indicated on the list are approved, but are subject to final field inspection before acceptance.

Vendors wishing to add a product to the list shall submit a Water Utilities Product Evaluation Form with supporting documentation to the Public Works Engineering Department. Vendors may also submit items, at no cost to the City, for evaluation. The City may test new water and wastewater products. Once a product has been added to the approved products list, minor product changes do not require an evaluation, although the vendor shall submit specification sheets and a sample of the product for the City to inspect. During an initial review, the following will be considered:

- Does the documentation received indicate that the product will perform as stated?
- Does a true need exist for the product in Lee's Summit?
- Will the product be economically competitive?
- Will the product function properly with existing City facilities?
- Will new equipment and new skills be needed to maintain the product?

The vendor supplying the product shall provide specifications and a certification that the product meets and or exceeds City specifications before any testing is performed. Products that are not performing satisfactorily will be removed from the approved products list if the vendor cannot provide timely correction of the problem.

If a vendor is proposing a product that does not meet City specifications, an explanation of why the product meets or exceeds the current specifications must be provided by the vendor in writing. If approved, the product may be tested to determine if the product is satisfactory. If the product is satisfactory, the City will consider a revision to the applicable specifications. Products will not be added to the Approved Products List that do not meet City specifications.

Products not performing as required or not supported by vendors or manufacturers are subject to removal from the list. Grounds for removal of products may include, but are not limited to:

- Significant change in product specifications or design without notification to the City,
- Failure to correct or replace products that are defective in manufacturing or workmanship,
- Repeated patterns of malfunction of a product not adequately corrected by vendor,
- Unreasonable pricing or timing of repair parts or repair work,
- Excessive delivery times for purchases.

Changes in standard specifications may also necessitate removal of specific products from the list. The product will be retained on the list if it is revised to meet the new criteria.

## 1. WASTEWATER PRODUCTS

| **AIR RELEASE ASSEMBLY** | **MODEL** |
|---|---|
| ARI | D-26 |

**CASING RUBBER END SEALS** **MODEL**
(Section 3501.N.2.a)

| | |
|---|---|
| Cascade Waterworks | CCES |
| CCI Pipeline Systems | ESW |
| PSI | W |

**CASING SPACERS** **MODEL**
(Section 3501.N.2.a)

| | |
|---|---|
| Cascade Waterworks | CCS (12” Width) |
| CCI Pipeline Systems | CSS12 |
| PSI | S12G2 |

**CONNECTION OF PIPES OF DISSIMILAR MATERIALS** **MODEL**
(Section 3502.B.12.b)

| | |
|---|---|
| Fernco | Strong Back Repair Coupling |
| Mission Rubber Company LLC | Flex-Seal Adjustable Repair Coupling |
| Gripper Gasket LLC | MaxAdapter |
| Total Piping Solutions Inc. | Hymax |

**EPOXY MANHOLE LINER** **MODEL**
(Section 3501.P.10.a)

| | |
|---|---|
| Citadel | SLS-30 |
| Neopoxy | NPR-5300 |
| Raven | 405 |

**JOINT SEALANT**

**BETWEEN JOINTS** **MODEL**
(Section 3501.P.4.a)

| | |
|---|---|
| Press-Seal | EZ-STIK |

**EXTERIOR OF JOINTS** **MODEL**
(Section 3501.P.4.b)

| | |
|---|---|
| Press-Seal | EZ-Wrap |
| Sealing Systems | Infi-Shield Gator Wrap |
| Canusa-CPS | WrapidSeal |
| Sealing Systems Inc. | Infi-Shield Uni-Band |

## MANHOLE CASTINGS

**STANDARD 24" MANHOLE FRAME AND COVER** **MODEL**
(Section 3501.O.9, Standard Drawing SAN-2)

Lee's Summit Part Numbers
Frame: LS101A
Cover: LS101B
Clay & Bailey ..... 2007MR, 2007
EJ ..... 1502
R.B. Agarwalla & Co ..... 2007-01-6000
Deeter ..... 1320

**BOLT-DOWN MANHOLE FRAME AND COVER** **MODEL**
(Section 3501.O.9, Standard Drawing SAN-2)

Lee's Summit Part Numbers
Frame: LS102A
Cover: LS102B
Clay & Bailey ..... 2014OR
Deeter ..... 1313

**SLAB MANHOLE FRAME AND COVER** **MODEL**
(Section 3501.O.9, Standard Drawing SAN-3)

Lee's Summit Part Numbers
Frame: LS103A
Cover: LS103B
Clay & Bailey ..... 2002, 2007
Deeter ..... 1332

**SLAB BOLT-DOWN MANHOLE FRAME AND COVER** **MODEL**
(Section 3501.O.9, Standard Drawing SAN-3)

Lee's Summit Part Numbers
Frame: LS104A
Cover: LS104B
Clay & Bailey ..... KCMO R4

## PIPE TO MANHOLE CONNECTORS **MODEL**

(Sections 3501.O.1.d, 3501.O.6, Std Drwg SAN-2, SAN-3, SAN-4, SAN-5)

**For new manholes**
A-Lok ..... Premium (12" and greater)
A-Lok ..... X-CEL (less than 12")

(Section 3502.B.11.b, Standard Drawing SAN-5)

**For existing manholes and core drilled openings through outside drop manholes**
Press Seal ..... PSX Direct Drive
A-Lok ..... G3

**POLYETHYLENE ENCASEMENT FILM**
(Section 3501.D.5)

| **LINEAR LOW DENSITY 8MIL AWWA C105** | **MODEL** |
|---|---|
| Sigma Corporation | 8 mil Linear LDPE |
| AA Thread Seal Tape, Inc. | 8 mil Linear LDPE |

**2. WATER PRODUCTS**

**CASING RUBBER END SEALS** **MODEL**
(Section 3901.R.2)

| | |
|---|---|
| Cascade Waterworks | CCES |
| CCI Pipeline Systems | ESW |
| PSI | Model W |

**CASING SPACERS**
(Section 3901.R.2)

| **STAINLESS STEEL** | **MODEL** |
|---|---|
| Cascade Waterworks | CCS |
| CCI Pipeline Systems | CSS12 |
| PSI | S12G2 |

**FIRE HYDRANTS** **MODEL**
(Section 3901.P)

| | |
|---|---|
| American AVK | 27N/PHH/NG |
| Clow | Medallion |
| Kennedy | Guardian K-81D |
| Mueller | Super Centurian |
| Waterous | Pacer (WB-67-250) |

**GRATE 18" X 18"** **MODEL**
(Standard Drawing WAT-12)

| | |
|---|---|
| Clay & Bailey | 2157BG |
| EJ | V5718 |
| Deeter | 3203 |

**MANHOLE COVERS**

| **TRAFFIC CONDITIONS** | **MODEL** |
|---|---|
| (Standard Drawing WAT-12) | |
| Clay & Bailey | 2002, 2007 |
| Deeter | 1332 |

| NON-TRAFFIC CONDITIONS | MODEL |
|---|---|
| (Standard Drawings WAT-12) | |
| Bilco | K-1 |
| EJ | H24242701 |

| AIR RELEASE ASSEMBLY | MODEL |
|---|---|
| (Standard Drawing WAT-10) | |
| A. Y. McDonald | 74M36 |
| Ford | MC-36 |

## POLYETHYLENE ENCASEMENT FILM

| LINEAR LOW DENSITY 12 MIL AWWA C105 | MODEL |
|---|---|
| (Section 3901.C.7) | |
| AA Thread Seal Tape, Inc. | 12 mil Clear Linear LDPE |
| Trumbull Manufacturing | 12 mil Clear Linear LDPE |

## STEPS

(Section 3901.O.2.b, Standard Drawing WAT-12)

| | MODEL |
|---|---|
| M. A. Industries | PS-2-PF |
| American Step Co | ML-13-NCR |

## TAPPING SLEEVES

| IRON BODY | MODEL |
|---|---|
| (Section 3901.M.1) | |
| American Flow Control | Series 2800 |
| Mueller | H-615 |
| Tyler/Union | 25U |
| U.S. Pipe | T-9 |

| STAINLESS STEEL | MODEL |
|---|---|
| (Section 3901.M.2) | |
| Cascade | Series CST-EX |
| Dresser | Style 630 |
| Ford | Style FTSS |
| JCM | Model 432 |
| Romac | SST-III |
| Smith-Blair | 665 |

## VALVES

| BUTTERFLY | MODEL |
|---|---|
| (Section 3901.L.2) | |
| Henry Pratt | Groundhog, Class 150B |
| Mueller | Lineseal III |

| GATE | MODEL |
|---|---|
| (Section 3901.L.3) | Gate Valve |
| American Flow Control | Series 2500 |
| Clow | Resilient Wedge Gate Valve |
| Kennedy | KS-FW |
| M&H | Style 4067, NRS |
| Mueller | 2360 Series |
| U.S. Pipe | A-USPO Resilient Wedge |

## VALVE BOXES

| CAST IRON COVERS | MODEL |
|---|---|
| (Section 3901.N.) | |
| Clay & Bailey | 2194 |
| Clay & Bailey | 2195 |

| CAST IRON VALVE BOXES | MODEL |
|---|---|
| (Section 3901.N.) | |
| Clay & Bailey | 5 ¼" (Screw Type) P1108 |

**BIG CREEK INTERCEPTOR SEWER UPSIZING, LEE'S SUMMIT MIDDLE SCHOOL #4**
**LEE'S SUMMIT, MISSOURI**

**July 2021**

**Olsson Project No. 020-01030**