

SECTION 02311**SUPPORT OF EXCAVATION****PART 1 GENERAL****1.01 SUMMARY**

- A. This section covers requirements for temporary support of excavations. Design, furnish, install, and maintain excavation support systems, including bracing and related components, to safely retain excavations and control ground movement. Upon completion of the required construction, remove supports (unless otherwise noted), and restore excavation and staging areas.
- B. The Work shall include all labor, materials, tools, equipment, design, services and incidentals required to complete excavation support including, but not limited to, the following: benching or grading; fencing and signing; staging areas; design, construction, and removal of or leaving in place excavation support systems; design, construction, and removal of cofferdam; control and disposal of excavated material; backfilling; and site restoration.
- C. Retain a licensed Professional Engineer registered in the Commonwealth of Massachusetts, with at least ten (10) years of experience in the design and construction of support of excavation systems, to prepare excavation support system designs and submittals required in this section.
- D. Sizing of excavations shall be the responsibility of the Contractor. The size of excavations shall be adequate for construction of structures and pipelines, removal of materials, and providing sufficient space for the Contractor's selected construction method.
- E. The excavation support system shall control groundwater, limit ground movement, protect adjacent structures, ensure a safe and stable excavation, and prevent subgrade disturbance, heave, or other instability.
- F. All excavations and excavation support systems shall conform to Contract Documents, applicable OSHA excavation, trenching, and shoring standards, which are contained in the 29 CFR Part 1926, and other federal, state, and local requirements. In case of conflict, comply with the more stringent requirements.
- G. This section is not applicable to trenchless excavations, however, it shall apply to jacking and receiving pits for the trenchless work.

1.02 RELATED SECTIONS

- A. Section 01300 – Submittals

- B. Section 01390 – Condition Survey
- C. Section 01400 – Quality Control Testing
- D. Section 02200 – Earthwork
- E. Section 02240 – Construction Dewatering and Groundwater Control
- F. Section 02440 – Auger Boring
- G. Section 02495 – Geotechnical Instrumentation

1.03 CODES AND STANDARDS

- A. American Society for Testing and Materials International (ASTM):
 - 1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A242 – Standard Specification for High-Strength Low-Alloy Structural Steel.
 - 3. ASTM A252 – Standard Specification for Welded and Seamless Steel Pipe Piles.
 - 4. ASTM A328 – Standard Specification for Steel Sheet Piling.
 - 5. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - 6. ASTM A690 – Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.
 - 7. ASTM A722 – Standard Specification for High-Strength Steel Bars for Prestressed Concrete.
 - 8. ASTM A1011 – 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.
 - 9. ASTM C33 – Standard Specification for Concrete Aggregates.
 - 10. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 11. ASTM C150 – Standard Specification for Portland Cement.

- B. American Welding Society (AWS):
 - 1. AWS D1.1 – Structural Welding Code-Steel.
- C. American Wood Protection Association (AWPA) Book of Standards.
- D. Post Tensioning Institute (PTI) Recommendations for Prestressed Rock and Soil Anchors.
- E. Codes:
 - 1. Occupational Safety and Health Administration (OSHA) Regulations, 29 CFR Part 1926 Subpart P – Excavations.
- F. Where reference is made to one of the above standards the revision in effect at the time of the bid opening shall apply.

1.04 SUBMITTALS

- A. Submittals shall be in accordance with Section 01300 – Submittals.
- B. At least 90 days prior to commencement of related construction activities, submit for review and acceptance, the Contractor's and Contractor's Design Engineer's qualifications.
- C. At least 60 days prior to commencement of related construction activities, submit for review and acceptance, Shop Drawings, construction procedures, Design Calculations, and materials and equipment catalog cuts for the Contractor-designed excavation support and cofferdam systems signed and sealed by a licensed Professional Engineer registered in the Commonwealth of Massachusetts. Submittals shall include the items listed below, as a minimum:
 - 1. Shop Drawings shall include:
 - a. Proposed excavation support system(s) relative to existing features and proposed construction, including extent of each excavation support system, existing and proposed grading around the excavation, and location and type of instrumentation and monitoring points within the area of influence of the excavation. The instrumentation and monitoring shall be performed in accordance with Section 02495 – Geotechnical Instrumentation and Contract Drawings.
 - b. Detail plan layout of the system, indicating dimensions, clearances, member sizes, material properties, locations, spacing and embedment depths of all members, and locations and layout of various types of lateral supports. Include on the plan existing and proposed utilities, structures, and other obstructions.

Penetration(s) and support for existing utilities shall also be shown on the plan.

- c. Wall elevations, bottom of excavation elevation, and locations and angles of all bracing.
 - d. Method and overall sequence of installation and removal of excavation support and bracing, indicating levels to which the work will be carried out before bracing is installed or removed.
 - e. Member connection details, method of preloading bracing, the design load and preload for each member, and the method of locking-off the preload. Include detailed drawings of the connections, jacking supports and method of shimming.
 - f. Details, layout, arrangement, equipment requirements, installation procedures, and method of construction of the proposed excavation support system.
 - g. Details, requirements, and design of launching and receiving pits of trenchless crossing including, but not limited to, penetration seal and reaction block/thrust block against jacking load.
 - h. Minimum lateral distance(s) from the edge of the excavation support system, to zone(s) where vehicles, construction equipment, and stockpiled construction and excavated materials are allowed.
 - i. Procedures for resolving difficulties arising from misalignment of members exposed during excavation or encountering obstruction, and criteria for implementing those procedures.
 - j. A plan showing deformation monitoring points and other geotechnical instrumentation as specified to monitor the performance of the excavation support system in accordance with Specification Section 02495 – Geotechnical Instrumentation and Contract Drawings. The plan shall include location(s) and elevation(s) of the monitoring point(s) and frequency of monitoring. Survey the elevation/location of each monitoring point and conduct monitoring of other geotechnical instrumentation in accordance with the approved plan.
 - k. Submit Excavation monitoring data of horizontal and vertical deflections of support of excavation within 24 hours of each survey along with all previous survey data.
2. Design Calculations shall include:
- a. Loads on the excavation support system for all stages of excavation, bracing installation, support elements or bracing removal, and concrete placement,

including material, hydrostatic, equipment, traffic, and surcharge loads on adjacent ground during construction, and jacking load where applicable. Loading shall meet the minimum requirements as shown on the Contract Documents.

- b. Design assumptions, procedures, and references.
 - c. Design evaluations for walls and bracing members including details for all stages of construction.
 - d. Theoretical deflections of the excavation support system for each stage of construction and deformation of structures, pipelines, and other improvements located within the area of influence of the excavation at the stage where maximum deformation is anticipated.
- D. For movable trench bracing, submit working drawings showing the proposed excavation locations, excavation depths and widths, clearance, existing and proposed utilities, structures and facilities, and type of movable trench bracing to be used. Include certification and manufacturer's specification, recommendation, and limitation of the proposed movable trench bracing, construction sequence, description, procedures, and equipment.
- E. Cofferdam
- 1. A U.S. Army Corps of Engineers Nationwide Permit #7 was obtained by the Authority and is provided in Appendix E to the Contract Specifications. The permit is subject to special conditions which must be followed during construction. Complete and return the Work-Start Notification 14 days prior to the anticipated project start date and the Compliance Certification form within 30 days of completing the project to USACE, with a copy to the Authority.
- F. At least 60 days prior to commencement of related construction activities, submit for review and acceptance, a plan of action to be implemented in the event any deformation exceeds the calculated theoretical deflections or threshold values on the deformation of the excavation support monitoring points as specified in Specification Section 02495 – Geotechnical Instrumentation. The plan of action shall be positive measures by the Contractor to limit further movement including, but not limited to, addition of struts and wales, placement of granular earth berms against the wall, installation of additional struts, or combinations thereof. The details of the mitigating measures shall include a schedule of implementation, location, and/or availability of materials, structural details for all connections to the wall and support elements, design calculations prepared and signed and sealed by the Contractor's Design Engineer, and a detailed description of the method of implementation.
- G. Submit quality control measures as required to ensure that the performance of the

excavation support system is consistent with the approved Shop Drawings and the requirements herein.

- H. Submit welder qualifications and weld procedures in accordance with AWS D1.1.
- I. Where an obstruction is encountered before the specified embedment is reached or interferes with the location of any portion(s) of the excavation support system, submit an evaluation and revised Shop Drawings, prepared and signed and sealed by the Contractor's Design Engineer, for modification of the excavation support system, realignment of the support and additional toe stability measure.
- J. Submit a certification by the Contractor's Design Engineer that the excavation support system and any pipeline support of excavation are constructed in accordance with the applicable design, following the complete installation of each system and after any modifications made by the Contractor during construction.
- K. For excavation support systems left in place, submit as-built information prior to covering the excavation support system. As-built information shall include:
 - 1. Survey locations of the excavation support systems, including end points and points of change in direction.
 - 2. Type and material of the excavation support system.
 - 3. Elevation of top and bottom of the elements left in place.
- L. Do not proceed with any excavation support system or protection activities until the submittal has been approved by the Authority and the geotechnical instrumentation systems are installed and initialized.
- M. Submit to the Authority for review and approval, an Emergency Action Plan addressing flood events that exceed the water levels assumed in the design of SOE and cofferdam. The Emergency Action Plan shall identify flood trigger elevations, monitoring and notification procedures, responsible personnel, emergency contacts, and actions to be implemented to protect the Work, maintain site safety, and prevent damage to adjacent properties and infrastructure. The plan shall also describe procedures for suspension of work, evacuation of personnel, protection of equipment and materials, and restoration of the work and the site following the flood event.

1.05 QUALITY ASSURANCE

- A. Regulations: Perform all work in accordance with current applicable regulations and codes of all federal, state, and local agencies.
- B. Installation of the excavation support systems shall be performed by the Contractor or Subcontractor that meets the qualification requirements herein (Paragraph 1.06) with

suitable equipment, competent personnel, and a history of satisfactorily performing similar work.

- C. Provide quality control measures as required to ensure that the performance of the excavation support system is consistent with the approved Shop Drawings and the requirements herein. Measures shall include, at a minimum:
 - 1. On-site inspections of the excavation support system by the Contractor's Design Engineer at the start of the excavation support installation, and periodically throughout system installation.
 - 2. Quality control testing as required, including, but not limited to, testing of concrete, welding, and grout strength in accordance with requirements in Specification Section 01400 – Quality Control Testing and herein. Refer to Specification Section 02200 – Earthwork for frequency of quality control testing of fill and backfill materials.
 - 3. Review of quality control testing results, deformation and performance monitoring data by the Contractor's Design Engineer.
 - 4. Review of the installed excavation support system relative to the Shop Drawings and system modifications made.
- D. Conduct all testing and preloading in the presence of the Authority. Work conducted without the Authority present will not be accepted and shall be re-tested as directed by the Authority at no additional cost to the Authority.
- E. Contractor's documentation shall include:
 - 1. On-site inspection records of the excavation support system.
 - 2. Records of quality control testing results, and performance monitoring data.

1.06 QUALIFICATIONS

- A. Contractor or subcontractor that is responsible for excavation support system installation shall have at least five (5) years of experience with work comparable to the Work shown and specified, and employing labor and supervisory personnel who are similarly experienced in this type of work. The Contractor is not required to submit qualifications for the Support of Excavation installation.
- B. Contractor's Design Engineer shall be a licensed Professional Engineer registered in the Commonwealth of Massachusetts with at least ten (10) years professional experience in the design and construction of excavation support systems similar to those proposed for this project and shall have completed not less than five (5) successful excavation support system projects of comparable type, size, and complexity to that required for

the Work within the last five (5) years.

- C. The cofferdam design engineer shall be licensed to practice professional engineering in the Commonwealth of Massachusetts and have at least ten (10) years of experience in design of cofferdams for similar projects. The cofferdam design engineer shall sign and seal the Cofferdam construction drawings and calculations supporting the design.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Time delivery and installation of materials to avoid extended on-site storage and to avoid delays. Keep materials protected during fabrication, delivery, storage, handling, and erection. Keep timber dry during storage and provide air circulation in stacks of timber.
- B. Store structural steel, sheeting, and bracing materials to prevent sagging or permanent deformation. Keep concentrated loads during stacking, lifting or transportation below the level that would produce permanent deformation of the material.

1.08 PROJECT/SITE CONDITIONS

- A. Refer to Appendix A of the Contract Specifications for subsurface conditions.
- B. Examine the Contract Drawings to determine the sequence of operations. Start of work shall signify acceptance of field conditions and acknowledgement of all work requirements.
- C. The Contract Documents are based on available information and limited field investigation and inspection and may not represent the actual conditions across the entire site. Actual field conditions may vary. Field verify elevations and dimensions of the existing structures. If discrepancies are observed and elevations and dimensions of excavations and structures need adjustment, submit the proposed adjustments for approval prior to the start of work.

1.09 DEFINITIONS

- A. Zone of Influence – area extending down and away from the outer edge of the foundation or from spring line of pipe, then outward and downward at a slope of one (1) horizontal to one (1) vertical.
- B. Cofferdam – a structure that retains water and soil that allows the enclosed area to be pumped out and excavated in the dry to permit construction.
- C. SOE – Support of Excavation

1.10 TOLERANCE

- A. Design the temporary SOE and dewatering systems to limit horizontal deflection of the SOE to 1.0 inch.

1.11 DESIGN REQUIREMENTS

- A. The design of SOE is the responsibility of the Contractor. Design SOE systems in accordance with the requirements of this section and in accordance with all OSHA requirements and other agencies and local requirements. These criteria are the minimum acceptable standards.
- B. Design the SOE system to minimize horizontal and vertical movements to limits established in Specification Section 02495 – Geotechnical Instrumentation, and to protect adjacent structures and utilities from damage.
- C. Design shall consider all phases of construction, and each member or support element shall be designed to support the maximum loads that can occur during construction with appropriate factors of safety. Design shall consider conditions that may occur during the various stages of construction including, but not limited to, temporary or permanent alteration of soil in-situ properties caused by the selected methods of construction, temporary bracing (installation, relocation, and removal), excavation below bracing, dewatering of excavation, ground improvement, time related effects, penetrations, shrinkage of concrete, and load transfer to permanent structure.
- D. Soil parameters for the design of SOE system are tabulated in Table 1. The friction angle between the soil outside the excavation and the SOE wall shall be taken as zero. Refer to Appendix A of the Contract Specifications for the boring logs and the subsurface information.

Table 1 Soil Parameters for SOE Design

Stratum	Drained Friction Angle (Degrees)	Total Unit Weight (Pounds Per Cubic Foot)
Fill	30	120
Alluvial Deposits	35	125
Glaciofluvial Deposits	32	122
Glacial Till	37	137

- E. The at-rest earth pressure coefficient shall be used if the SOE wall is not designed to move or deflect sufficiently to reach minimum active conditions. The active earth pressure coefficient should be used if the SOE wall is permitted to deflect or move sufficiently to reach the active conditions.
- F. Include the hydrostatic pressure in the design of SOE systems. The minimum design

groundwater elevations are presented in Table 2. Take into account the seasonal variations of the groundwater in the SOE design.

Table 2 Minimum Design Groundwater Elevations for SOE Design

Station	Minimum Design Groundwater Elevation (NAVD88)
0+00 to 11+00	104.0
11+00 to The Charles River	96.0

- G. Traffic loading shall be taken into account for all excavations if active traffic is expected within a distance at least equal to the depth of the SOE elements from the edge of excavation. The construction surcharge shall in no case be assumed to be less than an equivalent soil height of 2 feet.
- H. The Contractor's design of the cofferdam, SOE and dewatering systems shall assume that the bottom of the excavation may be lowered by 2 feet below the design invert elevation. This lowering may be due to over-excavation or removal of unsuitable materials.
- I. If the Contractor's SOE system includes cross struts, the Contractor's SOE design engineer shall determine whether preloading is required and, if so, specify the preload magnitude and sequencing in the signed and sealed SOE design submitted to the Authority for approval. The SOE design must integrate with the dewatering approach and satisfy all performance criteria specified in the Contract Documents.
- J. Maintain a minimum factor of safety of 1.5 against heave, uplift, piping, global instability, and instability due to seepage gradients at the base of the excavations. Where applicable, the factor of safety against deep-seated failure should be evaluated. The minimum factor of safety shall be 1.5.
- K. For excavation support systems in which bracing is installed between opposite sides of the excavation, design the excavation support of both sides to be nearly the same when feasible. Use the apparent earth pressures for the design of SOE structures braced at more than one level.
- L. Select methods of excavation and excavation support system that are compatible with project site conditions, ground conditions, and requirements for placement of permanent structures, control of water, safety of personnel, and protection of adjacent property.
- M. Excavations below the level of the base of any adjacent foundation or retaining wall shall not be permitted, unless the design of the excavation and bracing includes an analysis of the stability of the corresponding retaining wall or structure supported by

the corresponding foundation and, as necessary, the Work incorporates required bracing/underpinning of the foundation. Undermining of an existing structure must not occur.

- N. Penetrations through the excavation support system shall include measures to retain soil and groundwater around the penetrations and prevent loss of ground or damage to existing utilities or structures.
- O. Provide measures to prevent ground loss at the transition around the soil and rock interface.
- P. Jacking and receiving pits shall be designed in full compliance with the SOE and dewatering requirements outlined in this section and in Specification Section 02240 – Construction Dewatering and Groundwater Control. Penetration details shall be provided on the SOE walls to accommodate and facilitate trenchless construction operations. Design the thrust block and backstop to safely resist the maximum anticipated jacking load.
- Q. Excavation using movable trench bracing shall be evaluated and designed by the Contractor's Design Engineer and in accordance with approved submittal.
- R. Where necessary to resist point loads, pipe piles used as soldier piles shall be filled with concrete with a compressive strength not less than 3,000 pounds per square inch. The strength of the concrete shall not be considered in the design of the pipe piles for bending stress.
- S. Refer to the construction zone safety plan drawing CT-001 for the traffic limitations and requirements for the design and installation of the support of excavation.
- T. COFFERDAM DESIGN
 - 1. Contractor shall assume all responsibility for the stability and adequacy of cofferdams erected by Contractor and all costs and damages resulting from any failure or defect thereof.
 - 2. The cofferdam design shall provide for adequate working space, watertightness, and a suitable dewatering system. The cofferdam design shall be performed based on the requirements of the Contract Documents.
 - 3. Include the hydrostatic pressure in the design of cofferdam. The minimum design water elevation for the Charles River shall be in accordance with Table 2. Top of cofferdam shall be no lower than the design water elevation.
 - 4. Structural steel grades shall be in accordance with the American Institute of Steel Construction (AISC) standards.

5. Steel used in sheet piling shall be in accordance with ASTM A572, or A690.
 6. Allowable unit stresses shall be in accordance with AISC. No increase in stresses due to temporary loads shall be considered. No overstress permitted for any reason.
 7. Contractor shall use higher water and/or earth elevations than the required design elevations shown in the Contract Documents, if higher water and/or earth levels are anticipated on the cofferdam exterior.
 8. Increase the design loading if construction operations will impose higher loads than those shown on Contract Documents. Include the anticipated construction surcharge loading in the design.
 9. Materials shall be undamaged and free from defects which impair the strength or suitability.
- U. All underground and above-ground utility lines shall be identified, located, and protected from damage or displacement. Excavation and excavation support system shall be designed to accommodate and protect underground and above-ground utilities. Utility companies and other responsible authorities shall be contacted to locate and mark the locations and, if they desire, direct or assist with protecting the underground installation. When required, obtain an excavation permit from the authority having jurisdiction prior to the initiation of any excavation work.
- V. Design temporary fencing around all excavations. Provide pedestrian and traffic control around working areas and excavation support systems located within or adjacent to streets, roadways, freeways, driveways, walkways, or parking lots.
- W. Receipt of the Contractor's plans and methods of construction does not relieve the Contractor of their responsibility to provide an adequate excavation support system achieving the specified requirements. Design review and field monitoring activities by the Authority shall not relieve the Contractor of their responsibilities for the Work.

1.12 PROTECTION

- A. In performing this work, the Contractor shall take care so as not to impair the stability and integrity of the existing adjacent buildings, structures, utilities, sidewalks, pavement, and other facilities or induce settlements in them. The Contractor shall take whatever measures necessary to prevent and fix any damage at no additional cost to The Authority
- B. Monitoring of existing structures and facilities and the support of excavation during and after excavation shall be performed in accordance with the Specification Section 02495-geotechnical instrumentation.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Timber, structural steel, steel sheet piling, and movable trench bracing used for the excavation support systems, whether new or used, shall be sound and free from defects that may impair their strength.
- B. Soldier piles and structural steel members shall conform to ASTM A572, ASTM A690, or ASTM A242 unless approved otherwise. All steel conforming to ASTM A572 shall be Grade 50 or better. No members with permanent deformations are to be provided. Members shall not be spliced unless designed by the Contractor's Design Engineer and reviewed and approved by the Authority.
- C. Pipe piles used as soldier piles shall conform to ASTM A252, Grade 3 or better.
- D. Steel sheet piling shall conform to ASTM A328, ASTM A572, or ASTM A690. All steel sheet piling conforming to ASTM A572 shall be Grade 50 or better.
- E. Liner plates and sheet piling shall be fabricated from structural quality hot-rolled carbon steel sheets or plates conforming to ASTM A1011.
- F. Concrete shall conform to ASTM C33 and ASTM C150.
- G. Timber shall be structural grade with a minimum allowable flexural strength of 1,100 pounds per square inch. Timber lagging shall be at least 3 inches thick and free of large or loose knots.
- H. Timber lagging may be treated or untreated and fabricated from mixed hardwood species and may be supplied in random widths and lengths, provided all boards meet the minimum structural requirements.
- I. Preservative and fire-retardant treated wood shall comply with AWWA Standards.
- J. Wood shims for braces and wales shall not be permitted. Steel shims shall be used when required.

PART 3 EXECUTION**3.01 GENERAL**

- A. Install all SOE system elements, including sheet pile, braces, struts, walers, and connections tight and secure to ensure connections and elements are functioning and transmitting the forces acting on the SOE system.
- B. Installation of the excavation support system and commencement of excavation shall

occur only after Shop Drawings have been reviewed and accepted by the Authority and a preconstruction survey has been conducted in accordance with Section 01390 – Condition Survey, and Specification Section 02495 – Geotechnical Instrumentation.

- C. All instrumentation required per Specification Section 02495 – Geotechnical Instrumentation shall be installed and initialized prior to the start of SOE installation.
- D. Protect and support in place or relocate existing utilities that would be impacted by or interfere with the excavation or excavation support system in coordination with the utility owner.
- E. Methods of construction for excavations shall ensure the safe execution of the Work and protection of the Contractor's employees, Authority, and Authority's employees and inspectors, the public, and adjacent property and improvements, whether public or private.
- F. Install excavation support systems in accordance with the approved Shop Drawings and applicable permits.
- G. As a minimum, place fencing, gates, lights, and signs as necessary around excavations and staging areas to provide for public safety.
- H. Monitor performance of excavation support systems for horizontal and vertical deflections in accordance with Specification Section 02495 – Geotechnical Instrumentation and approved submittal. If monitoring data indicates that deflections have exceeded the threshold value in accordance with Section 02495 and Contract Drawings, or the theoretical deflections provided in the approved submittal, implement the approved plan of action.
- I. If deformation of existing facilities, deflection of excavation supports or monitoring data from geotechnical instrumentation as specified in Specification Section 02495 – Geotechnical Instrumentation indicates that an excavation support system requires modification to prevent excessive movements, the Contractor's Design Engineer shall redesign and resubmit revised Shop Drawings and calculations at no additional cost to the Authority. The Contractor shall be prepared to work 24 hours per day to implement such remedial or mitigation measures continuously, as required, to maintain the stability of the excavation system. All such work shall be performed at no cost to the Authority.
- J. If the Authority is of the opinion that at any point sufficient or proper supports have not been provided, the Authority may order additional supports placed at no additional cost to the Authority. Compliance with such order shall not relieve the Contractor from their responsibility for the sufficiency of such supports.
- K. Conduct all work, including excavation, backfilling, shoring, temporary facilities,

materials storage, and construction traffic within Limits of Disturbance established for the project.

- L. Care shall be taken to prevent voids outside of the excavation support system, but if voids are formed, they shall be immediately filled with clean sand or granular material. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete or other material as approved by the Authority.
- M. If unstable material is encountered during excavation, all necessary measures shall be taken immediately to contain it in place and prevent subgrade disturbance and/or ground displacement.
- N. Sufficient quantity of excavation support materials, backfill materials, and other supplies as identified in the Contractor's plan of action shall be maintained on site for protection of Work and for use in case of accident or emergency.
- O. Include and perform any dewatering necessary to facilitate the SOE installation. Perform dewatering so as not to cause loss of support, settlement, or adverse impacts to the adjacent buildings, structures, utilities, sidewalks, pavement, and other facilities. The contractor shall be responsible for securing all permits and paying all fees necessary to perform dewatering and for discharging dewatering effluent.
- P. Perform dewatering in accordance with the Specification Section 02240 – Construction Dewatering and Groundwater Control.
- Q. All welding shall conform to the applicable provisions of AWS D1.1.

3.02 MOVABLE TRENCH BRACING

- A. Portable trench boxes or sliding trench shields may be used for the protection of workers only and shall not be relied upon as the primary control of ground deformation, protection of adjacent facilities, or protection of subgrades.
- B. Trench boxes and shields shall not be used for excavations that extend within the zone of influence of existing structures.
- C. Additional excavation, backfilling, and surface restoration required as the result of using a trench box or shield shall be at no additional cost to the Authority.
- D. Trench boxes or shields shall be designed, constructed, and maintained to meet the Contract Document's requirements and acceptable engineering and industry standards.
- E. Install shields in a manner that restricts lateral, or unexpected, movement due to a sudden lateral load being applied to the shield.

- F. Maintain a copy of the trench box manufacturer's specifications, recommendations, and limitations in written form at the job site during all excavation work.
- G. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or support bracing to prevent movement of the pipe, or disturbance of the pipe bedding, and disturbance of the backfill.
- H. When installing rigid pipe (e.g. reinforced concrete), raise the trench box above mid-diameter of pipe prior to moving the box ahead to prevent the separation of installed pipe joints due to movement of the box.
- I. When flexible pipe (e.g. PVC, ductile iron, steel) is being installed, trench boxes, movable sheeting, shoring, or plates shall not extend below mid-diameter of the pipe.
- J. As trench boxes, movable sheeting, shoring, or plates are moved, place granular material to fill any voids created and recompact the granular material, pipe bedding and backfill to provide uniform side support for the pipe.

3.03 SOLDIER PILES AND LAGGING

- A. Soldier piles and lagging shall only be allowed in a dry excavation. Conduct dewatering ahead of excavation, where applicable, to maintain the groundwater level below the bottom of excavation.
- B. Soldier piles shall be installed in pre-drilled holes.
- C. Provide casing or other methods of support as necessary to prevent caving of holes and loss of ground.
- D. Backfill predrilled holes for soldier piles with concrete from the pile tip elevation to the elevation of the bottom of the excavation. Backfill the remainder of the predrilled hole with lean concrete or sand. Concrete strength shall be in accordance with the approved Shop Drawings.
- E. The predrilled hole diameter shall be sufficient to allow for proper alignment and concrete backfilling of the pile.
- F. Provide timber lagging of sufficient thickness to withstand earth pressures and in accordance with the approved Shop Drawings.
- G. Install lagging such that ground loss does not occur between adjacent boards or below the lowest board. As the excavation proceeds, the maximum height of the unlagged face of the excavation shall not exceed 2 feet, or smaller if necessary.
- H. As the installation progresses, backfill the voids between the excavation face and the

lagging to establish a tight contact. Pack materials such as hay, burlap, or geotextile filter fabric where necessary to allow drainage of ground water without loss of ground.

3.04 STEEL SHEET PILING

- A. Except where obstructions are anticipated, do not excavate in advance of steel sheet piling installation.
- B. If boulders or other subsurface obstructions are encountered, the Contractor shall employ appropriate measures such as pre-excavation or pre-drilling to ensure sheet piles are installed to the required tip elevations for stability and groundwater control. All such work shall be performed at no additional cost to the Authority and shall not extend below the lowest planned excavation level nor penetrate into bearing soils for existing or future structures.
- C. Prior to installation, thoroughly clean and inspect the sheet piles for defects and for proper interlock dimensions. Provide a tool for checking the interlock dimensions.
- D. Use templates or other temporary alignment facilities to maintain the piling line and to ensure the sheeting maintains a plumb position.
- E. Install sheeting in a manner that ensures each sheet pile is fully interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground. Exercise care in driving so that interlocking members can be extracted without damaging adjacent structures or utilities. The methods of driving, vibrating, cutting, and splicing shall conform to the approved Shop Drawings.
- F. Each sheet pile shall have sufficient clearance in the interlocks to slide, under its own weight, into the interlock of the sheet pile previously placed.
- G. Install steel sheet piling with the minimum embedment depths as shown on the approved Shop Drawings. Remove obstructions that prevent obtaining the specified embedment for the piles. Where obstructions cannot be removed, the Contractor's Design Engineer shall re-evaluate the sheet pile system for the resulting reduced embedment, and, if required, provide additional toe stability measures. Alternatively, if approved by the Authority, realign the sheet pile wall as needed. Provide a submittal of the evaluation and proposed measures to the Authority for approval.
- H. Withdraw damaged piling or piling with faulty alignment and drive new piling properly in its place at no additional cost to the Authority.

3.05 INTERNAL BRACING

- A. Provide internal bracing to carry the maximum design load for any excavation stage

without distortion or buckling. The bracing shall be preloaded to at least 60 percent of the design load, unless otherwise approved.

- B. Include web stiffeners, plates, or angles as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Account for eccentricities caused by field fabrication and assembly.
- C. Install and maintain all bracing support members in tight contact with each other, with the excavation support system, and with the ground being supported.
- D. Coordinate excavation work with installation of bracing. Excavation shall not extend more than 2 feet below any brace level prior to installation of the bracing.
- E. Use procedures that produce uniform loading of bracing members without causing eccentricities, overstressing, or distortion of the excavation support system.
- F. Preload bracing members in accordance with procedures and sequence as described on the accepted Shop Drawings. Transfer load by jacking without introducing eccentricity. Use steel shims and steel wedges welded or bolted in place to maintain the preloading force in the bracing after release of the jacking equipment force. Perform all preloading in the presence of the Authority.

3.06 REMOVAL OF EXCAVATION SUPPORT SYSTEM

- A. Leave in place after completion of work SOE systems and cofferdam on which the support or stability of existing structures is dependent. Do not remove vertical support members that were installed within the zone of influence of new or existing structures or new pipelines. Support members installed within this zone shall be left in place.
- B. Remove all SOE and cofferdam structures not located within zone of influence of the new pipeline or structure, unless otherwise approved by the Authority. Carefully remove materials such that no damage or loss of support occurs beneath roadways, utilities, sidewalks, or structures adjacent to the SOE system. Immediately remove from the site any material removed from the SOE system and properly dispose of it in accordance with all applicable state, city, and federal codes and regulations.
- C. Cut off and remove excavation support elements left in place at least 5 feet below finished grade, unless otherwise approved by the Authority.
- D. Remove all untreated timber lagging and do not leave them in the ground.
- E. Keep records of the details and locations of left-in-place support of excavation members. Submit the records to The Authority.
- F. Do not remove internal bracing and transfer loads to the permanent structure without prior acceptance of the Authority.

- G. Excavation support system removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly, and the excavation support system carefully observed to note any indication of possible failure of the remaining members or possible cave-in of the sides of the excavation.
- H. Backfilling of excavations shall progress together with the removal of excavation support systems.
- I. Immediately refill all voids left after withdrawal of the excavation support systems with compacted sand or rammed lean concrete. Use tools especially adapted for compacting and ramming refill materials into the voids. For voids that cannot be properly compacted or rammed with refill material, fill the voids with a cement-based grout or other refill material as approved by the Authority. Cement-based grout shall be placed into the voids using tremie methods.
- J. Remove materials used for the excavation support system from the Site immediately.
- K. SOE components left in place for the convenience of the Contractor shall be at no additional cost to the Authority.

**** END OF SECTION ****