Department of

Environmental Safety

DIVISION OF ADMINISTRATIVE AFFAIRS

TRENCHING AND SHORING PLAN

Approved as UM Policy – September 2006

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Policy Statement

I. Purpose.

This is a statement of official University policy to establish the process for compliance with the Occupational Safety and Health Administration (OSHA) regulation, "Excavations, Trenching and Shoring", 29 CFR 1926.650, .651, and .652 as enforced by the Maryland Occupational Health and Safety program (MOSH), with the provisions of the Annotated Code of the Public General Laws of Maryland Article 78 Subtitle 28A, "Underground Facilities".

II. SCOPE

The Trenching & Shoring Plan shall apply to all faculty, staff and students who are involved in excavation operations on property owned and/or operated by the University of Maryland and satellite locations and operations associated with the campus which are located in the State of Maryland. For sites outside of Maryland but in the United States of America or its territories, provisions of OSHA regulations 29 CFR 1926.650, .651 and .652 for “Excavation, Trenching and Shoring” shall apply, unless more stringent safety regulations for that jurisdiction are in effect. For sites outside of the United States of America or its territories, local provisions shall apply as long as they offer worker protection equivalent to aforementioned OSHA regulations. If local standards do not offer equivalent protection, then University personnel should follow OSHA provisions.

Contractors involved in excavation operations on University property are required to comply with all applicable provisions of OSHA/MOSH regulations as per their contract.

III. Policy.

The University is dedicated to providing safe work facilities for students and employees, and complying with federal and state occupational health and safety standards. Administrators, faculty, staff and students all share a responsibility to reduce the hazards associated with excavations.

IV. Responsibilities.

A. Department of Environmental Safety (DES) shall:
   1. Provide consultation;
   2. Prepare the *Trenching and Shoring Plan* with periodic review and revisions as needed;
   3. Distribute the *Trenching and Shoring Plan* to each affected department for distribution to all individuals who are authorized by the department to excavate;
   4. Investigate and document all reported accidents and/or near-miss accidents that are directly or indirectly related to trenching; and,
   5. Coordinate training and retraining of those who may be involved in excavations.
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B. Department Heads shall:
   1. Designate a supervisor to be in charge of each excavation; and,
   2. Assure that necessary resources are made available to the designated supervisor to allow for compliance with this plan.

C. Designated Supervisors shall:

1. Implement all provisions of the *Trenching and Shoring Plan* for work areas under their control;
2. Receive training for "Competent Person" for trenching as defined by OSHA.
3. Act as the "Competent Person" for excavation sites under their control;
4. Assure that the equipment necessary to complete an excavation safely is available and in good condition;
5. Assure that all underground utility installations such as sewer, telephone, fuel tanks, electric, gas, and water lines are located and marked before excavation begins;
6. Receive written approval from the Department of Facilities Management - Energy & Utilities for digging, trenching or excavation on the UM campus.
7. Conduct soil tests to determine soil type;
8. Ensure that underground installations are protected, supported or removed while the excavation is open. Notify Energy & Utilities when utility systems are exposed during the excavation process to allow the location and condition of the utility to be evaluated;
9. Ensure worker protection and compliance with other applicable safety plans, programs and guidelines;
10. Ensure protection of the public with appropriate barricades;
11. Determine what protective systems will be used to prevent cave-ins;
12. Conduct daily inspections of excavations, the adjacent areas, and protective systems for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions; and,
13. Immediately notify Work Control in the event a utility system is damaged during the excavation process on the UM campus.

D. Department of Facilities Management shall:

1. Review project concepts and designs for potential impact to utility systems on University of Maryland property. Approve project as appropriate from a utility standpoint, or recommend changes to projects if there are conflicts with utility systems. Provide written authority to proceed with excavation if the project impact to utilities is acceptable;
2. Coordinate the marking of underground utilities on UM campus;
3. Provide for the marking of underground utilities under its authority;
4. Notify Washington Gas in the event of a broken gas line;
5. Inspect utility systems exposed during the excavation process;
6. Review utility repair proposals and approve if acceptable, or recommend repair procedures. Inspect utility repairs after they are completed and prior to covering them; and,
7. Interface with contractors under its control to monitor compliance with this OSHA/MOSH regulations.

E. The Department of Information Technology (DIT) shall:

1. Provide for the identification and marking of underground telecommunications lines.

F. Employees shall:
   1. Complete all safety training requirements and request further instruction if unclear on any part of the *Trenching and Shoring Plan;*
   2. Use appropriate safety and personal protective equipment (PPE);
   3. Adhere to the requirements of the *Trenching and Shoring Plan*; and
   4. Report all work place injuries and unsafe conditions.

V. Information

Assistance will be provided by DES to any Department or individual requesting guidance or training to satisfy implementation of this policy.

Call DES at (301)405-3960;
Send electronic mail to Safety@umd.edu; or
View the DES home page at http://www.essr.umd.edu

Definitions and Acronyms

Accepted Engineering Practices are procedures compatible with the standards of practice required of a registered professional engineer.

Adjacent Structures Stability refers to the stability of the foundation(s) of adjacent structures whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the failure zone of the excavation or trench.

Competent Person is an individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who *has authorization to take prompt corrective measures to eliminate or control these hazards and conditions.*

Confined Space is a space that, by design and/or configuration, has limited openings for entry and exit, unfavorable natural ventilation, may contain or produce hazardous substances, and is not intended for continuous employee occupancy.

Excavation. An **Excavation** is any man-made cut, cavity, trench, or depression in an earth surface that is formed by earth removal. A **Trench** is a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width, and the width (measured at the bottom) is not greater than 15 ft. If a form or other structure installed or constructed in an excavation reduces the distance between the form and the side of the excavation to 15 ft or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Hazardous Atmosphere is an atmosphere that by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful may cause death, illness, or injury to persons exposed to it.

Ingress and Egress mean "entry" and "exit," respectively. In trenching and excavation operations, they refer to the provision of safe means for employees to enter or exit an excavation or trench.

Protective System refers to a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Registered Professional Engineer is a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer who is registered in any state is deemed to be a "registered professional engineer" within the meaning of Subpart P when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Support System refers to structures such as underpinning, bracing, and shoring that provide support to an adjacent structure or underground installation or to the sides of an excavation or trench.

Subsurface Encumbrances include underground utilities, foundations, streams, water tables, transformer vaults, and geological anomalies.

Surcharge means an excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect trench stability.

Tabulated Data are tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Underground Installations include, but are not limited to, utilities (sewer, telephone, fuel, electric, water, and other product lines), tunnels, shafts, vaults, foundations, and other underground fixtures or equipment that may be encountered during excavation or trenching work.

Unconfined Compressive Strength is the load per unit area at which soil will fail in compression. This measure can be determined by laboratory testing, or it can be estimated in the field using a pocket penetrometer, by thumb penetration tests, or by other methods.

Information and Training

All personnel involved in trenching or excavation work shall be trained in the requirements of this plan. Training shall be performed before anyone is assigned duties in excavations. Call Environmental Safety at (301)405-3960 for assistance in training arrangements.

A. **Training of the Designated Supervisor**

1. All Designated Supervisors of trenches and excavations shall meet the OSHA requirements for "a Competent Person" (see Appendix II).
2. Designated Supervisors will attend "Competent Person" training conducted by a DES approved training source such as the Maryland Fire and Rescue Institute (MFRI) or MOSH.

B. **Training of Workers**

Personnel who perform work in excavations shall comply with the requirements of this plan and shall receive appropriate training that shall include at a minimum:

1. Safe work practices that must be followed during work in excavations;
2. The use of personal protective equipment (PPE) that will typically be required during work in excavations, including but not limited to safety shoes, hardhats, and fall protection devices;
3. Procedures to be followed if a hazardous atmosphere exists or could reasonably be expected to develop during work in an excavation; and
4. Emergency and non-entry rescue methods, and procedures for calling rescue services.

Retraining will be performed whenever work site inspections conducted by the Designated Supervisor or DES indicate that a worker does not have the necessary knowledge or skills to safely work in or around excavations.

Training records will be maintained by the Designated Supervisor and DES.

Excavation Procedures

A. **Project Development and Impact to Utilities.** The Designated Supervisor shall ensure that a campus project is coordinated with Facilities Management - Energy & Utilities early in the programming and development stages, so that conflicts with utilities can be resolved early. The Designated Supervisor shall obtain written approval from Energy & Utilities indicating that the impact to utilities has been reviewed and approved prior to proceeding with excavation.

B. **Utilities and Pre-work Site Inspection.** The Designated Supervisor shall inspect the site before the excavation is started to determine what safety measures are to be taken. Underground sewer, telephone, gas, water and electric lines shall be located and clearly marked. The Designated Supervisor shall arrange to have these utilities protected, removed or relocated as directed by Energy & Utilities and as may be needed to do the work safely. Excavation shall be done in a manner that does not endanger the underground installations or those engaged in the work. Utilities left in place shall be protected by barricades, shoring, suspension or other means as necessary.

   For sites in the State of Maryland, Washington D.C., Delaware and Northern Virginia, MISS UTILITY shall be notified to arrange for the marking of underground utilities. For sites in other areas of the United States and other parts of the world, the local procedures for marking utilities before excavation shall apply.

C. **Stability of Adjacent Structures.** The Designated Supervisor shall take precautions as needed to protect workers, nearby buildings or other structures. A Registered Professional Engineer should evaluate these structures and recommend precautions such as shoring, bracing, or underpinning. The Designated Supervisor shall ensure that the recommendations of the engineer are carried out. Plans that outline the design of such precautions approved by the engineer shall be maintained on site while the work is in progress.

D. **Protection of the Public.** Barricades, walkways, lighting and signs shall be provided for the protection of the public prior to the start of excavation operations. Guardrails, fences, or barricades shall be provided adjacent to walkways, driveways and other pedestrian or vehicle thoroughfares.

E. **Protection of Workers in Excavations.** The Designated Supervisor shall assure that workers are protected from hazards that may arise during excavation work.

   1. **Ingress and Egress**. Access to and exit from the trench require the following conditions:

      a) Trenches 4 ft or more in depth should be provided with a fixed means of egress.

      b) Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 ft laterally to the nearest means of egress.

      c) Ladders must be secured and extend a minimum of 36 in above the landing.

      d) Metal ladders should be used with caution, particularly when electric utilities are present.

2. Those workers exposed to vehicular traffic shall wear warning vests made of high visibility material.

3. No one shall work underneath loads handled by lifting or digging equipment. Workers shall stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials.

4. A warning system shall be used when mobile equipment is operated next to the edge of an excavation if the operator does not have a clear, direct view of the edge of the excavation.

5. Materials and equipment should be kept at least 2 feet from the edge of the excavation with the proper protective system in place.

F. **Hazardous Atmospheres and Confined Spaces.** Workers shall not be permitted to work in hazardous and/or toxic atmospheres. Such atmospheres include those with the following:

1. Atmospheric oxygen concentration below 19.5% or above 23.5%.

2. A combustible gas concentration greater than 10% of the lower flammable limit.

3. Concentrations of hazardous substances that exceed those specified in the Threshold Limit Values (TLVs) for airborne contaminants established by the American Conference of Industrial Hygienists (ACGIH).

If there is any possibility that the trench or excavation could contain a hazardous atmosphere, the Designated Supervisor shall ensure that atmospheric testing is conducted prior to worker entry and continuously during work. Excavations near underground storage tanks or that contain gas pipelines should be monitored. Suitable precautions shall be taken as necessary to protect workers. These precautions may include the following:

1. Engineering controls such as ventilation;

2. Respiratory protection: Those required to wear respiratory protection must be enrolled in the *University of Maryland Respiratory Protection Program*. Enrollment in the program requires workers to:

   a) Complete respiratory protection training; Training for air purifying respirators is provided by DES and for SCBA/SAR by the MFRI.

   b) Obtain a fit test provided by DES;

   c) Complete a medical examination provided by the University Health Center; and

   d) Maintain annual re-certification.

3. Full body harnesses and lifelines.

Some trenches qualify as permit-required confined spaces. The Designated Supervisor shall ensure compliance with the *University of Maryland Confined Space Plan* when an excavation has one or more of the following characteristics:

1. Contains or has the potential to contain a hazardous atmosphere, OR

2. Contains a material that has the potential for entrapping, engulfing or suffocating an entrant, OR

3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section, OR

4. Contains any other recognized serious or health hazard.

G. **Personal Protective Equipment (PPE).** The Designated Supervisor shall ensure that all workers wear all required safety equipment as detailed below. Hardhats, safety eye ware, gloves, hearing protection and fall protection devices shall be furnished by the worker's department or the contractor's employer. The department or employer must ensure that anyone conducting work in excavations wears safety footwear approved by the American National Standards Institute (ANSI).

1. Everyone working in trenches or excavations shall wear ANSI approved hardhats at all times.

2. Everyone working in trenches or excavations shall wear ANSI approved steel toed shoes or boots.

3. Those exposed to flying fragments, dust or other materials produced by drilling, sawing, sanding, grinding and similar operations shall wear safety glasses with side shields.

4. Those exposed to hazards produced by welding, cutting, or brazing shall wear approved eye protection or a welding face shield or helmet. The Designated Supervisor shall obtain a Hot Work Permit from the Department of Environmental Safety. Call (301) 405-3960 for information.

5. Those workers entering deep and confined excavations shall wear a harness with a lifeline securely attached to it. The lifeline shall be separate from any line used to handle materials. The lifeline shall be attended by a person at all times while the employee wearing the lifeline is in the excavation.

6. All workers shall wear gloves or other suitable hand protection as determined by the supervisor.

7. Workers at the edge of an excavation 6 feet or more deep shall be protected from falling by guardrails systems, fences, barricades, or other approved means.

A Workplace Hazard Assessment should be conducted by the supervisor or other qualified person according to the requirements described in the *University of Maryland Personal Protective Equipment Program*.

H. **Walkways and Guardrails.** Walkways shall be provided where workers or equipment are allowed to cross over excavations. Guardrails shall be provided on walkways used by the general public regardless of the height above the excavation. Guardrails shall be provided on walkways used only by on-site personnel if the walkway is 4 feet or more above lower levels. If workers pass below a walkway, then guardrails and toeboards shall be provided.

I. **Hazards Associated with Water Accumulation.** No one shall work in excavations with standing water or where water is collecting unless prior approval or instruction is given by the Designated Supervisor. Methods for controlling water accumulation must be provided and should consist of the following if anyone must work in the excavation:

1. Use of special support or shield systems approved by a Registered Professional Engineer.

2. Water removal equipment, such as well pointing, used and monitored by the Designated Supervisor.

3. Use of safety harnesses and lifelines.

4. No one shall work in excavations during a rainstorm unless circumstances warrant it and adequate precautions are taken.

5. Trenches shall be inspected by the Designated Supervisor after each rain and before anyone is permitted to re-enter the excavation.

J. **Protection of Workers from Falling Objects:** The Designated Supervisor shall ensure that workers are protected from loose rock or soil that could fall or roll from an excavation face. Such protection shall consist of:

1. Scaling to remove loose material;

2. Installation of barricades such as wire mesh or timber as needed to stop and contain falling material; OR

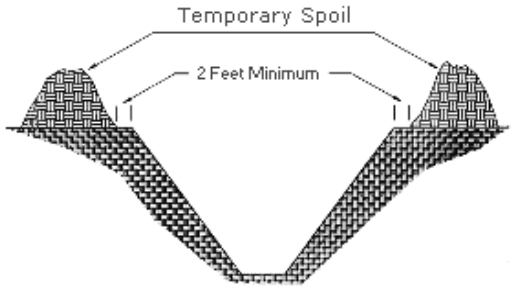
3. Sloping. Sloping may be used instead of barricades when practical.

Workers shall be protected from excavated materials, equipment or other objects that could pose a hazard by falling or rolling into excavation. These materials or equipment should be kept at least 2 feet from the edge of the excavation or otherwise restrained. Materials piled, grouped or stacked near the edge of an excavation must be stable and self-supporting.

4. Temporary Soil

Temporary spoil must be placed no closer than 2 ft from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Spoil should be placed so that it cannot accidentally run, slide, or fall back into the excavation.



5. Permanent Spoil

Permanent spoil should be placed at some distance from the excavation. Permanent spoil is often created where underpasses are built or utilities are buried. The improper placement of permanent spoil, i.e. insufficient distance from the working excavation, can cause an excavation to be out of compliance with the horizontal-to-vertical ratio requirement for a particular excavation. This can usually be determined through visual observation. Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

K. **Inspections.** The Designated Supervisor shall conduct daily inspections of excavations, adjacent area, and protective systems for evidence of a situation that could result in a cave-in, failure of protective systems, hazardous atmospheres, or other hazardous conditions. All inspections must be documented. The following guide specifies the frequency and conditions requiring inspections:

- Daily and before the start of each shift;
- As dictated by the work being done in the trench;
- After every rainstorm;
- After other events that could increase hazards, e.g. snowstorm, windstorm, thaw, earthquake, etc.;
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur;
- When there is a change in the size, location, or placement of the spoil pile; and
- When there is any indication of change or movement in adjacent structures.

Requirements for Protective Systems

A. **Protection of Workers in Excavations.** Personnel working in an excavation shall be protected from cave-ins by using either an adequate sloping and benching system or an adequate support or protective system. The only exceptions are when the excavation is made entirely in stable rock or the excavation is less than 4 feet in depth where examination of the ground by the Designated Supervisor provides no indication of a potential cave-in.

B. OSHA categorizes soil and rock deposits into four types, 1 through 4, as follows:

1. **Stable Rock** is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

2. **Type A Soils** are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) or greater. Examples of Type A cohesive soils are often: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam.

3. **Type B Soils** are cohesive soils with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf. Examples of other Type B soils are: angular gravel; silt; silt loam.

4. **Type C Soils** are cohesive soils with an unconfined compressive strength of 0.5 tsf or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable.

5. **Layered Geological Strata**. Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

C. **Soil Classification.** In order to design the most appropriate protective system, the Designated Supervisor shall determine the soil type using a visual test with one or more manual tests. The soils in the State of Maryland have been found to be Type B and Type C. If the soil is subject to vibration or previously disturbed or saturated, a B soil must be downgraded to a C classification.

1. Visual Test - The entire excavation site including the soil adjacent to the site is observed. During the visual test, the Designated Supervisor shall check for crack-line openings along the failure zone that indicate tension crack and observe the open side of the excavation for indications of layered geologic structuring. Other conditions to look for are signs of bulging, boiling, or sloughing, as well as signs of surface water seeping from the side of the excavation or from the water table.

2. Manual Tests

a) Thumb Penetration Test. When the thumb is pressed firmly into the soil and penetrates no further than the length of the nail, it is probably Type B soil. If the thumb penetrates the full length of the thumb, it is Type C. This is the **least accurate** of the manual test methods.

b) Dry Strength Test. If a sample of dry soil is crumbled freely or with moderate pressure into individual grains it is considered granular, or Type C. Dry soil that falls into clumps that subsequently break into smaller clumps is probably clay in combination with gravel, sand, or silt (Type B).

c) Plasticity or Wet Thread Test. A moist sample of the soil is molded into a ball and then rolled into a thin thread approximately 1/8 inch in diameter by two inches in length. If the soil sample does not break when held by one end, it may be considered Type B. If the soil sample does break, it is considered Type C.

A pocket penetrometer, shearvane, or torvane may also be used to determine the unconfined compression strength of soils.

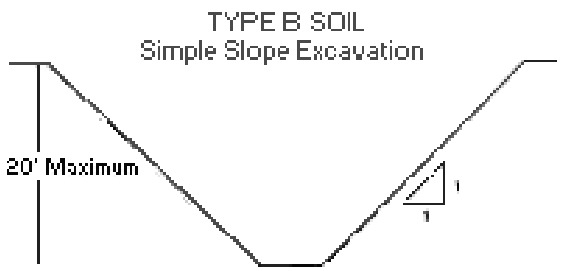
Additional detains are contained in Appendix I.

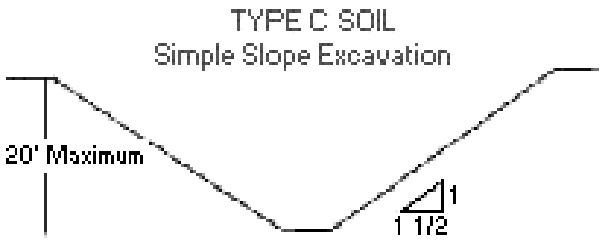
D. **Types of Protective Systems.** The following systems may be used to protect workers from cave-ins in trenches of more than 4 feet deep. The Designated Supervisor should select the method of protection that is most suitable for the particular job site, taking into consideration soil type and surrounding structures. If the soil is not classified, then the excavation must be sloped at an angle not steeper than one and a half horizontal to one vertical.

1. Sloping. Maximum allowable slopes for excavations less than 20 feet deep based on soil type and angle to the horizontal are as follows:

Soil Type	Height/Depth Ratio	Slope Angle
Type B	1:1	45°
Type C	1½:1	34°

A ten feet deep trench in Type B soil would have to be sloped to a 45 degree angle, or sloped 10 feet back in both directions. Total distance across a trench ten feet deep would be 20 feet plus the width of the trench. In Type C soil, the trench would be sloped at a 34 degree angle or 15 feet in both directions for a total of 30 feet across plus the width of the trench.





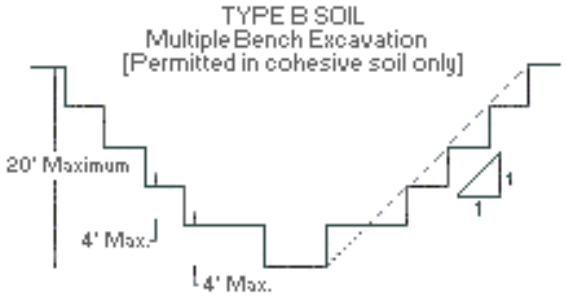
2. Benching. There are two types of benching:

   a) Single. One level or step, not exceeding 4 feet in height.

   b) Multiple. More than one level or step, each not to exceed four feet in height.

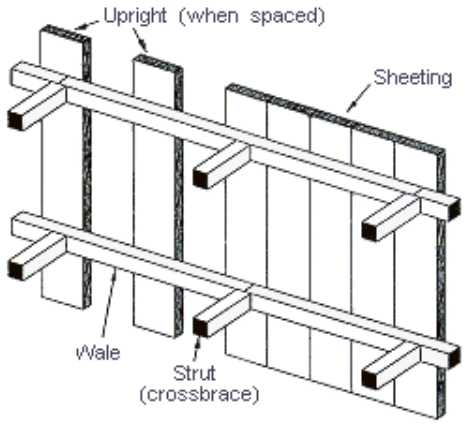
   Benching can be used in conjunction with simple sloping. Benches must be below the maximum allowable slope for that soil type. A ten-foot deep trench in Type B soil must be benched back 10 feet in each direction with the maximum of a 45 degree angle.

   Benching is not permitted in Type C soil.



3. Shoring. Shoring is used when the location or depth of the trench makes sloping back to the maximum allowable slope impractical. There are two basic types of shoring: timber and aluminum hydraulic.

   a) Timber. The Designated Supervisor should use the information in the tables of 29 CFR 1926 Subpart P Appendix C - Timber Shoring for Trenches (see OSHA web site at http://www.osha.gov). Use the chart for oak timber. The members of the shoring system that are to be selected using the tables are the cross braces, the uprights, and the wales where wales are required. The Designated Supervisor shall select the size and spacing of members using the appropriate table. The selection is based on the depth and width of the trench where the members are to be installed. In most instances, the selection is also based on the horizontal spacing of the cross braces. Where a choice is available, the horizontal spacing of the cross braces must be chosen before the size of any member can be determined.

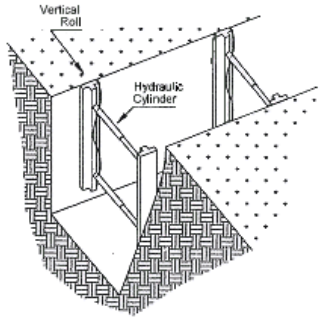


b) Hydraulic Aluminum Shoring. Hydraulic shoring provides a critical advantage over timber shoring because workers do not have to enter the trench to install them. They are also light enough to be installed by one worker, they are gauge-regulated to ensure even distribution of pressure along the trench line and they can be adopted easily to various trench depth and widths.

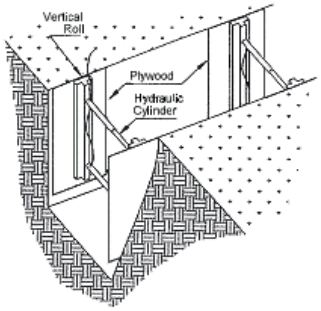
Hydraulic Shoring Support Systems shall be constructed and used in accordance with all specifications, recommendations and limitations issued by the manufacturer.

Hydraulic shores must be installed in accordance with the 1926 Subpart P Appendix D - Aluminum Hydraulic Shoring for Trenches (see OSHA web site at http://www.osha.gov). The Designated Supervisor should use the tables in this standard to determine the maximum vertical and horizontal spacing that may be used with various aluminum member sizes and various hydraulic cylinder sizes.

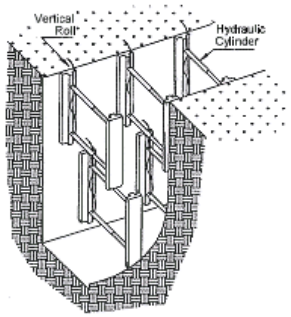
All shoring shall be installed from the top down and removed from the bottom up. Hydraulic shoring shall be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts. The top cylinder of hydraulic shoring shall be no more than two feet from the top edge of the excavation. Two feet of trench may be exposed beneath the bottom of the rail or plywood sheeting, if used.



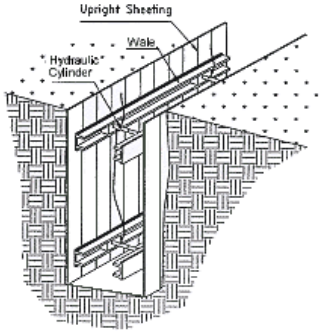
Vertical Aluminum Hydraulic Shoring
(Spot Bracing)



Vertical Aluminum Hydraulic Shoring
(With Plywood)



Vertical Aluminum Hydraulic Shoring
(Stacked)



Aluminum Hydraulic Shoring Waler System
(Typical)

4. Shielding. Trench boxes are different from shoring because instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins. Trench boxes are generally used in open areas, but they may be used in combination with sloping and benching. The Designated Supervisor shall ensure that the following safety measures are taken:

   a) Trench boxes shall be inspected for good condition before each use.

   b) The excavated area between the outside of the trench box and the face of the trench should be minimized. The space between the trench box and the excavation side must be backfilled to prevent lateral movement of the box.

   c) The trench box must extend at least 18 inches above the surrounding area if there is sloping toward the excavation. This can be accomplished by providing a sloped area adjacent to the box.

   d) Shields may ride two feet above the bottom of the excavation provided they are calculated to support the full depth of the excavation and there is no caving under or behind the shield.

   e) Any modifications to the shields must be approved by the manufacturer.

   f) Workers must enter and leave the shield in a protected manner, such as by a ladder. Workers may not remain in the shield while it is being moved.

5. Protective Methods Using Other Tabulated Data. Other tabulated data, such as tables and charts, may be selected for the design of sloping, benching, shoring, or shielding systems. The tabulated data used must be written and include the following:

   a) Identification of the factors that affect the selection of a protective system;

   b) Identification of the limits of use of the data;

   c) Information needed by the user to make a correct selection of a protective system from the data; and

   d) At least one copy of the tabulated data which identifies the Registered Professional Engineer who approved the data shall be maintained at the job site during construction of the protective system.

6. Design by a Registered Professional Engineer. Sloping, benching, shoring and shielding systems may be designed by a Registered Professional Engineer. The design shall be written and shall include the following:

   a) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system.

   b) The identity of the Registered Professional Engineer approving the design.

   At least one copy of the design shall be maintained at the job site during construction of the protective system.

NOTE: All excavations more than 20 feet in depth must be approved by a Registered Professional Engineer.

Contractors Performing Excavation Operations

Contractors who are hired by any agent of the University to perform excavation operations must have their own trenching safety policies that are in compliance with federal and state OSHA/MOSH regulations.

Contractors are expected to coordinate with Facilities Management early in the programming and development stages to determine their project's impact to utilities.

The contractor shall obtain written approval from Energy & Utilities indicating that the impact to utilities has been reviewed and approved prior to bidding the work or proceeding with excavation.

The contractor shall coordinate with Facilities Management the identification and marking of underground utilities including sewer, telecommunication, gas, water, steam and electric. The contractor shall arrange to have these utilities protected, removed, or relocated as directed by Energy & Utilities.

Emergency Rescue

In the event of any emergency situation requiring rescue from an excavation, University of Maryland personnel **shall not** attempt to enter an unprotected trench to perform rescue.

When on the College Park campus, University Police shall be notified of all emergencies by calling 9-1-1 or 301-405-3333 on any campus or pay phone, by calling #3333 on a cell phone, or by calling for help via radio. In other areas in the State of Maryland, the local emergency services shall be notified by calling 9-1-1. In all other areas of the United and States and around the world, the local emergency services shall be notified using the standard reporting system for that area.

Rescue services that can be performed safely from outside the excavation, such as hoisting a harnessed victim, shall be undertaken. Other personnel in the excavation shall exit immediately, providing assistance only when not endangering their own safety.

Emergency rescue services will be provided for all trench emergencies on the College Park campus by Prince George's County Fire Department and fire departments in other jurisdictions as needed for mutual aid. The appropriate local fire department will provide rescue services in all other areas of the state. Local fire and rescue services will provide their own equipment and training in accordance with federal and state regulations.

Appendix I

Test Equipment and Methods for Evaluating Soil Type

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area, as described below.

A. **Pocket Penetrometer**. Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf). However, Penetrometers have error rates in the range of ± 20-40%.

1. **Shearvane (Torvane)**. To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf).

2. **Thumb Penetration Test**. The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil, and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.

3. **Dry Strength Test**. Dry soil that crumbles freely or with moderate pressure into individual grains is granular. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

B. **Plasticity or Wet Thread Test**. This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

C. **Visual Test**. A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the

soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions. In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

Appendix II

Competent Person

The designated competent person should have and be able to demonstrate the following:

- Training, experience, and knowledge of:
  - soil analysis;
  - use of protective systems; and
  - requirements of 29 CFR 1926 Subpart P

- Ability to detect:
  - conditions that could result in cave-ins;
  - failures in protective systems;
  - hazardous atmospheres; and
  - other hazards including those associated with confined spaces.

- Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

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Appendix III

Trenching and Shoring Checklist

Item	Comment
Is the cut, cavity, or depression a *trench* or an *excavation*?	
Is the cut, cavity, or depression more than 4 ft (1.2 m) in *depth*?	
Is there *water* in the cut, cavity, or depression?	
Are there adequate means of *access* and *egress*?	
Are there any *surface encumbrances*?	
Is there exposure to *vehicular traffic*?	
Are *adjacent structures stabilized*?	
Does *mobile equipment* have a *warning system*?	
Is a *competent person in charge* of the operation?	
Is *equipment operating* in or around the cut, cavity, or depression?	
Are procedures required to monitor, test, and *control hazardous atmospheres*?	
Does a competent person *determine soil type*?	
Was a *soil testing device* used to determine soil type?	
Is the *spoil* placed 2 ft or *more from the edge* of the cut, cavity, or depression?	
Is the *depth* 20 ft *or more* for the cut, cavity, or depression?	
Has a *registered professional engineer* approved the procedure if the depth is more than 20 ft?	
Does the procedure require *benching* or *multiple benching*? *Shoring*? *Shielding*?	
If provided, *do shields extend at least 18 in above* the surrounding area if it is sloped toward the excavation?	
If shields are used, is the depth of the cut *more than 2 ft below the bottom of the shield*?	
Are any required *surface crossings* of the cut, cavity, or depression the *proper width and fitted with hand rails*?	
Are means of *egress* from the cut, cavity, or depression *no more than 25 ft from the work*?	
Is *emergency rescue equipment* required?	
Is there *documentation of the minimum daily excavation inspection*?	