PIP PLSC0011
Trenching and Excavation for Pipelines
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

This Practice is subject to revision at any time.

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Table of Contents

1. Scope ........................................... 2

2. References ................................. 2
   2.1 Process Industry Practices .......... 2
   2.2 Industry Codes and Standards ...... 2

3. Definitions ................................. 2

4. Requirements .............................. 4
   4.1 Soil Classification ...................... 4
   4.2 Safety ..................................... 4
   4.3 Preparation ............................. 9
   4.4 In-Progress Excavation .............. 11
   4.5 Trench Specifications ............... 19
   4.6 Documentation ......................... 21

Appendix A: Soil Classifications .. 23
1. **Scope**

   This Practice provides requirements for the installation of pipelines constructed in accordance with *ASME B31.8*, “Gas Transmission and Distribution Piping Systems” and *ASME B31.4*, “Pipeline Transportation Systems for Liquids and Slurries.” This Practice covers trenching and excavation for pipelines to be buried below existing grade to a depth of 6.1 m (20 feet) or less.

2. **References**

   Applicable parts of the following Practices and industry codes and standards shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles will be used herein where appropriate.

   **2.1 Process Industry Practices (PIP)**
   - PIP CVS02100 - *Site Preparation, Excavation and Backfill Specification*

   **2.2 Industry Codes and Standards**
   - OSHA
     - 29 CFR 1926 *Safety and Health Regulations for Construction, Subpart P, Excavation*

3. **Definitions**

   *Owner/operator:* The organization that exercises control over the operation, engineering, inspection, repair, alteration, pressure testing and rating of pipeline systems.

   *benching system:* Method of protecting employees against cave-ins by cutting the sides of an excavation to form one or more levels or steps, usually with vertical or near-vertical sides

   *cemented soil:* Soil which is held together by natural cement-like chemical agents. Hand-size samples cannot be crushed into powder or individual soil particles by finger pressure. Cemented soils include caliche and hardpan. These soils are very difficult to excavate.

   *clay soil:* Soil that is hard to break up if dry, but can be crushed to a powder; and moldable and sticks together (i.e., cohesive) if wet.

   *cohesive soil:* Soil with high clay content that sticks together if wet or dry. Cohesive soil does not crumble, can be dug with vertical sides, and is moldable if moist. Cohesive soil is hard to break up if dry, and sticks together if wet or underwater.

   *fissured:* Cracked. A characteristic of some soils to break along definite lines and fracture easily; soil that has open cracks (e.g., tension cracks) on the ground or excavation face

   *granular soil:* Gravel or sandy soils, possibly including silt, with little or no clay content. Granular soil has very little or no cohesive strength. Granular soil cannot be molded if moist and
crumbles easily if dry. Some moist granular soils can stick together and temporarily stand on a vertical slope, but typically cannot be trenched with vertical slopes.

**hydraulic shoring:** Structure that uses metallic rails and hydraulic cylinders that apply pressure to the walls of a trench to prevent the walls from collapsing. The types of hydraulic shoring are vertical shores and horizontal walers.

**protective system:** Method of protecting personnel against cave-ins, material falling from an excavation face or into an excavation, or the collapse of nearby structures. Types of protective systems include nearby shoring, sloping and benching, and shield and trench box systems.

**purchaser:** The party who awards the contract to the supplier. The purchaser may be the owner/operator or their authorized agent.

**Qualified Individual:** Person who understands the nature of the work to be performed and the precautions necessary to perform the work in a safe manner. A Qualified Individual, per 29 CFR 1926, subpart C, has completed trenching and excavation competent person training provided by the owner/operator.

**shield:** Structure that may not prevent a cave-in but is able to withstand the soil forces caused by a cave-in and thereby protect personnel within the structure. Shields used in trenches are typically referred to as “trench boxes” or “trench shields.”

**shoring:** Structure (e.g., hydraulic shoring) that supports the sides of an excavation and helps prevent cave-ins

**slope:** Degree of deviation of a soil surface from horizontal. Slope is expressed as the ratio of horizontal distance to the vertical rise. For example, a vertical rise or fall of 2 feet in a 100-foot horizontal distance is a 2% slope. Actual slope means the slope to which an excavation face is excavated.

**sloping system:** Method of protecting personnel against cave-ins by cutting the sides of an excavation at an angle. The angle needed to prevent a cave-in changes with different factors (e.g., soil type, weather exposure, and application of surcharge loads).

**supplier:** The party responsible for providing the trenching and excavation services

**support system:** Structure that supports nearby above or below ground structures or the sides of an excavation (e.g., underpinning, bracing, and shoring)

**slit trench:** Narrow trench used to locate underground piping or utilities typically within a compressor or processing facility

**trench:** Narrow excavation. The depth of a trench is greater than the width, but the width at the bottom is not greater than 4.6 m (15 feet).

**waler:** Type of shoring that uses horizontal structural members that are supported by hydraulic cylinders. A hydraulic waler system exerts continuous pressure on the trench walls helping to prevent a cave-in.
4. Requirements

4.1 Soil Classification

4.1.1 Soils shall be classified by a Qualified Individual as follows in accordance with the descriptions in Appendix A:
   a. Stable Rock
   b. Type A - Intact, Hard Soil
   c. Type B - Medium Soil
   d. Type C - Soft, Saturated or Submerged Soil

4.1.2 Soil classification shall be based on accepted industry methods and OSHA Standards that enable the Qualified Individual to readily identify soil conditions by field observation and testing.

4.1.3 The classifications of the deposits shall be made based on the results of a minimum of one visual and one manual analysis.

4.2 Safety

4.2.1 General

4.2.1.1 All excavation and trenching activities shall be conducted in accordance with sound engineering and construction practices, OSHA regulations, applicable municipal, county and state regulations, and owner/operator requirements provided in the contract documents.

4.2.1.2 If applicable, owner/operator shall furnish requirements regarding excavations defined by OSHA as “Confined Spaces.”

4.2.2 Protective Systems

4.2.2.1 A protective system shall be capable of preventing cave-ins and resisting all loads that can reasonably be expected on the system.

4.2.2.2 Protective systems of the following types shall be considered:
   a. Sloping and benching
   c. Trench shields and boxes
   d. Hydraulic shoring (i.e., vertical shores and horizontal walers)
   e. Site-specific engineered systems

4.2.2.3 Soil type shall be considered in accordance with Table 1 for determining appropriate protective systems.

4.2.2.4 For excavations with multiple soil types, the excavation shall be designed for the most unstable soil conditions.
Table 1. Protective System Selection Based on Soil Type
(see Appendix A for Soil Type descriptions)

<table>
<thead>
<tr>
<th>Protective System</th>
<th>Soil Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Sloping</td>
<td>Yes</td>
</tr>
<tr>
<td>Benching</td>
<td>Yes</td>
</tr>
<tr>
<td>Trench Shields and Boxes</td>
<td>Yes</td>
</tr>
<tr>
<td>Vertical Shores</td>
<td>Yes</td>
</tr>
<tr>
<td>Horizontal Walers</td>
<td>No</td>
</tr>
<tr>
<td>Site Specific Engineered</td>
<td>Yes</td>
</tr>
<tr>
<td>Systems</td>
<td></td>
</tr>
</tbody>
</table>

4.2.2.5 Trenches or other excavations dug in stable rock do not require a protective system.

4.2.2.6 A protective system shall be provided for all trenches and other excavations that are 1.2 m (4 feet) deep or greater and are intended for personnel entry.

4.2.2.7 If a trench or excavation is less than 1.2 m (4 feet) deep and there is a potential for a cave-in, a protective system shall be provided.

4.2.2.8 For excavations greater than 6.1 m (20 feet) deep, the protective system shall be designed by a registered professional engineer with appropriate expertise.

4.2.3 Sloping and Benching

4.2.3.1 For determining safe sloping and benching systems, the following method shall be used:
   a. The soil shall be classified in accordance with Appendix A.
   b. The maximum allowed angle of the bank based on soil type shall be determined in accordance with Figure 1.
   c. An appropriate trench configuration shall be determined in accordance with Figures 1, 2, 3, and 4.

4.3.2.2 Protection against loose rock or soil that can be a hazard by falling or rolling from an excavation face shall be stabilized as follows:
   a. Scaling to remove loose material
   b. Installing protective barricades (e.g., wire mesh)

4.3.2.3 Benching shall not be used for trench access or egress.
Figure 1. Minimum Slope Angles and Excavated Material Distance

Figure 2. Type A Soil Benching Example (53° slope)

Figure 3. Type B Soil Benching Example (45° slope)
4.2.4 Trench Shields and Boxes

4.2.4.1 Trench shields and boxes shall be aluminum or steel structures designed to protect workers by withstanding the forces imposed by a cave-in.

4.2.4.2 Trench shields and boxes shall be used in accordance with manufacturers’ ratings and recommendations.

4.2.4.3 Manufacturers’ tabulated ratings data shall be provided on the job site during construction.

4.2.4.4 Excavations around a trench shield or box shall be in accordance with the following:
   a. Soil shall be stable
   b. Excavation shall not be greater than 2 feet below the bottom of the shield or box
   c. Excavation shall not show signs of soil loss

4.2.5 Hydraulic Shoring

4.2.5.1 Hydraulic shoring shall be used in accordance with manufacturers’ ratings and recommendations.

4.2.5.2 Manufacturers’ tabulated ratings data shall be provided on the job site during construction.

4.2.5.3 If manufacturers’ tabulated data is not available, the shoring shall be in accordance with Tables 2 and 3 as applicable.

4.2.5.4 For applications of vertical shores, a minimum of three shores shall be provided, equally spaced in the horizontal direction.

4.2.5.5 Plywood may be used between a hydraulic shore and the excavation face; however, plywood shall not be used as a structural member.

4.2.5.6 Because of the instability of the soil, hydraulic shores used for Type C soil shall be horizontal walers.
4.2.5.7 For spacing and width of aluminum hydraulic shoring, see the following tables:

a. Table 2 for soil Type A

b. Table 3 for soil Type B.

### Table 2. Aluminum Hydraulic Shoring for Vertical Shores with Soil Type A

<table>
<thead>
<tr>
<th>Depth of Trench (feet) D = depth</th>
<th>Hydraulic Cylinders</th>
<th>Width of Trench (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Horizontal Spacing (feet)</td>
<td>Maximum Vertical Spacing (feet)</td>
</tr>
<tr>
<td>5 &lt; D ≤ 10</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>10 &lt; D ≤ 15</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>15 &lt; D ≤ 20</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. 2-inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer’s specification, extending the full, collapsed length.

### Table 3. Aluminum Hydraulic Shoring for Vertical Shores with Soil Type B

<table>
<thead>
<tr>
<th>Depth of Trench (feet) D = depth</th>
<th>Hydraulic Cylinders</th>
<th>Width of Trench (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Horizontal Spacing (feet)</td>
<td>Maximum Vertical Spacing (feet)</td>
</tr>
<tr>
<td>5 &lt; D ≤ 10</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>10 &lt; D ≤ 15</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>15 &lt; D ≤ 20</td>
<td>5.5</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. 2-inch diameter cylinders, at this width, shall have structural steel tube (3.5 x 3.5 x 0.1875) oversleeves, or structural oversleeves of manufacturer’s specification, extending the full, collapsed length.

### 4.2.6 Site-Specific Engineered Systems

4.2.6.1 If sloping and benching, shoring, and trench shields cannot be used because of site-specific circumstances, a registered professional engineer with appropriate expertise shall design a system specifically for the application.
4.2.6.2 The engineer shall be registered in the state where the trenching system is to be installed, and shall approve the design.

4.3 Preparation

4.3.1 General

4.3.1.1 All applicable permits shall be obtained before starting any type of excavation work.

4.3.1.2 Consent letters and crossing agreements shall be obtained as needed or required before starting an excavation.

4.3.1.3 All relevant information pertaining to the excavation including the following items shall be reviewed before starting an excavation:
   a. Drawings
   b. Locate marks
   c. Job Safety Analysis
   d. Observations from the site
   e. Contractor qualifications.

4.3.1.4 All trenching activities shall be contained within the staked workspace as shown on the construction drawings in the contract documents.

4.3.1.5 All construction roles and hazard control measures shall be defined and agreed before starting an excavation.

4.3.1.6 DOT Operator Qualification (OQ) tasks, if any, shall be identified.

   Comment: Excavating DOT-regulated systems near underground facilities and associated backfilling are considered covered tasks.

4.3.1.7 Only personnel qualified to perform DOT OQ tasks shall oversee DOT-regulated work.

4.3.1.8 Inspections of excavations and the adjacent areas shall be performed by the Qualified Individual to check for the following:
   a. Evidence of unstable soil that could result in a cave-in
   b. Indications of protective system failure
   c. Hazardous atmospheres
   d. Potential hazards (e.g., water accumulation, power lines, traffic, and railroads)

4.3.1.9 The Qualified Individual shall provide methods to mitigate the risks associated with each unsafe condition identified during the inspections.

4.3.1.10 The inspections shall be performed as follows:
   a. Daily before start of work
b. As needed throughout the shift and at the discretion of the Qualified Individual
c. Following a rainstorm or other event that increases hazard potential

4.3.1.11 If excavating inside or near compressor stations or third-party above-ground facilities, excavation plans shall be reviewed with facility representatives.

4.3.1.12 The Qualified Individual shall provide on-site supervision and shall be present when excavation work is in progress.

4.3.1.13 The signaler and equipment operator shall establish and maintain reliable communication with each other through the use of 2-way radios, intercom, horn, hand signals, etc., when mobile equipment is being operated.

4.3.1.14 The work surface shall be inspected for stability to prevent equipment from sliding, tipping, etc. External factors (e.g., wind, rain, snow, ice, mud, etc.) shall be considered.

4.3.1.15 A qualified engineer shall determine the maximum unsupported length of pressurized pipe that can be exposed for excavation.

4.3.1.16 All third-party notifications and construction requirements shall be performed.

4.3.1.17 A site-specific procedure shall be developed and approved by owner/operator for cases where hand excavation is not possible or practical (e.g., pipeline under water, in a rock ditch, too deep, etc.)

4.3.2 Equipment Use

4.3.2.1 Examples of mechanical machinery that may be used for typical excavation activities include, but are not limited to, excavators, wheel-type ditchers, beaches, drag lines, rotors, rock plows, and rippers.

4.3.2.2 Equipment shall be kept a minimum of 0.6 m (2 feet) from the edge of the excavation to prevent the equipment from falling or rolling into the excavation.

4.3.2.3 Hand trenching shall be performed in, but not limited to, the following cases:
   a. Within 0.6 m (2 feet) of existing underground structures
   b. Where required in accordance with permits or agreements
   c. Within areas specified on alignment sheets or construction line lists furnished with the contract documents

4.3.2.4 If required during excavation activities to prevent damage to the right-of-way, mats shall be provided in accordance with construction line lists furnished in the contract documents or as otherwise specified by the owner/operator.
4.3.3 **Line Locate and One Call**

4.3.3.1 All One Call notifications shall be submitted a minimum of 72 hours, or more if required by local agencies before starting any excavation.

4.3.3.2 All line locates shall be completed before starting any excavation.

4.3.3.3 Emergency dig requests may be approved by supplier’s managers or superintendents if required because of a sudden or unexpected occurrence involving a clear and imminent danger that requires immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services.

4.3.3.4 The proposed excavation area shall be marked (i.e., white-lined) before submitting a One Call notification and before performing any line locate activity.

4.3.3.5 White-line, One Call, and line locate markings shall not be disturbed before starting excavation.

4.3.3.6 Above ground locate marks shall be confirmed to be consistent with the location of all underground facilities shown on applicable drawings included in the contract documents. Any differences shall be investigated and resolved before starting excavation.

4.3.3.7 If the proposed protective system for trenching overlaps or is within 3.0 m (10 feet) of a third-party underground facility or pipeline, the facility or pipeline shall be exposed to the extent necessary to avoid contact during excavation.

4.3.3.8 If excavating in parallel with an existing underground facility or pipeline, the facility or pipeline shall be exposed (e.g., potholed, daylighted, etc.) before starting excavation.

4.3.3.9 An underground facility shall be exposed at intervals equal to or less than 76.2 m (250 feet) to confirm location and alignment.

4.3.3.10 All points of inflection shall be exposed and identified before excavation.

4.3.3.12 All above-ground facilities within 9.1 m (30 feet) of an excavation shall be clearly identified and protected.

4.3.3.13 Appropriate local, state and federal permits and notifications shall be obtained/completed, before starting any blasting activity.

4.4 **In-Progress Excavation**

4.4.1 **Property Access and Drainage**

4.4.1.1 Passageways around or across trenches shall be maintained for construction equipment, landowners, and livestock at owner designated points along the right-of-way.

4.4.1.2 All existing drainage, including, but not limited to, ditches and watercourses, shall be maintained or appropriately rerouted during trenching activities.


4.4.2 Site Precautions

4.4.2.1 Underground

1. Under cutting of an excavation wall shall not be permitted.

2. For excavations in soil that is unstable and near a structure’s foundation, because the excavation may compromise the integrity of the foundation, the following shall apply:
   a. The distance from a structure’s foundation to the edge of the excavation shall be less than or equal to the depth of the excavation.
   b. The depth of the excavation shall not be deeper than the bottom of the structure’s foundation.
   c. If the limitations in Sections 4.4.2.1.2.a and b cannot be met, a qualified engineer shall be consulted.

4.4.2.2 Above-Ground

1. Traffic around an excavation site shall be controlled, and barricades, signs, and flag persons provided as needed to control vehicular and pedestrian traffic and livestock.

2. Workers exposed to public vehicular traffic shall be provided with and wear warning vests marked with or made of reflective or high-visibility material.

3. If a site is accessible to the public and left unattended, temporary fencing and hazard lighting shall be provided.

4. Fencing shall be a minimum of 1.1 m (42 inches) high around the perimeter of an excavation.

5. If an excavation is within a secured area, warning tape may be used.

6. If an excavation is 1.2 m (4 feet) deep or less, the fence shall be a minimum of 0.9 m (3 feet) from the edge of the excavation.

7. If an excavation is greater than 4 feet deep, the fence shall be a minimum of 1.8 m (6 feet) from the edge of excavation.

8. See Figure 5 for a summary of the fencing requirements.
9. If the potential exists for personnel to fall 1.2 m (4 feet) or more into an excavation, or if an excavation is obscured or has a narrow opening, stronger fencing or other fall protection measures shall be provided.

10. Workers shall be made aware of hazardous areas around the excavation before work is started.

11. If employees or the public are permitted to cross over an excavation, walkways or bridges shall be provided with guardrails and toe boards in accordance with Figure 6, and extend a minimum of 0.61 m (24 in) past the surface edge of the trench.
12. In populated areas, fencing shall be provided around spoil piles or other excavation materials to prevent unauthorized access.

13. Excavation materials shall be placed a minimum of 0.6 m (2 feet) from the edge of an excavation to prevent the materials from falling or rolling into the excavation.

14. Heavy equipment and vehicles shall be kept as far away from an excavation as practical to reduce vibration.

15. Spoil piles shall not be greater than a height that causes the piles to be unstable and spill over into an excavation.

16. Sloping of a spoil pile shall be provided if required to prevent the spoil from falling into an excavation.

17. Spoil piles shall be placed as required to prevent loss of spoil because of wind or water.

18. Gaps shall be left in spoil piles to provide for the following:
   a. Allow for equipment, landowners, livestock, etc. to travel around the piles as required.
   b. Prevent surface water from accumulating and flooding adjacent property.

19. Spoil piles shall not be placed on top of loose debris or other foreign matter.

20. Spoil piles shall be kept free of rock, welding stubs, skids, trash, and other foreign materials.

21. Spoil piles shall be placed a minimum of 15.2 m (50 feet) from surface waters.

22. For cases where structures are horizontally located less than or equal to the excavation depth, the need for a support system shall be evaluated by a qualified engineer.

4.4.2.3 Excavation Access and Egress

1. Trenches, 4 feet deep or greater, intended for personnel entry shall have ladders, ramps or steps located a maximum of 15.2 m (50 feet) apart.

2. If a structural ramp is used for personnel access or egress, the ramp shall be designed by a Qualified Individual and constructed and installed in accordance with the design criteria.

3. If a structural ramp is used for equipment access or egress, the ramp shall be designed by an engineer qualified in structural design.

4. Ramps and runways constructed of two or more structural members shall be of uniform thickness and be connected together to prevent displacement. The means of connecting the ramp or runway shall not cause a tripping hazard.
5. Structural ramps used in lieu of stairs shall have cleats or other surface treatments on the top surface to prevent slipping.

6. If a ladder is provided for personnel access or egress, the ladder shall be secured and extend a minimum of 0.9 m (3 feet) above grade.

7. Unless a properly designed ramp is provided for a benched or sloped excavation, the access and egress points shall be inside a protective system.

8. Personnel shall not be permitted to enter any excavation that is not in accordance with the applicable state or federal regulations for the jurisdiction in which the excavation is located.

4.4.3 Excavation in Solid Rock

4.4.3.1 Solid rock shall first be broken up by drilling and blasting, or by pavement breakers.

4.4.3.2 Owner/operator approval shall be obtained before mechanically excavating near an adjacent pipeline in rock.

4.4.3.3 The license of the blaster and appropriate local, state and federal permits and notifications shall be obtained/completed, before starting any blasting activity.

4.4.3.4 A visual inspection of the trench material shall be performed before starting excavation to determine if any hazardous demolition remnants (e.g., blasting caps, drilled holes in rock, and residual unexploded dynamite) are present.

4.4.3.5 Adequate protection (e.g., mats) shall be provided to prevent damage to pipe coatings when excavating in rock.

4.4.3.6 Large boulders shall be cleared away from a pipeline and then removed from the excavation area.

4.4.3.7 Boulders shall not be lifted over a pipeline or placed where they can roll down and strike the pipeline.

4.4.3.8 Adequate protection shall be provided to prevent damage or instability to a buried facility during the removal or movement of boulders in an excavation.

4.4.3.9 If excavating in a rock located near an adjacent pipeline, excavation shall not be started until appropriate pipeline pressure can be determined by a qualified engineer and implemented.

4.4.3.10 Blasting

1. Blasters shall be licensed in accordance with all local, state, and federal agencies and shall provide evidence of previous explosives handling experience and safe blasting performance.

2. Blaster shall provide the blasting plan to be executed.
3. Before starting blasting, approval by owner/operator shall be obtained.
4. Before starting blasting, if active pipelines are in the general area, the owner(s) of those lines shall be notified.
5. Leak surveys shall be completed before and after blasting.
6. If rock debris from a blast is scattered across a right-of-way, the debris shall be cleaned up and disposed of in accordance with state and local regulations.

4.4.3.11 Blasting Safety

1. Before starting blasting, occupants of all buildings, stores, houses, or places of business within 90 m (300 feet) of a right-of-way shall be notified.
2. Farmers shall be notified 24 hours before starting blasting to protect livestock and property.
3. Smoking, firearms, matches, and open-flames of any kind shall not be permitted within 15.2 m (50 feet) of explosive magazines or while explosives are being handled, transported, or used.
4. Explosives shall be accounted for at all times. An inventory and use record of all explosives shall be maintained.
5. All explosive material shall be stored separately in locked magazines.
6. Explosives shall not be primed or fused until immediately before use.
7. Warning signs shall be provided and maintained at all approach points to the blast area before, during, and after blasting has started.
8. Before starting blasting, a clear and adequate warning shall be given to all personnel in the blasting area.
9. Loaded holes shall not be left unattended.
10. All explosives shall be verified as discharged before starting excavation.
11. A trench shall be blanketed before blasting to contain the blast and protect any nearby structures (e.g., telephone or power lines).
12. Before starting blasting, adequate protection shall be provided for nearby below ground structures.

4.4.4 Excavation near Existing Underground Facilities

4.4.4.1 Excavation near existing underground facilities shall be performed in accordance with all applicable local, state, and federal regulations.

4.4.4.2 If an underground facility is exposed, the event shall be documented.

4.4.4.3 If the location of an underground facility is uncertain, a line locator shall be used in front of the excavating equipment.
4.4.4.4 Unless otherwise specified in local, state, or federal regulations, before starting excavating, an underground facility shall be probed to ensure a minimum of 0.6 m (24 inches) of cover.

4.4.4.5 Unless otherwise specified in local, state, or federal regulations, to prevent potential damage, mechanical excavation equipment shall not be used within 0.6 m (24 inches) of an underground facility.

4.4.4.6 Backhoes shall be operated at a safe and controlled level in accordance with the following requirements when working in close proximity to an underground facility:
   a. The bucket shall be curled when lifted over the facility.
   b. Backhoe teeth shall be barred or a rubber bucket shall be used.
   c. Side cutters shall not be permitted.

4.4.4.7 Bell hole shall be created to enable manual excavation.

4.4.4.8 If excavation is within 0.6 m (24 inches) of an underground facility, shovels shall be used to expose the 9 o’clock to 3 o’clock positions of the facility.

4.4.4.9 Perpendicular digging should be avoided when approaching underground facilities. If necessary, competent engineering review shall be completed and the results approved by the owner/operator prior to excavation. This may include consideration of supporting, interference with cathodic protection, damage prevention, etc.

4.4.4.10 After an underground facility has been exposed, the facility shall remain visible to the equipment operator during the excavation.

4.4.4.11 Unless not possible, equipment operator and signaler shall maintain a continuous line of site with the top and sides of the hand-exposed underground facility.

4.4.4.12 If it is not possible to maintain a continuous line of sight because of the depth of the excavation or an obstruction, the equipment operator shall follow the signaler’s directions and proceed with extreme caution.

4.4.4.13 Pipe, valves, sleeves, and other assets shall be properly supported at all times during excavation, repair and backfill operations.

4.4.4.14 If the integrity of an underground facility is in question (e.g., geotechnical instability, evidence of third-party damage, dents, corrosion, etc.), owner of that facility should be notified. Owner of that facility should determine the appropriate action.

4.4.5 Slit Trench Excavation

4.4.5.1 Within all above-ground facility areas (e.g., the fence or boundary of compression, processing, treating facilities, or liquids terminals), hydraulic vacuuming and/or hand exposure techniques shall be used to excavate a slit trench on the perimeter of the proposed excavation area, including slope area.
4.4.5.2 A slit trench shall be excavated along the center line of the underground pipe to be exposed. The depth of the slit trench shall be a minimum of 0.3 m (12 inches) deeper than the planned excavation.

4.4.5.3 Slit trenches shall be backfilled after underground facilities have been verified, inspected and documented.

4.4.5.4 Because slit trenching can cause unstable trench walls, the stability of the walls shall be evaluated and protective measures shall be implemented as required.

4.4.5.5 See Figure 7 for an illustration showing a slit trench area.

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**Figure 7. Slit Trench**
4.4.6 Double Ditching

4.4.6.1 In some cases (e.g., trenching in streams, wetlands, or if rock is encountered while trenching), double ditching (i.e., topsoil segregation) shall be performed.

4.4.6.2 Double ditching is performed by removing the top 0.3 m (12 inches) of soil and segregating the soil from the rest of the spoil during pipeline construction.

4.4.6.3 The segregated soil shall be placed on top of the spoil during backfill.

4.5 Trench Specifications

4.5.1 Trench Width

4.5.1.1 Unless otherwise specified in the drawings or on the construction line lists provided in the contract documents, trenches shall be a minimum of 0.3 m (12 inches) wider than the pipe being installed.

4.5.1.2 For trenches containing multiple lines, the minimum distance of the pipe from the trench wall shall be a minimum of 0.3 m (12 inches).

4.5.2 Trench Depth of Cover

4.5.2.1 Depth of cover shall be determined by measuring the shortest vertical distance from the top of the pipe to the average level of original or restored grade on either side of the trench.

4.5.2.2 Trenches in pipeline right-of-ways and within facility boundaries shall provide the minimum depth of cover in accordance with Table 4.

4.5.2.3 Additional trench depth may be required in the following circumstances:

   a. Approaches to crossings of pipelines, bodies of water, roads, utilities, etc.
   b. Over bends and side bends to permit proper clearance of the pipe and trench bottom or side
   c. To prevent unnecessary bending of the pipe
   d. Tie-in points or at other bell-hole locations
   e. Required by construction line lists, permit, or local or state governing body
### Table 4. Minimum Depth of Cover for Pipelines in Right-of-Ways (see Notes 1 and 2)

<table>
<thead>
<tr>
<th>Location</th>
<th>Containing Gas</th>
<th>Containing Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cover (inches)</td>
<td>Cover (inches)</td>
</tr>
<tr>
<td></td>
<td>For normal excavations</td>
<td>For rock excavations</td>
</tr>
<tr>
<td>Cultivated agricultural areas or where subsurface ripping is common</td>
<td>48</td>
<td>N/A</td>
</tr>
<tr>
<td>Crossing of wetlands, streams, and rivers</td>
<td>48</td>
<td>18</td>
</tr>
<tr>
<td>Industrial, commercial, and residential areas</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Drainage ditches at public roads and railroads</td>
<td>48</td>
<td>24</td>
</tr>
<tr>
<td>Cased/uncased crossings of public roads (See note 3)</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Cased crossings of railroads (See note 3)</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Uncased crossings of railroads</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>All other areas</td>
<td>36</td>
<td>24</td>
</tr>
</tbody>
</table>

**Notes:**
1. Estimated maximum wheel load is equal to 35,000 pounds for the minimum depth of cover in the table above.
2. If estimated maximum wheel load is greater than 35,000 pounds or pipe is placed in an area where a crane’s outriggers might be set, further study is needed to determine required depth of cover.
3. Cased crossing should not be used unless required by a governing body or other third party.

#### 4.5.3 Trench Quality

4.5.3.1 Grading of a trench shall be performed to prevent unnecessary bending or stress of the pipe installed.

4.5.3.2 The final grade of a trench shall be uniform and provide a consistent load-bearing surface.
4.5.3.3 A finished trench shall be free of loose rocks, hard clods, and other foreign matter that can damage the pipe or pipe coating.

4.5.3.4 All tree roots shall be cut flush with the side and bottoms of a trench to prevent damage to the pipe.

4.6 Documentation

4.6.1 The Qualified Individual shall maintain documentation of all safety checks and the Job Safety Analysis.

4.6.2 Appropriate documentation, revisions to as-built drawings, alignment sheets, schematics, and other documentation requested in the contract documents shall be completed and provided to owner/operator.

4.6.3 Written records of inspections performed by owner/operator of any underground facilities that were excavated and subsequently backfilled shall be obtained from the owner’s representative. The written record shall be retained in the project file.

4.6.4 Documentation shall include reports of the following events:

a. Exposures of underground facilities

b. Discovery of internal or external corrosion or other integrity concerns
Appendix A

Soil Classifications
A.1 Stable Rock

Stable Rock is defined as natural solid mineral matter that can be excavated with vertical sides and remains intact while exposed.

A.2 Type A Soil

A.2.1 Type A Soil is defined as cohesive soil with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater.

A.2.2 Examples of Type A Soils include: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A Soils.

A.2.3 A soil is not a Type A Soil if the soil is any of the following:
   a. Fissured
   b. Subject to vibration from heavy traffic, pile driving, or similar effects
   c. Previously disturbed
   d. Part of a sloped, layered system, and the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater
   e. Subject to other factors that require the soil to be classified as a less stable material

A.3 Type B Soil

Type B Soil is defined as any of the following:

a. Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa)

b. Granular cohesionless soil such as angular gravel (i.e., crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam

c. Previously disturbed soil except soil that would otherwise be classed as Type C Soil

d. Soil that is in accordance with the unconfined compressive strength or cementation requirements for Type A Soil but is fissured or subject to vibration effects

e. Dry rock that is not stable

f. Material that is part of a sloped, layered system, and the layers dip into the excavation on a slope of less than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B Soil
A.4 Type C Soil

Type C Soil is defined as any of the following:

a. A cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less
b. Granular soils including gravel, sand, and loamy sand
c. Submerged soil or soil from which water is freely seeping
d. Submerged rock that is not stable
e. Material in a sloped, layered system, and the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater