BYU

BRIGHAM YOUNG

UNIVERSITY

Provo, Utah

EXCAVATION PROGRAM

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1.0 Overview

Excavation cave-ins are one of the leading causes of death in the construction industry. Implementation of the requirements found in this program will help minimize the risk associated with excavation work at BYU. Departments involved in excavation work must understand the hazard, applicable OSHA safety standards, and the policies of the university. Adequate funding and reasonable time frames must be provided for the safe completion of excavation projects. Appropriate training and certification of employees must be completed in accordance with local, state, and federal law. Projects must be monitored for compliance, and records documenting each aspect of the program must be properly maintained.

2.0 Policy

Departments performing excavation work must ensure that supervisors and employees comply with all aspects of the current BYU Excavation Program. Excavation work includes any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. All university employees must successfully complete this training program, and receive certification, prior to engaging in excavation work. Contractors working on university projects are expected to meet or exceed the requirements found in this program, and comply with all applicable statues and regulations governing excavation as listed in Section 3.0 of the current BYU Excavation Program.

3.0 Requirements

OSHA Standard 29 CFR § 1926 Subpart P, Excavations

4.0 Purpose

At least 100 workers die each year in the United States in excavation related accidents. This program has been developed to reduce that risk, and to help ensure the university complies with federal, state, and local law. OSHA safety standards can not be compromised to compensate for under-funded projects, or to meet unrealistic deadlines. The solution lies in implementing an effective program through management support, employee involvement, and education.

5.0 Scope

This program applies to all excavation work performed by BYU employees and contractors, while engaged in university projects.

6.0 Procedures

6.1 Pre-Project Planning

- Project Managers must designate a Competent Person who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- The Competent Person will identify all known existing utilities on BYU campus, by following the guidelines in Appendix E. For off campus projects utilize Dig Safe Utah at 1-800-662-4111.
- The Competent Person must determine and classify the type of soil when employees will enter the excavation.
- Based upon the hazards present and the type of soil to be excavated, the Competent Person selects protective measures and controls necessary to protect the individuals working within and near the excavation. (Appendix D).

6.2 Operation

- An excavation checklist must be completed for each daily inspection of excavations 4-feet or deeper, and for inspection of those excavations less than 4-feet in depth that show signs of a cave-in that may result in serious injury.
- Prior to beginning an excavation, the Competent Person must conduct a pre-job training session for all individuals involved with the excavation. The hazards associated with the excavation and those measures the individuals need to take to protect themselves throughout the excavation project must be addressed during the pre-entry safety session.
- The Competent Person must see that all necessary controls are implemented prior to allowing workers to enter the excavation.
- Once ground has been broken the Competent Person must visually inspect the excavation on a daily basis to ensure worker safety.
- The Competent Person must be present and oversee work activities performed in excavations 4-feet in depth or deeper; and must be present and oversee work activities performed in excavations less than four-feet in depth anytime such excavations show signs of a potential cave-in that could harm those entering the excavation.
- Protective systems (i.e. sloping or shoring) must be used whenever an excavation is four or more feet in depth or, upon examination, there are indications of a potential cave-in. This means a protective system must be utilized in excavations less than four-feet in depth if there are signs of a potential cave-in that may result in a serious injury.
- If a hazard arises within the excavation then the Competent Person must withdraw individuals from the excavation and prevent entry of individuals into the excavation until the hazard is eliminated or controlled.

6.3 Atmospheric Hazards

- Individuals must not perform work in an excavation that contains, or potentially contains a hazardous atmosphere. A hazardous atmosphere is one in which any of the following conditions exist:
    - The atmosphere contains less than 19.5% or more than 23% oxygen.
    - A combustible gas concentration is present in excess of 10% lower explosive limit (LEL).
    - Concentrations of hazardous substances are present in excess of their acceptable airborne exposure concentration – airborne concentrations cannot exceed ACGIH and/or OSHA limits.

- If the excavation to be entered meets the criteria for a confined space (not designed for continuous occupancy, has limited means for entry and egress, and is large enough to enter and perform work) and may contain a hazardous atmosphere then entry must be performed in accordance with the Brigham Young University Confined Space Program. If the potential for a hazardous atmosphere exists then atmospheric testing must be performed prior to and throughout entry into the excavation. Examples of excavations that may contain a hazardous atmosphere include, but are not limited to, excavations made near a landfill or adjacent to hazardous materials/pipelines, or when the work being performed in the excavation may introduce or create a hazardous atmosphere (i.e. welding). If airborne concentrations of contaminants exceed, or potentially could exceed acceptable limits then forced air ventilation must be used to control the atmosphere.

6.4 Air Monitoring Frequency:

- Testing will be conducted before employees enter the excavation.
- Testing will be performed at regular intervals to ensure that the trench remains safe.
- Testing will be increased if equipment is operating in the trench or if welding, cutting or burning is being performed in the trench.

Note: Employees required to wear respiratory protection must be trained, fit-tested and enrolled in BYU's Respiratory Protection program prior to wearing a respirator.

6.5 Falling Loads

- All employees on an excavation site must wear a hard hat.
- Individuals must not work under loads being lifted or moved by heavy equipment.
- Individuals must stand away from equipment that is being loaded and/or unloaded.

Note: Equipment operators or truck drivers are allowed to remain in their equipment/vehicles during loading and unloading operations so long as the equipment/vehicle is outfitted with a cab shield or canopy.

- Mobile equipment warning systems. The following measures must be implemented to prevent vehicles from accidentally falling into the trench:
    - Barricades must be installed, as necessary.
    - Hand or mechanical signals must be used.
    - Stop logs (chock barriers) must be installed if there is danger of vehicles falling into the trench.
    - Prior to excavating, the soil must be graded where vehicle control and channeling of run-off water is necessary.
    - Vehicle and equipment traffic must be minimized near the excavation.
    - Trenches must be fenced and barricaded if left open overnight.

6.6 Ingress/Egress

- Excavations 4-feet or more in depth must be provided with a means for individuals to easily enter and exit the excavation, such as but not limited to a ladder or sloped edge.
- Spacing between ladders (or other means of egress) must be in such a manner that a worker does not have to travel more than 25-feet laterally to the nearest means of egress once inside the excavation.
- Ladders must be secure, and extend a minimum of 36 inches above the landing. Metal ladders are not to be used when electric utilities are present.
- Excavations, under the base footing of a foundation or wall, require a support system designed by a registered professional engineer.
- Sidewalks and pavements must not be undermined, unless an (engineer) approved support system or similar method of protection against possible collapse is provided for employees.
- Excavations 4-feet or more in depth must not be entered unless the excavation is sloped, benched, shored, and/or shielded in accordance with 29 CFR 1926, subpart P (see protective systems below).

6.7 Protective Systems

- One or more protective system, outlined in sections 6.8 through 6.12, must be utilized to protect individuals entering excavations 4-feet or deeper. The most common protective systems used to protect individuals who enter excavations are as follows:

6.8 Sloping

- Maximum allowable slopes for excavations less than 20 feet based on soil type (see paragraph 6.13 for soil definitions) and angle to the horizontal are as follows (*Note: Type A has not been included since there is no Type A soil at BYU campus*):

Soil Type	Height/Depth Ratio	Slope Angle
Type B	1:1	45 degrees

Type C	1 ½ : 1	34 degrees

Examples ➔ a 10-foot deep trench in Type B soil would be sloped to a 45 degree angle – 10-feet back in both directions. Total distance across a 10-foot deep trench would be 20-feet, plus the width at the bottom of the trench itself. In Type C soil, the trench would be sloped at a 34 degree angle – 15-feet back in both directions, for at least 30-feet across, plus the width at the bottom of the trench itself.

6.9 Benching

- There are two basic methods to bench an excavation: 1) Single; and 2) Multiple. Either method can be used in conjunction with sloping. **Benching is not allowed in Type C soil.**
- In Type B soil, the vertical height of benches must not exceed 4-feet.
- Benches must be below the maximum allowable slope for that soil type. For example, a 10-foot deep trench in Type B soil must be benched back 10-feet in each direction, having a 45 degree angle from the bottom of the trench to surface level.

6.10 Shoring

- Shoring is used when location or depth of the cut makes sloping back to the maximum allowable slope impractical. The two basic types of shoring are timber and aluminum hydraulic. Due to cost and effort of using lumber, aluminum hydraulic is the preferred method. Hydraulic shoring provides a critical safety advantage over timber because workers do not have to enter the trench to install it. Hydraulic shoring is also light enough to be installed by one worker, they are gauge related to ensure even distribution of pressure along the trench line, and can be easily adapted to various trench depths and widths. If lumber shoring is used, it must meet the requirements set forth in 29 CFR 1926, subpart P.
- All shoring will be installed from the top down, and removed from the bottom up.
- Hydraulic shoring must be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, or any other damage or defective parts. Unserviceable equipment will not be used at any time.
- The top cylinder of hydraulic shoring must be no more than 18-inches below the top of the excavation.
- The bottom cylinder must be no higher than 4-feet from the bottom of the excavation. Two-feet of trench wall may be exposed beneath the bottom of the rail or plywood sheeting.
- Three vertical shores, evenly spaced, must be used to form a system.
- Wales are installed no more than 2-feet from the top, no more than 4-feet from the bottom, and no more than 4-feet apart (vertically).

- Hydraulic shoring for Type B and Type C soil must be installed in accordance with Appendix D to 29 CFR 1926, Subpart P.

6.11 Shielding

- Shielding (trench boxes) differ from shoring, instead of supporting the trench face they are intended primarily to protect workers from cave-ins.
- Excavation areas, between the outside of the trench box and face of the trench must be backfilled, to prevent lateral movement of the box once placed in the excavation.
- Trench Boxes must not be subjected to loads exceeding those for which the system was designed to withstand.
- Shields may be used in combination with sloping and benching.
- Shields must extend at least 18 inches above the surrounding area if there is sloping toward the excavation. This can be accomplished by providing a benched area adjacent to the shield.
- Any modifications to the shields must be approved by the manufacturer.
- Shields may ride above the bottom of an excavation, provided they are calculated to support the full depth of an excavation, and there is no caving under or behind the shield.
- Workers must enter and exit from the trench box via a ladder, ramp, or other equivalent means.
- Workers must not remain in an excavation while shielding is being moved.

6.12 Protective Systems

- Support systems designed by a registered professional engineer must be utilized as specified when the protective systems listed above cannot be used.
- If the excavation is deeper than 20-feet or if there is any deviation from 29 CFR 1926 subpart P requirements pertaining to protective systems an engineering design must be completed and signed by a registered professional engineer prior to excavating soil.

6.13 Soil Tests

A manual soil test must be performed by the Competent Person for any excavation 4-feet or deeper, or for any excavation less than 4-feet in depth where there are signs of a potential cave-in that would result in serious injury. Using an excavation checklist, the Competent Person must also perform a visual inspection of such excavation sites and surrounding areas.

- Manual test methods:
  - Thumb penetration test. Attempt to press the thumb firmly into the soil being tested. If the thumb penetrates no further than the length of the nail, it is normally Type B soil. If the thumb penetrates the full length of the thumb, it is Type C soil. It should be noted that the thumb

penetration test method is the least accurate of the manual test methods listed.

- Dry strength test. Take a dry soil sample, if it crumbles freely or with moderate pressure into individual grains it is considered granular (Type C). If the dry soil falls into clumps, which in turn can be broken into smaller clumps, and these smaller clumps can only be broken with difficulty, it is probably clay in combination with gravel/sand/silt (Type B).
- Plasticity or wet thread test. Take a moist sample of soil. Mold it into a thin thread, approximately 1/8 inch in diameter by 2 inches in length, if the soil does not break when held by one end, it may be considered Type B.
- A pocket penetrometer, shearvane, or torvane may also be used to determine the unconfined compression strength of soils.

- Visual inspections consist of looking for:

  - Crack-line openings along the failure zone that would indicate tension cracks;
  - Areas adjacent to the excavation for signs of foundations or other intrusions into the failure zone;
  - Observe the open side of the excavation for indicators of layered geologic structuring;
  - Signs of bulging, boiling or sloughing, as well as for signs of surface water seeping from the sides of the excavation or from the water table;
  - Water accumulation and erosion of excavation walls; and
  - Surcharging load limit and the spoil distance from the edge of the excavation.

6.14 Spoils (Excavated Material)

- Spoils must be placed no closer than 2-feet from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. Further distance may be required, depending upon the type of soil being removed, and whether or not the spoils will be placed back into the excavation or permanently removed. Spoils must be placed so that they cannot accidentally run, slide or fall back into the excavation.

6.15 Surface Crossings

- Surface crossing of trenches will not be made unless absolutely necessary. If necessary, they are permitted under the following conditions:
- Vehicle crossings must be designed by and installed under the supervision of a registered professional engineer.
- Walkways or bridges must:
  - Have a minimum clear width of 20 inches.
  - Be fitted with standard top and mid-rails and toe boards.

- Extend a minimum of 24 inches past the surface edge of the trench.

6.16 Vehicle Traffic

- Employees exposed to vehicular traffic are required to wear reflective vests or other suitable garment marked with or made of reflecting or high-visibility materials.

6.17 Water

- Rainwater or other run-off water must be directed away from excavations.
- Individuals must not enter an excavation that has accumulated more than a few minor puddles of water. If water begins to significantly accumulate within an excavation, then all individuals must exit the excavation and measures to eliminate or adequately control water accumulation must be implemented prior to subsequent entry. *Note: Additional safety measures may also be needed to keep the walls from caving in upon the entrants.* Any support system used to hold the walls of an excavation that contains water must be approved by a professional engineer.

7.0 Responsibilities

7.1 Departments Involved in Excavation Work

- Implement and administer the Excavation Program.
- Review the Excavation Program annually for compliance and effectiveness.
- Verify that all employees who work in or around excavation sites are properly trained.
- Maintain written training records for all employees including the name of the trainer.
- Designate a Competent Person for each excavation, and ensure proper training.
- Make recommendations for program revisions if necessary.

7.2 Supervisors

- Coordinate training, and certify that all employees receive annual Training, which includes, but is not limited to, the items listed in Section 8.0 of this program.
- Ensure that only trained and qualified individuals work in or around excavation sites.
- Verify employee compliance with the principles and practices outlined in the Excavation Program.
- Observe excavation sites and correct unsafe practices.

7.3 Competent Person

- Perform inspections of excavations four or more feet in depth daily, before individuals enter the excavation, as needed throughout each shift, following a rainstorm, or when any other event increases the hazard within the excavation.
- Perform daily visual inspections of excavations less than four feet in depth that will be entered by employees and that show signs of a potential cave-in that could lead to a serious injury.
- When inspecting excavations four or more feet in depth, fill out an excavation checklist, documenting the inspection (Appendix B, of the Excavation Program).
- Complete an excavation checklist when inspecting any excavation less than 4 feet in depth that shows evidence of potential cave-in, which may result in serious injury.
- Eliminate hazards and/or implement controls to safely manage hazards prior to and throughout excavation work.
- Request the presence of a Risk Management & Safety representative when performing an emergency excavation. RM&S Phone Number = 422-4468
- Withdraw individuals, and prevent entry into an excavation if a hazard arises within the excavation until the hazard is eliminated or adequately controlled.
- Satisfy the requirements of the current Brigham Young University Confined Space Program if the excavation contains, or potentially could contain a hazardous atmosphere.
- Provide safe access into and out of the excavation.
- Monitor water removal equipment to ensure it is functioning properly.
- Keep excavations open the minimum amount of time needed to complete operations.
- Review 29 CFR 1926 Subpart P.
- Competent Persons that oversee excavations that employees will enter must obtain the following additional training:
  - Soil analysis & classification.
  - How to properly select protective systems.
  - How to properly use all of the protective systems selected.

7.4 Employees

- Complete general excavation training, and any other training required for safe use of equipment, prior to entering or working around an excavation.
- Do not remove or damage protective systems.
- Do not enter an excavation if you have not received the proper training and/or have not been authorized to enter.
- Do not enter an excavation where the hazards have not been eliminated or controlled, or if the protective systems are compromised.
- Follow all of the applicable guidelines and rules set forth in this program.

7.5 Risk Management and Safety

- Annually review and update the Excavation Program, as necessary.
- Provide orientation and initial training as requested by university departments and/or contractors.
- Provide the general safety training requirements for program.
- Monitor the effectiveness of program by receipt of copies of training rosters, and Excavation Checklists. (Appendix B)
- Upon request, evaluate work areas & employee work practices.
- Observe excavation sites, and report unsafe practices to the appropriate supervisor.
- When requested, help departments and supervisors select the proper protective systems.
- Revise the program as needed.

8.0 Training

8.1 General

- All employees who work in or around excavation sites must complete initial training prior to assuming their duties at an excavation site.
- All employees who work in or around excavation sites must also receive training in the proper use of personal protective equipment, and training related to the specific hazards at the work site.
- All employees who work in or around excavation sites will receive annual refresher training including, but not limited to:
  - Review of the online training program.
  - Review of Section 6 – Procedures.
  - Updated information on new equipment or techniques.
  - Review of the university Excavation Program.

8.2 Competent Person

- Meet all requirements in Section 8.1.
- Competent Persons that oversee excavations that employees will enter must obtain the following additional training:
  - Soil analysis & classification.
  - How to properly select protective systems.
- How to properly use all of the protective systems selected.
- Complete an Excavation Training course, which satisfies OSHA standards, upon initial job assignment and every 3 years thereafter until relieved of Competent Person responsibilities.

8.3 Training Records

- Each department must maintain a record of all individual training, including:

- Subject of training.
- Date of training.
- Name of individual trained.
- Name of trainer.
- Competent Person training records must be maintained by the department for a minimum of 3 years; other training records need to be maintained until individuals end their employment with BYU or until a more current record is obtained and saved.

9.0 Monitoring

9.1 Departments Involved in Excavation Work

- Collect and maintain training records as described in this program.
- Review documents submitted by competent persons to ensure they are completed properly and that any safety needs are addressed.
- Review excavation evaluation findings, submitted by Risk Management & Safety, and ensure any safety needs are satisfied.
- Collect and maintain the following documents:
  - Initial and annual training records.
  - Completed excavation checklists (Appendix B). Completed checklists must be maintained by the department responsible for the evaluation for at least one year.

9.2 Competent Person

- Remain at the excavation site while employees designated to perform excavation work are present within the excavation.
- Observe each excavation project under your direction to assess compliance with this program.
- Complete site inspections and fill out daily excavation checklists as described in this program.
- Submit completed excavation checklists to your department as they are completed.

9.3 Risk Management and Safety

- Quarterly (summer, fall, winter, and spring) contact the Grounds Office for a list of current excavation sites, select one of the excavation sites to visit, and evaluate the work being performed to determine compliance with the requirements outlined in this program; and
- Evaluation findings will be entered into a database and the results of the evaluation will be sent to the department responsible for the excavation work.

10.0 Appendices

Appendix A
Definitions

Aluminum Hydraulic Shoring. An engineering shoring system comprised of aluminum hydraulic cylinders (cross braces), used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such a system is designed specifically to support the sidewalls of an excavation and to prevent cave-ins.

Benching. A method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near vertical surfaces between levels.

Cave-in. Separation of mass of soil or rock materials from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent Person. One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. All Competent Persons will have and be able to demonstrate the following:

a. Training, experience and knowledge of soil analysis, use of protective systems, and the requirements outlined in 29 CFR 1926, subpart P.

b. 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, lockout/tagout, etc.

Excavation. Any man-made cut, cavity, trench or depression in an earth surface formed by earth removal.

Registered Professional Engineer. A person who is registered as a professional engineer in the state where the work is to be performed, or any state if approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Shield (Shield System or Trench Box). A structure that is able to withstand the forces imposed on it by a cave-in and thereby protects the employees with the structure. Shields can be permanent structure or can be designed to be portable and moved along as work progresses. Also known as trench box or trench shield.

Shoring (Shoring System). A structure such as metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sloping (Sloping System). A method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins.

The angle of incline varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Soil Types:

> **Type A:** Most stable. Clay, silty clay, and hardpan (resists penetration). No soil is Type A if it is fissured, is subject to vibration of any type, has been previously disturbed, or has seeping water.
>
> **Type B**. Medium stability. Silt, sandy loam, medium clay and unstable dry rock; previously disturbed soils unless otherwise classified as Type C; soils that meet the requirements of Type A soil but are fissured or subject to vibration.
>
> **Type C**. Least stable. Gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock, and soil from which water is freely seeping.

Trench (Trench Excavation). A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less, the excavation is also considered to be a trench.

Wales. Horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

Appendix B
Excavation Checklist

Competent Person: _____ (Please Print)

Date: _____ Time: _____

Location: _____ Weather Conditions: _____

Item	Yes	No	Action Required
1. Is cut, cavity, depression or excavation >4 feet in depth?	☐	☐	
2. Is Excavation > 20 feet in depth? *Note: if yes, an engineer must approve the protective system.*	☐	☐	
3. Is a competent person in charge and present at the site?	☐	☐	
4. Is there water in the excavation?	☐	☐	
5. Has the competent person classified the soil?	☐	☐	
6. Is ingress/egress adequate?	☐	☐	
7. Have underground utilities been identified (prior to dig)?	☐	☐	
8. Are there any surface hazards (i.e. power-lines)?	☐	☐	
9. Are procedures in place to protect against falling loads?	☐	☐	
10. Is there exposure to vehicular traffic & vibration?	☐	☐	
11. Does mobile equipment have warning system?	☐	☐	
12. Is spoil placed at least 2-feet away from the excavation?	☐	☐	
13. Are surface crossings required?	☐	☐	
14. Are all employees wearing hardhats?	☐	☐	
15. Are hazardous atmospheres present, or likely?	☐	☐	
16. Are respirators required? Users tested & trained?	☐	☐	
17. Does the excavation require benching? (B, or C soil?)	☐	☐	
18. Does the procedure require shoring/sloping/ shielding?	☐	☐	
19. If provided, does the shield extend at least 18 in. above the surrounding excavation area? *Mark an X between yes and no if non-applicable.*	☐	☐	
20. If shields are used, is the depth of the cut >2 feet below the bottom of the shield?	☐	☐	
21. Are means of egress (ladders) provided no more than 25 feet from individuals in the excavation?	☐	☐	
22. Is emergency rescue equipment required?	☐	☐	
23. Are daily excavation inspections performed and documented?	☐	☐	

Appendix C
Soil Mechanics

Soil, for trenching and excavation purposes, is defined as any material to be removed from the ground to form a hole, trench, or cavity for the purpose of working below the earth surface. Soil can be an extremely heavy material, weighing more than 100 pounds per cubic foot (pcf). A cubic yard of soil (3 ft x 3 ft x 3 ft) contains 27 cubic feet of material and could weigh more than 2,700 lbs. This is almost 1 1/2 tons or the equivalent weight of a car in a space less than the size of an average office desk. It is no surprise that the human body cannot support this heavy load without being injured. In addition, wet soil, rocky soil or rock is usually heavier.

Visualize the soil as a series of multiple columns of soil blocks, with the blocks piled one on top of the other. Each soil block weighs approximately 100 lbs and supports the weight of all the blocks above. This means the bottom block supports the vertical weight of itself and the 4 other blocks resting on it - all 500 lbs spread over a one-square-foot area (pcf). The column of soil exerts not only this vertical pressure but the horizontal force in all outward directions. The horizontal force pushing in all directions is half of the 500 lbs - or 250 pcf. Theoretically, as the weight of the column increases, there would be a tendency for the soil to compress and spread outward. However, in undisturbed soil conditions, this process is stopped by the presence of the surrounding columns pushing back with equal pressure. The hypothetical columns pressing against each other help maintain equilibrium.

Trench Failure - When soil has been excavated, this equilibrium no longer exists. The bottom block of soil may no longer be able to support its weight nor the weight of the blocks above it. At this point a wall could shear and break away from its stable position. It should be noted that cave-ins can start anywhere along the wall. Usually the first failure occurs when the bottom of the wall falls into the trench. This creates an undercut area at the base of the trench. This results in a second movement where more of the wall erodes. As the erosion of the base of the trench leaves the column unsupported, more soil is sheared off under its own weight and results in a cave-in. It is at the second and third stage that many would be rescuers attempting to save victims, find that they are trapped along with the first victims. Due to the uncertainty of time lapses between failures, time is a major consideration. The longer the trench is unsupported, the more potential there is for further trench collapse. Proper safety procedures are not a waste of time and money. They save time, money and more importantly lives.

Appendix D

Identification of Underground Utilities

The "Utilities Staking Form" (see following page) needs to be initiated at least two days before excavating with any mechanical equipment. The project foreman needs to complete the following lines found on the form prior to submitting the form to the Grounds Office:

- Name of project (name the project)
- Project foreman
- Project foreman's phone number
- Description of work to be done
- Work order number
- Request date
- Excavation date (date excavation is to begin)
- Target completion date
- Location of construction

Once all of the required information has been completed on the form, the project foreman needs to submit the "Utilities Staking Form" to the Grounds Office, or mail it to: Grounds, PPGO. If there is an emergency, an excavation must be made, and two days notice cannot be given, call 422-5510 to request emergency staking.

A foreman trained in locating utility lines will be assigned by the Utilities Shop to clearly mark all underground utilities. Physical Plant shops with concerns in the excavation area will be notified. The foreman marking all underground utilities (staking) and the foreman in charge of the project will discuss all known utilities in the area. When an excavation is to be created for installation of new utilities, approval must be obtained from the Utilities Shop Manager prior to beginning the excavation.

A final inspection of the excavation area will be performed by the Grounds Office and any damage to utilities will be noted on the "Utilities Staking Form".

If there is an emergency and two days notice cannot be given, Grounds will not be liable for any utility line damage. Please sign the following release to accept responsibility for any possible damage that may occur to the utilities if two days notice is not provided:

Signature: _____ Date: _____

Utilities Staking Form

Request #	
Work Order #	

Name of Project: _____

Project Foreman: _____ Phone #: _____

Description of Work: _____

_____

Request Date:	Excavation Date:	Target Completion Date:

Location of Excavation:

Staked By: _____ Date: Time:
(please print)

Physical Plant Shops Notified:

- ❒ Air Conditioning
- ❒ Civil Engineering
- ❒ Electrical Shop
- ❒ Electronic Media
- ❒ Gardening
- ❒ Heating Plant
- ❒ Landscape Specialty
- ❒ Mechanical Shop
- ❒ Site Development
- ❒ Utilities
- ❒ Other:

Checklist:

- ❒ Audio
- ❒ Canals
- ❒ Catch Basin
- ❒ Clean-Out
- ❒ Culinary Water
- ❒ Electric Power (Aerial)
- ❒ Electric Power (Buried)
- ❒ Fence
- ❒ Fire Hydrant
- ❒ Gas
- ❒ High Temperature Water
- ❒ Manhole
- ❒ Outdoor Lights
- ❒ Sanitary Sewer
- ❒ Sprinkler Control Line
- ❒ Sprinkler Control Wires
- ❒ Sprinkler Main Line
- ❒ Steam Line
- ❒ Storm Sewer
- ❒ Telephone (Aerial)
- ❒ Telephone (Buried)
- ❒ Television
- ❒ Utility Lines in Concrete
- ❒ Utility Pole
- ❒ Utility Tunnel (Box Type)
- ❒ Utility Tunnel (Walk-in)
- ❒ Wells
- ❒ Other

Approvals:

- ❒ Grounds Manager
- ❒ Permit Obtained for Digging on City Land
- ❒ Repair of Old Utility
- ❒ New Utility of Changes

Approved By: _____ (Utilities Manager)

Inspected By: _____ Date:

Closing Date: _____