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## 1.0 OVERVIEW

This safety policy provides guidance for conducting trenching and excavation activities at project sites. Emphasis is placed on sloping and benching as the primary controls to be utilized to prevent cave-in or collapse. If other scenarios for protection are utilized, review of the regulatory standard for excavations should be performed to ensure necessary controls are in place to safely perform excavation work.

## 2.0 REGULATORY GUIDANCE

- Occupational Safety and Health Administration (OSHA). 29 CFR Part 1926 Subpart P. “Excavations.”
- *Excavations*. OSHA Publication 2226. 1995 Revised.

## 3.0 PERTINENT ISSUES

Proper planning and execution of trenching and excavation work is required to ensure workers are protected while working in or adjacent to excavations. The following subsections provide the necessary information to ensure all trenching and excavation work is performed in a safe manner.

### 3.1 Pre-Excavation Planning

Pre-planning considerations shall include:

- Utilities;
- Traffic in the vicinity of the trench or excavation;
- Structures such as buildings, walls, towers, etc. in the vicinity of the excavation;
- Water table at the time of the excavation; and
- Weather conditions.

Each of these hazards shall be considered during the task hazard and controls process to ensure adequate controls are in place to prevent any of these conditions from being a hazard during the excavation work.

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### 3.2 Excavation Requirements

To ensure cave in is prevented during trenching and excavation work, all trenches or excavations 5 feet (ft) or greater in depth shall be properly sloped, benched, shored, and/or shielded. The method used to prevent cave-in shall be consistent with the requirements of the following subsections.

#### 3.2.1 Material Classification

Materials at the project site will be classified to ensure the proper support system is selected and implemented in a manner which will prevent cave in. Materials are divided into four types (Stable Rock, Type A, Type B, and Type C) based on their physical properties. The following subsections include a description of the four material types and methods to be used to determine soil type in the field.

##### 3.2.1.1 Stable Rock

Stable rock is defined as solid mineral matter that can be excavated with vertical sides which remain intact while exposed.

##### 3.2.1.2 Type A Soils

Type A soils are defined as cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) or greater. These soils typically 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. No soil is considered Type A if:

- The soil is fissured;
- The soil is subject to vibration from heavy traffic or similar effect;
- The soil has been previously disturbed;
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical or greater; or
- The soil is subject to other factors that would render it unsuitable as a Type A soil as determined by a Competent Person.

##### 3.2.1.3 Type B Soils

Type B soils are defined as cohesive soil with an unconfined compressive strength of 0.5 tsf or greater but less than 1.5 tsf. These soils may include cohesionless materials including angular gravel (crushed rock),

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silt, silt loam, sandy loam, and in some cases, silty clay loam and sandy clay loam. Other soil factors which may be considered as Type B soils include:

- Previously disturbed soils which do not have characteristics consistent of Type C soils;
- Soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration;
- Dry rock that is not stable; or
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical or less, but only if the material would otherwise be characterized as a Type B soil.

#### 3.2.1.4 Type C Soils

Type C soils are defined as soils with an unconfined compressive strength of 0.5 tsf or less. They may include granular soils including gravel, sand, and loamy sand. Other factors which may classify soils as Type C include:

- Submerged soil or soil from which water is freely seeping;
- Submerged rock that is not stable; or
- The soil is part of sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical or greater.

#### 3.2.2 Field Determination of Soil Type

If laboratory methods of soil classification are not available, field determinations may be employed to classify the soil as described below. At least one visual test and one manual test will be utilized to classify soils at the site.

##### 3.2.2.1 Visual Tests

A visual test will be performed by a Competent Person to aid in determining the soil classification. The following observations shall be made as part of the visual test:

- Observe the particle size of the soils in the sides of the excavation and in the excavated materials. Soils which are primarily fine-grained are cohesive material. Coarse grained or gravelly soils are considered granular materials.



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- Observe the soils as they are excavated. Soils that remain in clumps as they are excavated are considered cohesive. Soils which readily fall apart or break up are considered granular.
- Observe the sides of the excavation and the surface area adjacent to the excavation. If tension cracks form or other crack like features are observed, the soils could be fissured. Soils which spall off vertical sides could also be fissured. Small spalls are evidence of moving ground and shall be considered indicative of a hazardous situation that require additional controls.
- Observe the excavation for evidence of disturbed soils, utilities, or other underground structures.
- Observe the excavation for layered soil conditions and if the layer dips into the excavation, include an estimate of the degree of slope. The soil classification shall be based on the weakest layer.
- Observe the excavation for evidence of water seeping or flowing into the excavation.
- Finally, observe the excavation and areas surrounding the excavation for sources of vibration which may affect the stability of the excavation sides.

### 3.2.2.2 Manual Tests

Manual tests to classify soils shall be performed by a Competent Person. The following manual tests are considered acceptable for field classification of soils:

- *Plasticity.* Mold a moist or wet sample of the soil into a ball and attempt to roll the soil into 1/8-inch diameter threads. Cohesive materials can be successfully rolled into threads without crumbling.
- *Dry Strength.* If soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, the soil is considered granular. If the soil is dry and breaks into clumps which break into smaller clumps with difficulty, the material contain clay-sized materials as the predominant constituent. Soil may be considered unfissured if the soil is dry and beaks into clumps but cannot be easily broken into smaller clumps except with great difficulty.
- *Thumb Penetration.* The unconfined compressive strength of cohesive soils may be estimated using this test. Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented with the thumb, however, they can only be penetrated with the thumb using very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test shall be performed on a freshly excavated undisturbed sample (from a large clump of freshly excavated soil).



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- *Pocket Penetrometer.* Unconfined compressive strength may also be determined by use of a pocket penetrometer.
- *Drying Tests.* To determine if soils contain fissures or are unfissured cohesive soils or granular material a drying test may be performed where a soil sample approximately 1 inch thick by 6 inches in diameter is allowed to thoroughly dry. If the sample developed cracks as it dries, significant fissures are indicated. If the sample dries without cracking and the sample is broken by hand using considerable force, the sample may be considered cohesive unfissured soil. If the dried sample breaks easily by hand, the material is either fissured cohesive material or a granular material. To differentiate fissured cohesive material from granular material, pulverize a portion of the sample using hands or feet and if the soil does not pulverize easily, the material is cohesive and fissured. If the material pulverizes easily into small fragments the soil is granular.

### 3.2.3 Support Systems

#### 3.2.3.1 Sloping and Benching

If sloping or benching is utilized as the support system during excavation, the slope of excavations less than 20 ft deep shall not exceed the maximum allowable slope (expressed as horizontal:vertical) for the soil/rock type indicated below:

- Stable Rock shall not exceed a vertical slope (90 degrees).
- Type A Soils shall have a maximum allowable slope of 3/4:1 (53 degrees).
- Type B Soils shall have a maximum allowable slope of 1:1 (45 degrees).
- *Type C Soils* shall have a maximum allowable slope of 1 1/2:1 (34 degrees).

Supplemental information on sloping and benching configurations are presented in Exhibit 1. For excavations greater than 20 ft depth, the slope or bench shall be designed by a registered professional engineer.

#### 3.2.3.2 Shields

A trench shield or trench box may be used as a support system in trenches. The shield or box used shall be designed or approved by a registered professional engineer or based on tabulated data prepared or approved by a registered professional engineer. Materials used for shields and boxes may include timber or aluminum.

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### 3.2.4 Safety Precautions

To ensure adjacent structures such as buildings, walls, sidewalks, or pavement are protected during excavation activities, support systems such as shoring, bracing, or underpinning shall be employed.

Excavation is prohibited below the level of the base or footing of any foundation or retaining wall unless:

- A support system such as underpinning is provided;
- The excavation is in stable rock; or
- A registered professional engineer determines the structure to be sufficiently removed from the excavation and the excavation will not pose a hazard to employees.

Excavation under sidewalks and pavement is prohibited unless an appropriately designed support system is provided.

### 3.2.5 Installation and Removal of Protective Systems

During the installation of support systems, workers shall be protected by:

- Securely connecting members of support systems;
- Safely installing the support system by installing or removing the system which protects workers in a manner that prevents cave in, structural collapse, or the workers from being struck by the support system;
- Never overloading members of the support system;
- Installing other structural members when temporary removal of individual members are necessary; and
- Removal of the support systems by beginning and progressing from the bottom of the excavation in a slow manner.

Excavation below members of support or shield systems of a trench is permitted if the excavation is less than 2 ft below the member or (1) the system is designed to withstand the forces calculated at full depth of the trench, and (2) there are no indications, while the trench is open, of a possible cave in below the bottom of the support system. Installation of support systems shall be closely coordinated with the excavation of trenches. Trenches and excavations should be backfilled as the protective system is removed.

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Materials used for support systems shall be free of defects or damage and used in a manner consistent with manufacturers' recommendations. Support systems containing defects or damage shall not be used until approved for use by a registered professional engineer.

### 3.2.6 Fall and Equipment Protection

Workers in excavations shall be protected from fall hazards, falling loads, and mobile equipment. The following is required to prevent these hazards:

- Keep materials or equipment that might fall or roll off into an excavation at least 2 ft from the excavation edge, or have retaining devices, or both.
- Provide warning systems such as mobile equipment, barricades, hand or mechanical signals, or stop logs to alert operators of equipment of the edge of the excavation.
- Prohibit workers from working on faces of sloped or benched areas of excavations above other workers unless the lower workers are adequately protected.
- Provide scaling to remove loose rock and soil or install barrier systems to prevent rock and soil from falling on workers.
- Prohibit employees from being under loads that are handled by lifting or digging equipment.

### 3.2.7 Water Accumulation

Workers shall be prohibited from working in excavations where water has accumulated or is accumulating unless adequate protection has been taken. When water is removed from the excavation by mechanical means (pumps, etc.), operation of equipment shall be monitored by a Competent Person.

Surface water shall be diverted and prevented from entering excavations. Methods which may be used to prevent surface-water entry include diversion ditches or dikes. Methods used to prevent surface-water entry into the excavation shall be approved by the Competent Person.

### 3.2.8 Hazardous Atmospheres

If the potential exists for a toxic atmosphere or oxygen deficiency in an excavation greater than 4 ft deep, a Competent Person shall perform air monitoring in accordance with other provisions of the project site specific health and safety plan prior to worker entry into the excavation. If a hazardous condition exists, respiratory protection or ventilation shall be provided in accordance with other provisions of the project

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specific health and safety plan. Any controls used to reduce the toxic or oxygen deficient atmosphere shall be tested regularly by a Competent Person.

When a toxic or oxygen deficient atmosphere is known to be present or has a potential to be present, and adequately protected workers are in the excavation, emergency rescue equipment must be provided onsite. This equipment includes, but is not limited to, breathing apparatus, safety lines and harnesses, basket stretcher, etc.

### 3.2.9 Access and Egress

Safe access and egress from the trench or excavation shall be provided. For trenches or excavations 4 ft deep or greater shall have an appropriate means of exit, such as a ladder, steps, ramps, etc. within 25 ft of lateral travel. If structural ramps are used as a means of access and egress by workers, the structural ramp must be designed by a Competent Person. If structural ramps are used for vehicles, then the structural ramp must be designed by a Competent Person qualified in structural design. Structural members used for ramps shall be uniform in thickness and joined in a manner which prevents tipping or displacement.

### 3.2.10 Inspections and Approvals

Excavations and trenches shall be inspected daily by a Competent Person prior to entry by workers. The trench or excavation shall also be inspected after adverse weather events or as necessary to ensure protection of workers from cave in, failure of support systems, generation of hazardous atmospheres, or other hazardous condition. If an unsafe condition is recognized by the Competent Person, the trench or excavation shall be evacuated until the unsafe condition is corrected.

All approvals of support systems and access/egress methods shall be conducted by an individual meeting the approval requirements stipulated in the associated subsections of this safety policy.

## 4.0 ARCADIS TENNESSEE AREA OPERATIONS POLICY

It is the policy of ARCADIS Tennessee Area Operations to comply with the OSHA's excavation regulations. To ensure compliance is maintained, the following have responsibilities under this policy.

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- The Area Manager will have the responsibility to provide the resources necessary to comply with this policy. This includes providing the opportunity for the required employees to receive necessary training on proper excavation techniques in accordance with this policy.
- The Project Manager of each project will have the responsibility to obtain the necessary available information related to the work site and project activities to better aid in proper excavation design. This individual will also have the responsibility to ensure adequate funds are in place for proper excavation work to be performed. The Project Manager, or his/her designate, other than the Health and Safety Manager (HSM), will also assist the HSM in developing the task hazard analysis for the work tasks associated with the excavation project.
- The HSM, or his/her designate, will have the responsibility for carrying out the requirements of this policy including developing the task hazard analysis, assisting the Project Manager (or his/her designate), the Competent Person(s) and employees in design of excavation controls for the project.
- The Excavation Competent Person has primary authority over all aspects of excavation work and may issue stop work orders for weather or any other situation that may create an unsafe environment.
- Each employee working in or adjacent to trenches and excavations will have the responsibility to understand and follow the requirements of this policy. Each employee shall also follow additional requirements stipulated in the in the task hazard analysis for the excavation project or as specified by the Competent Person and will promptly report any unsafe condition arising from the excavation work. The employee shall stop work if excavation activities are considered by the employee or other site worker to be unsafe, and shall have an opportunity to have active input on project excavation work.

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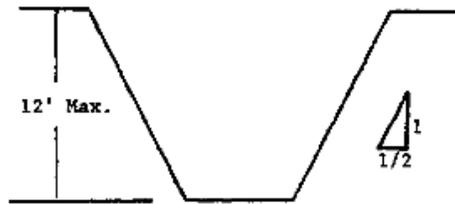
## Exhibit 1. Supplemental Sloping and Benching Information

### Excavations Made in Type A Soil.



*Simple Slope General.*

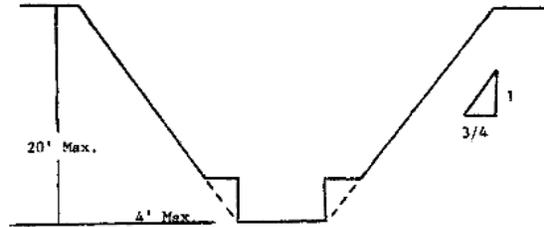
All simple slope excavations 20 ft or less in depth shall have a maximum allowable slope of  $\frac{3}{4}$ :1.



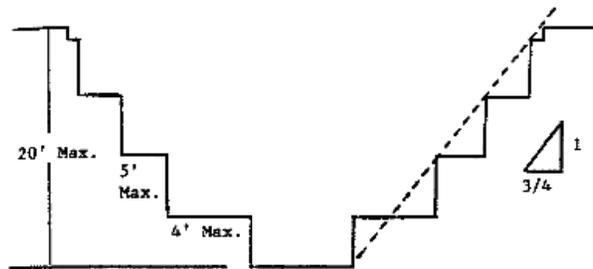
*Simple Slope Short Term.*

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 ft or less in depth shall have a maximum allowable slope of  $\frac{1}{2}$ :1.

## Exhibit 1. Supplemental Sloping and Benching Information (continued)

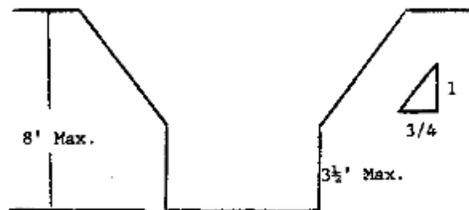


*Simple Bench.*



*Multiple Bench.*

All bench excavations 20 ft or less in depth shall have a maximum allowable slope of  $\frac{3}{4}$ :1 and maximum bench dimensions as specified above.

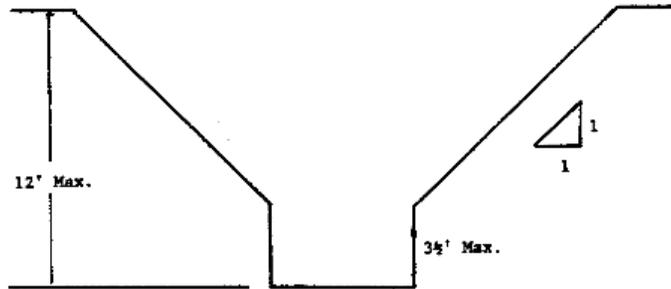


*Unsupported Vertically Sided Lower Portion- Maximum 8 ft in Depth.*

All excavations 8 ft or less in depth which have unsupported vertical sided lower portions shall have a maximum vertical side of 3.5 ft.

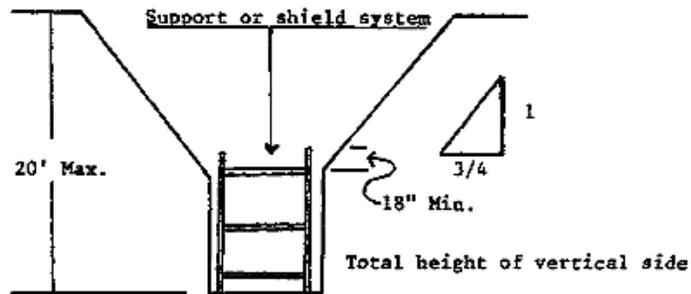
## Exhibit 1. Supplemental Sloping and Benching Information (continued)

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*Unsupported Vertically Sided Lower Portion – Maximum 12 ft in Depth.*

All excavations with more than 8 ft but not more than 12 ft in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and maximum vertical sides of 3.5 ft.

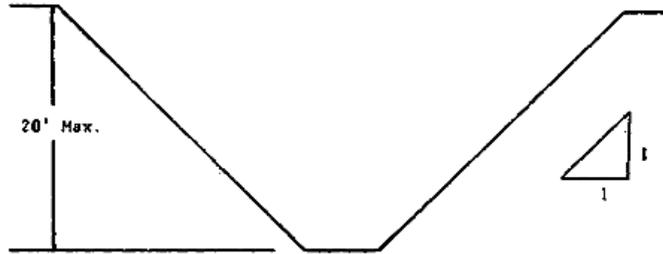


*Supported or Shielded Vertically Sided Lower Portion.*

All excavations 20 ft in depth or less which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of  $\frac{3}{4}$ :1. The support or shield system must extend at least 18 inches above the top of the vertical sides.

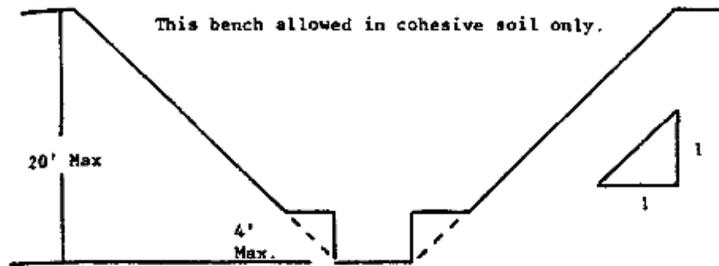
**Exhibit 1. Supplemental Sloping and Benching Information (continued)**

**Excavations Made in Type B Soil.**

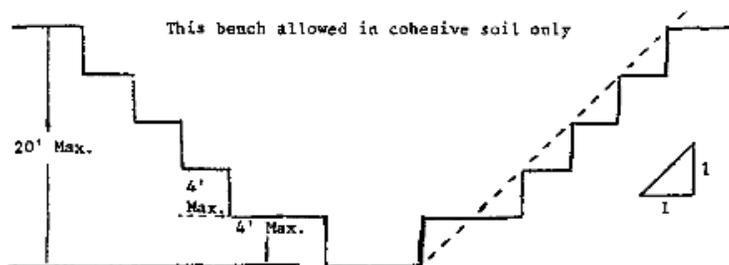


*Simple Slope.*

All simple slope excavations 20 ft or less in depth shall have a maximum allowable slope of 1:1.



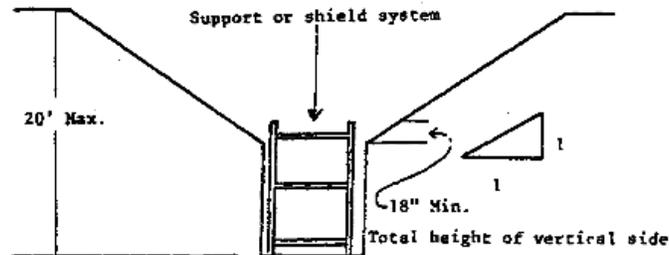
*Single Bench.*



*Multiple Bench.*

All bench excavations 20 ft in depth or less shall have a maximum allowable slope of 1:1 and a maximum bench dimensions as specified above.

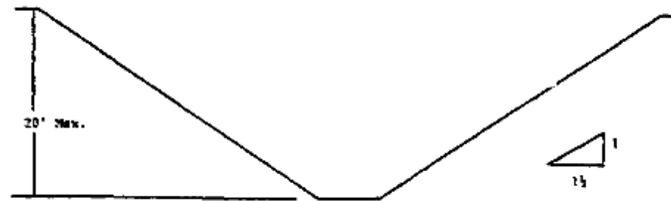
## Exhibit 1. Supplemental Sloping and Benching Information (continued)



*Vertically Sided Lower Portion.*

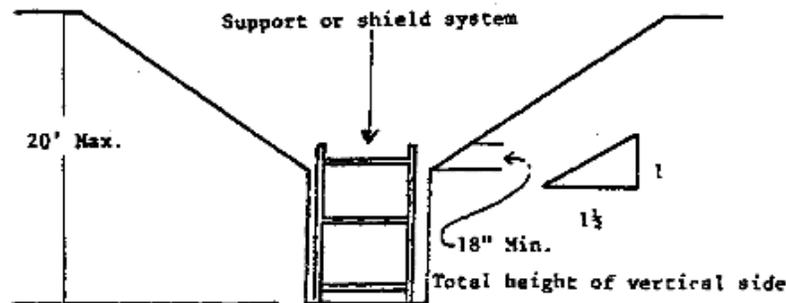
All excavations 20 ft in depth or less which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

### Excavations Made in Type C Soil.



*Simple Slope.*

All simple slope excavations 20 ft in depth or less shall have a maximum allowable slope of 1½:1.



*Vertical Sided Lower Portion.*

All excavations 20 ft in depth or less which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

### Exhibit 1. Supplemental Sloping and Benching Information (continued)

## Excavations Made in Layered Soils.

