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Important Phone Numbers

Infrastructure Information Team
665-1051

Excavation Help Line
665-SOIL (665-7645)

Emergency Management
667-6211

Excavation/Fill/ Soil Disturbance

Self-Study #31419

February 2018

Los Alamos NATIONAL LABORATORY EST. 1943

Operated by Los Alamos National Security, LLC for the NNSA

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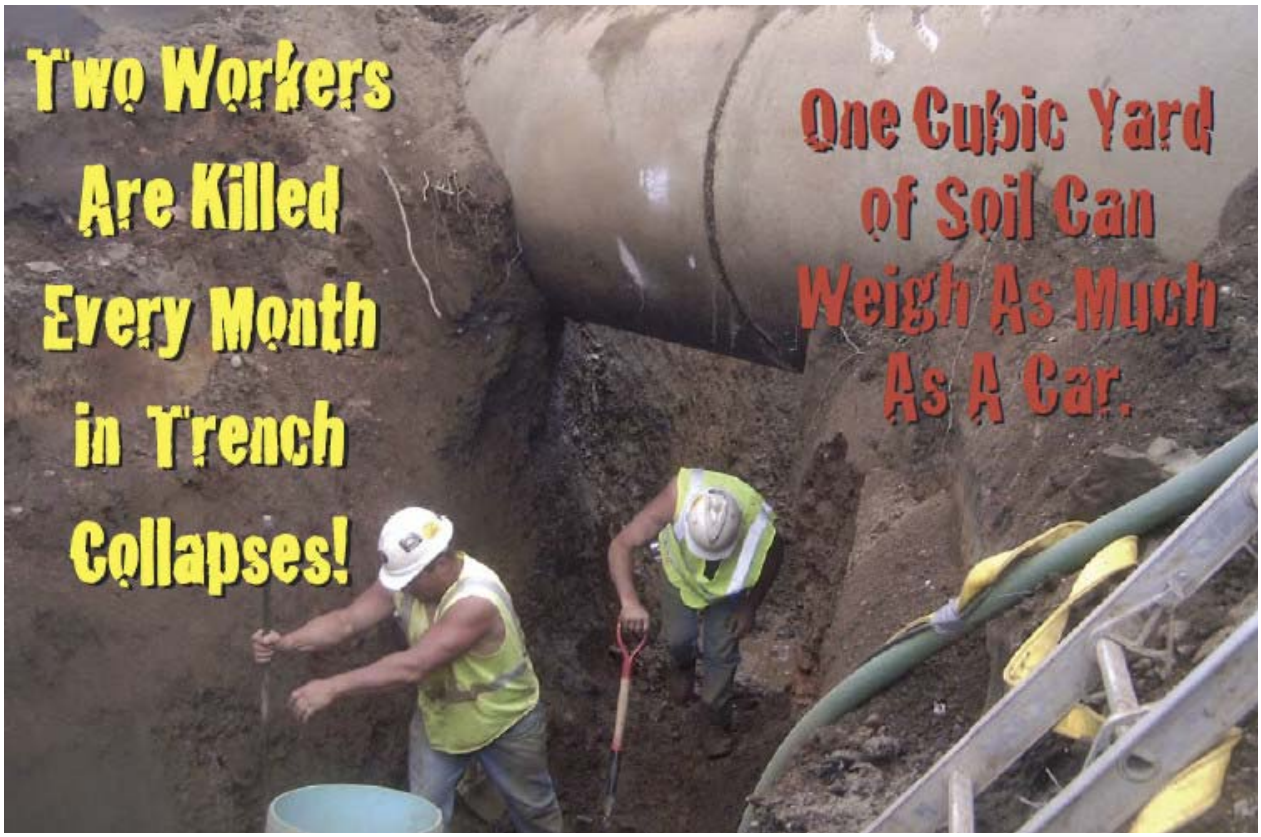


-from *OSHA Trenching and Excavation Dangers* poster, OSHA 3215-08R-11

Introduction

Course Overview

Fill is the placement of dirt or other material on top of an existing grade.

This course, *Excavation/Fill/Soil Disturbance Self-Study* (#31419), presents an overview of the hazards, controls, and requirements that affect safe excavations at Los Alamos National Laboratory (LANL). An overview of the LANL excavation/fill/soil disturbance permit (EXID permit) approval process is also presented, along with potholing requirements for planning and performing excavations at LANL.

Course Objectives

When you complete this course, you will be able to recognize

- common excavation hazards and controls;
- factors that affect the risk of excavation collapse;
- the soil classification system and approved protection systems for various types of soils;
- the LANL EXID permit process, including request priorities, scope and location of activity, expiration, revalidation requirements, and conditional and unconditional exclusions;
- requirements that affect excavation/fill/soil disturbance activities at a LANL potential release site;
- the responsibilities of key roles in excavation/fill/soil disturbance projects at LANL, including responsible line managers (RLMs), persons in charge (PICs), alternate PICs, competent persons, authorized workers/operators, and spotters.
- what to do if an excavation-related abnormal event or emergency occurs*;* and
- potholing requirements for planning and performing excavations at LANL.

Program Owner

This course was developed under the direction and technical oversight of Industrial Safety and Hygiene Group (ISH), the functional program owner for this training.

Training Target Audience and Frequency

Before beginning excavation/fill/soil disturbance activities, this course, *Excavation/Fill/Soil Disturbance Self-Study (#31419)*, must be successfully completed by the following personnel:

- excavation permit requester;
- PIC;
- alternate PIC;
- subcontract technical representative (STR); and
- any other personnel physically involved in or responsible for excavation/fill/soil disturbance activities on LANL property and within potential release sites (PRSs) located in Los Alamos County or surrounding communities, such as counties and pueblos.

PRS – potential release site

This training is required yearly. All excavation-associated workers should be assigned curriculum #7074, *Excavation/Fill/Soil Disturbance Activity* or the equivalent.

All excavation workers must complete this course, dated February 2018, within 6 months of the release of LANL procedure P101-17, *Excavation/Fill/Soil Disturbance,* dated 21 December 2017.

Course Limitations

See LANL P101-17, for excavation competent person training requirements.

This self-study course has the following limitations:

- Completing this course does not make you a competent person (see page 3 for the definition of a competent person).
- This course manual does not replace applicable federal regulations and LANL requirements.
- This course does not replace site-specific training.

About This Self-Study Course

Excavation/Fill/Soil Disturbance Self-Study (#31419) contains an introduction, three modules, and a quiz that is taken online. A score of 80% or better is necessary to receive credit for this course in the UTrain Learning Management System.

This course contains several links to websites. UTrain might not support active links, so copy and paste these links into the address line in your browser.

Definitions

Additional definitions are found in LANL Procedure P101-17, *Excavation/Fill/Soil Disturbance.*

benching—the creation of one or more horizontal levels or steps along the sides of an excavation to reduce the risk of a cave-in.

competent person—one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees AND who has the authorization to take prompt corrective measures to eliminate them.

conditional exclusion—an expedited review conducted for certain activities within 2 business days from the date of the request.

distress—soil in a condition in which a cave-in is imminent or likely to occur. Examples of distress include fissures next to an open excavation, the bulging of material from the bottom of an excavation, and the slumping of material from the face of an excavation.

excavation—any soil penetration, disturbance, or groundbreaking, including penetration through slabs (where the soil will be disturbed), using powered equipment or hand tools.

fill—the placement of dirt or other material (such as base course) on top of an existing grade**.**

fissure—a large crack in rock or soil.

potholing—the practice of digging one or more test holes using hand tools or vacuum excavation equipment to determine exactly where and how deep an underground utility is located.

potholing plan—a sketch or drawing that shows where existing buried utility lines are located within the excavation boundary and within 5 feet outside the excavation boundary.

potential release site—a unit identified by LANL where hazardous material from past activities has been placed and from which there may be a risk of release of hazardous waste or hazardous waste components.

revalidation—reverification of the utility locates for a project area.

scaling—the removal of loose material from the face of the excavation to prevent it from falling on persons below.

shield—a structure able to protect workers by withstanding a cave-in.

shoring—a structure that supports the sides of an excavation and protects against cave-ins.

sloping—angling the sides of an excavation to reduce the risk of a cave-in.

spoil—soil or other material that is removed during an excavation.

spotter—a person who looks for and reports any possible problem during the excavation process.

stability—the resistance of an earthen bank or spoil pile to sliding or collapsing.

surface encumbrances—any item, fixed or mobile, that creates a weight on the excavation walls or hinders excavation equipment.

trench—a narrow excavation.

two-foot rule—the practice of keeping material and equipment at least 2 feet from the edge of an excavation to prevent them from falling or rolling into the excavation.

unconditional exclusion—an exclusion that does not require utility locates or an excavation/ fill/soil disturbance (EXID) permit.

Acronyms

AOC	Area of Concern
APWA	American Public Works Association
CFR	Code of Federal Regulations
ES-UI-IIT	Engineering Services-Utilities and Infrastructure-Infrastructure Information Team (also referred to as IIT)
ESH	Environment, Safety, Health
EXID permit	excavation/fill/soil disturbance permit
FOD	Facility Operations Director
GIS	Geographic Information System
GPS	Global Positioning System
HPI	Human Performance Improvement
IIT	Infrastructure Information Team (part of ES-UI-IIT)
IRT	Integrated Review Tool
ISH	Industrial Safety and Hygiene (LANL)
IWD	Integrated Work Document
LANL	Los Alamos National Laboratory
LEL	Lower Explosive Limit
NMOC	New Mexico One Call
OSHA	Occupational Safety and Health Administration
PIC	Person in Charge
PPE	Personal Protective Equipment
PRS	Potential Release Site
PTS	Protected Transmission System
PVC	Polyvinyl Chloride
RLM	Responsible Line Manager
ROPS	Rollover Protective Structure
RPE	Registered Professional Engineer
SDRT	Soil Disturbance Review Team
SME	Subject Matter Expert
STR	Subcontract Technical Representative
SWMU	Solid Waste Management Unit
TA	Technical Area

Laborer Injured by Backhoe during Excavation

A water- and sewer-connection operation was scheduled at TA-46. When the excavation had sufficiently progressed to allow the use of a backhoe, one of the laborers acted as a spotter for the backhoe operator. As the bucket was extended and lowered, the laborer moved to a standing position directly in line with the backhoe hydraulic arm and bucket. The laborer's right foot was hooked under the steel-toe portion of his shoe by one of the four metal teeth of the bucket. The bucket then pulled the laborer into the excavation by his work boot. Later, at the Los Alamos Medical Center, the laborer's number one toe was removed during surgery. The adjacent toes were crushed but not removed.

ALO-LA-LANL-PHYSTECH-1995-0006

What could have been done to reduce the risk of this accident? Answer on page 53.

Module 1: General Excavation Safety

Module Objectives

When you complete this module, you will be able to recognize

- common excavation hazards and controls,
- factors that affect the risk of excavation collapse, and
- protection systems for excavations in various soil types.

Excavation Safety Overview

The following regulations and requirements identify excavation hazards and controls:

- Code of Federal Regulations. 29 CFR 1926, Subpart P, *Excavations.*
- LANL Procedure P101-17, *Excavation/Fill/Soil Disturbance* (December 2017).

This excavation safety overview addresses the following hazards:

Note: *This module presents many rules for performing safe excavations; however, other regulations, requirements, and site-specific rules may also apply.* ***If you are not sure about the safety of an excavation, DO NOT ENTER the excavation!*** *Talk to your competent person or supervisor first!*

Surface Encumbrances

Remove or control all surface encumbrances that may create a hazard. A *surface encumbrance* can be defined as *any item, fixed or mobile, that creates a weight on the excavation walls or hinders excavation equipment*. Examples of surface encumbrances that must be removed or controlled before work proceeds may include equipment, materials, supplies, buildings, roadways, trees, utility vaults, and boulders. A registered professional engineer (RPE) may need to design the support systems for tie-off or cribbing systems.

Remove or control surface encumbrances.

Underground Installations

The estimated location of utilities, foundations, lightning protection grids, and any other underground installations that might be encountered must be determined before an EXID permit is obtained.

The exact location of an underground installation is determined by ***potholing*****,** which is the practice of digging one or more test holes to find the exact location and depth of an underground installation, such as a utility. Potholing is addressed in Module 3.

While an excavation is open, underground installations must be protected, supported, or removed, as necessary, to ensure the protection of employees and utility systems.

Underground installations in an open excavation may need protection, support, or removal.

Access and Egress

Ladders, ramps, or stairs used to exit trenches that are 4 feet or more in depth must be located so that an employee does not have to travel more than 25 feet before reaching a means of egress. Thus, no more than 50 feet total can exist between egress points.

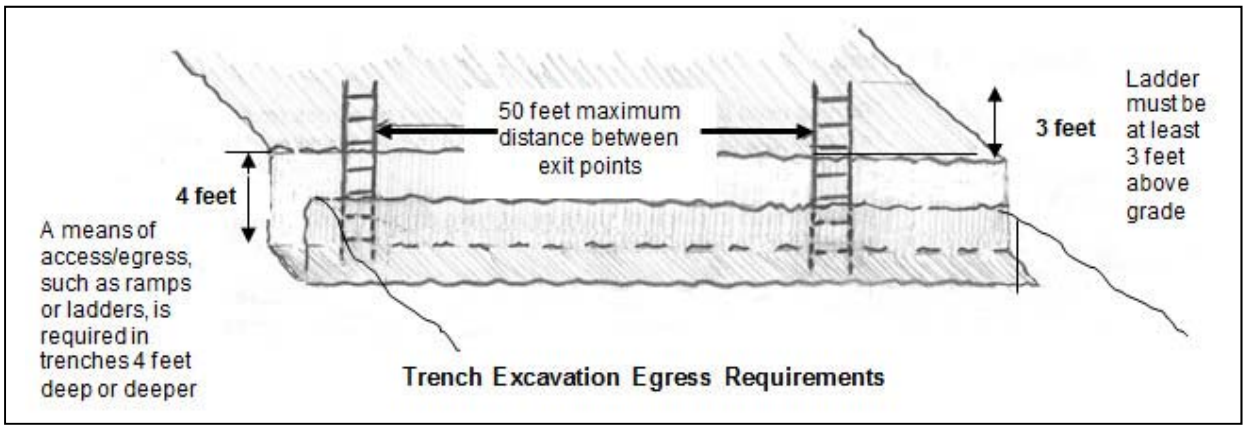
Methods of access and egress, such as ladders, ramps, or stairs, are required for trenches more than 4 feet deep. Ramps must be designed by a competent person.

Ramps used by employees or equipment to access (enter) or egress (exit) excavations must be designed by a competent person qualified in structural design. Ramps used in place of steps must have cleats or other surface treatments to prevent slipping.

Ladders must extend at least 3 feet above the grade (top) of the excavation.

The stepladder above is NOT a suitable means of access or egress because

- it does not extend 3 feet above the excavation and
- it is an improper use of a stepladder.



Vehicle and Heavy Equipment Hazards

LANL requirements for excavating near powered mobile equipment are found on page 41.

The operation of vehicles and heavy equipment near excavations is one of the main hazards for workers. Some Occupational Safety and Health Administration (OSHA) regulations that address operation of vehicles and heavy equipment near excavations are shown on this page. Additional LANL requirements for the use of powered mobile equipment near excavations are found on page 41.

Workers exposed to public vehicles must wear warning vests or other types of reflective, easy-to-see clothing.

When powered mobile equipment must approach the edge of an excavation and the operator cannot clearly see the edge of the excavation, a warning system such as barricades or hand signals must be used.

LANL spotter responsibilities and suggested hand signals are found on pages 36–37.

When possible, the grade should slope away from the excavation so that if a vehicle begins to roll, it will roll away from the excavation and not into the excavation.

Workers are NOT ALLOWED to be under raised loads or powered mobile equipment and should stand away from vehicles that are being loaded or unloaded.

Hazardous Atmospheres

Hazardous atmospheres in excavations can cause injury, illness, or death to any worker who enters. Hazardous atmospheres may be explosive, flammable, corrosive, oxygen-deficient, toxic (poisonous), or harmful in other ways.

Warning: *NEVER depend on your sense of smell to tell you if the atmosphere of an excavation is safe to enter!*

Toxic Atmospheres

Some hazardous atmospheres have poor warning properties, and you may not be able to smell or see them. Examples of chemicals with poor warning properties that can create hazardous atmospheres include

- carbon monoxide (which cannot be smelled), and
- hydrogen sulfide (which smells like rotten eggs at first, but which cannot be smelled after a short while).

You cannot always smell a hazardous atmosphere!

DANGER!: *Excavations with atmospheres containing carbon monoxide or hydrogen sulfide can kill entrants unless proper controls are in place!*

Oxygen-Deficient/Oxygen-Rich Atmospheres

Oxygen-deficient atmospheres (less than 19.5% oxygen) can be caused when oxygen is displaced by other liquids or gases or when oxygen is consumed, as by combustion (burning) or bacterial activities. Oxygen-deficient atmospheres can cause death. NEVER enter an excavation that has less that 19.5% oxygen! If there is less than 19.5% oxygen or if other hazards in the atmosphere exist, controls such as ventilation or respiratory protection must be used.

Oxygen-rich atmospheres can be caused by leaking oxygen cylinders or hoses. Oxygen-rich atmospheres increase the risk of fire or explosion. NEVER enter an excavation that has more than 23.5% oxygen!

Flammable Atmospheres

Flammable atmospheres can result from leaking gas cylinders, fuel lines, or underground tanks. Flammable atmosheres increase the risk of fire or explosion. NEVER enter an excavation with a flammable gas concentration greater than 10% of the lower explosive limit (LEL).

Don't let this happen to you!

Testing for Hazardous Atmospheres

Atmospheric testing is required before workers enter excavations greater than 4 feet deep where a hazardous exists or may exist, such as

- in landfill areas,
- in areas where hazardous substances are stored nearby,
- where known radiological or chemical lines are buried, and
- where gas-operated equipment may be used.

Excavation sites with natural gas lines, waste lines, or chemical storage tanks have a higher risk of a hazardous atmosphere.

When testing for atmospheric contaminants, Environment, Safety, Health (ESH) personnel must

- test the atmosphere before workers enter the excavation and regularly during the work to ensure the excavation remains safe; and
- increase the frequency of testing, as needed, if
    - equipment is operating in the excavation;
    - controls (such as ventilation) are used to manage the hazardous atmosphere;
    - welding, cutting, or burning is performed in the excavation; or
    - gas-powered equipment is used in the excavation.

ESH personnel choose monitoring equipment to ensure that the monitor(s) used will detect the atmospheric hazard(s) of concern before workers enter the excavation.

Monitoring for hazardous atmospheres should occur more often if welding, cutting, or burning is performed within the excavation.

Warning! *If you are not sure whether the atmosphere is hazardous, DO NOT enter the excavation!*

One Employee Killed and Two Injured in Natural Gas Explosion

Employee #1, the crew foreman, Employee #2, the lead crewman, and Employee #3, a helper, were assigned to cut and cap an old steel gas line and to redirect the gas flow to a new plastic gas line. Employees #2 and #3 were inside the excavation and squeezed the old steel gas line to stop the gas flow. Employee #2 made the first cut into the old steel gas line, and gas started leaking out. At the direction of Employee #1, he waited a few minutes for the gas to bleed. Employee #1 started to make a second cut when a spark ignited the gas, resulting in a fire and explosion. Employee #1 sustained third-degree burns over 79% of his body and inhaled superheated gasses; he was killed. Employees #2 and #3 were hospitalized with third-degree thermal burns.

OSHA Accident Investigation Search #300968625

Rescue Equipment for Hazardous Atmospheres

When work is performed where a hazardous atmosphere exists or may exist, the RLM must ensure that emergency rescue equipment is readily available. Examples of emergency rescue equipment that might be needed include a

- safety harness and line,
- basket stretcher, and
- breathing apparatus.

Warning: *At the first sign of an emergency, call 911 or Emergency Management at 667-6211 immediately!*

Examples of emergency rescue equipment: safety harness, basket stretcher, and breathing apparatus.

Water Hazards

Work must not take place in excavations in which water has accumulated unless controls are used to protect the workers. Examples of standing water and water accumulation controls include

- using shield systems to stop cave-ins (approved by an RPE),
- using water removal equipment (monitored by a competent person),
- using safety harnesses and lifelines,
- diverting surface water away from the excavation, and
- removing workers from the excavation during rainstorms.

Note: *Excavations must be inspected by a competent person after each rain and before workers are permitted to reenter the excavation.*

Standing water *(left)* must be controlled before worker entry. At right, it has just rained. A competent person must inspect the site before workers can reenter the excavation.

Concerns at right include housekeeping, water control, access and egress, and slope angles.

Adjacent structures *(above)* must be removed or secured to prevent collapse.

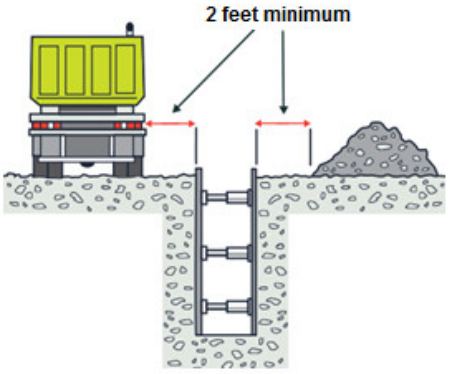
Adjacent Structures

Adjacent structure hazards, such as building walls, can collapse if they are not properly secured. Before you excavate beneath an adjacent structure, make sure that the structure has been removed or secured to prevent collapse. Excavations under the base of the footing of a foundation or wall require a support system designed by an RPE.

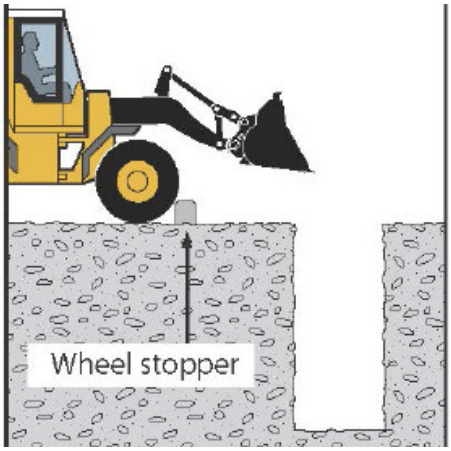
Employee Killed when Wall Collapses into Excavation

Employee #1 was using a laser transit to measure the grade of an excavation. The west side of the excavation was next to a building wall, where its foundation was exposed. The 17-foot-high brick wall was not supported or underpinned and collapsed. Employee #1 died when he was caught between a section of wall and the excavation face.

OSHA Accident Investigation Search #170830517



(Above)—keep materials and equipment at least 2 feet from the edge of excavations. *(Below)*—Wheel stopper used to stop equipment from rolling into an excavation.



Falling Objects and the Two-Foot Rule

Materials and equipment must be kept at least 2 feet from the edge of excavations unless retaining devices that prevent materials or equipment from falling or rolling into excavations are used. The **two-foot rule** also applies to spoil piles.

Workers are not allowed to work on the faces of sloped or benched excavations above other employees unless the workers below are protected from equipment and material that may fall, roll, or slide down on them. Examples of such protection include **scaling** to remove loose material or barricades that will stop and contain falling material.

Crossing over Excavations

Workers or the general public may not cross over excavations either by foot or with vehicles unless absolutely necessary. In such cases,

- vehicle crossings must be designed by and installed under the supervision of an RPE; and
- walkways or bridges for pedestrian traffic must be at least 20 inches wide, have standard guardrails, and extend at least 24 inches past each surface edge of the excavation.

Worker wearing a safety harness (*left*). At right, guardrails are required for the walkway if the trench is 6 feet deep or deeper.

Employee Injured in Fall from Walkway

Employee #1 was crossing a walkway over an 8-foot-deep open space between the sides of an excavation and some formwork. The single sheet of plywood was not secured, nor was it equipped with guardrails. Employee #1 fell into the excavation and was injured.

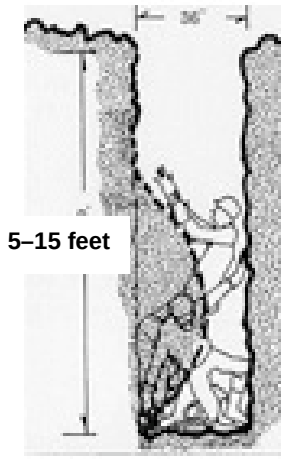
OSHA Accident Investigation Search #000839365

Protective System Inspections

When materials or equipment used for protective systems is damaged, a competent person must examine the material or equipment before continued use. If the competent person cannot ensure that the equipment is still suitable for use, it must be removed from service. All equipment that is removed from service (for any reason) should be properly tagged or destroyed and disposed of so that other persons will not use it by mistake.

LANL excavation inspection requirements are found on page 35.

Factors That Affect the Risk of Excavation Collapse



The greatest risk to excavation workers is collapse (cave-in). No warning usually occurs before a cave-in. Most accidents occur in trenches that are 5–15 feet deep.

Protective systems are used to maintain the safety of workers entering excavations. Protective systems are required in all cases, EXCEPT when

- excavations are made entirely in stable rock or
- excavations are less than 5 feet deep AND examination of the ground by a competent person provides no indication of a potential cave-in.

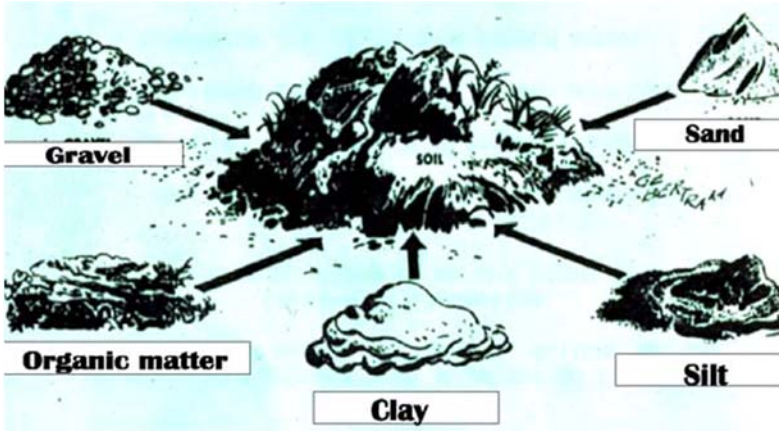
Many factors affect the risk of excavation collapse, including

- **Soil type.** Soil is classified according to ***stability***, which is the resistance of an earthen bank or spoil pile to sliding or collapsing. The order of soil classification, from most stable to least stable, is
  - Stable rock—solid matter that can be excavated with vertical sides and remain intact while exposed.
  - Type A soil—clays and many clay-containing soils. No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, or has seeping water.
  - Type B soil—silts, loams, and sandy loams.
  - Type C soil—the least stable type of soil, including gravels and sands.

Loam is a mixture of sand, silt, clay, and organic matter.

All soils at LANL must be designated as Type C soils unless a determination is made by the **competent person** that the soil is another type. If the properties of the soil or conditions change, the soil might need to be reclassified**.** See Module 2 for other responsibilities of a competent person.

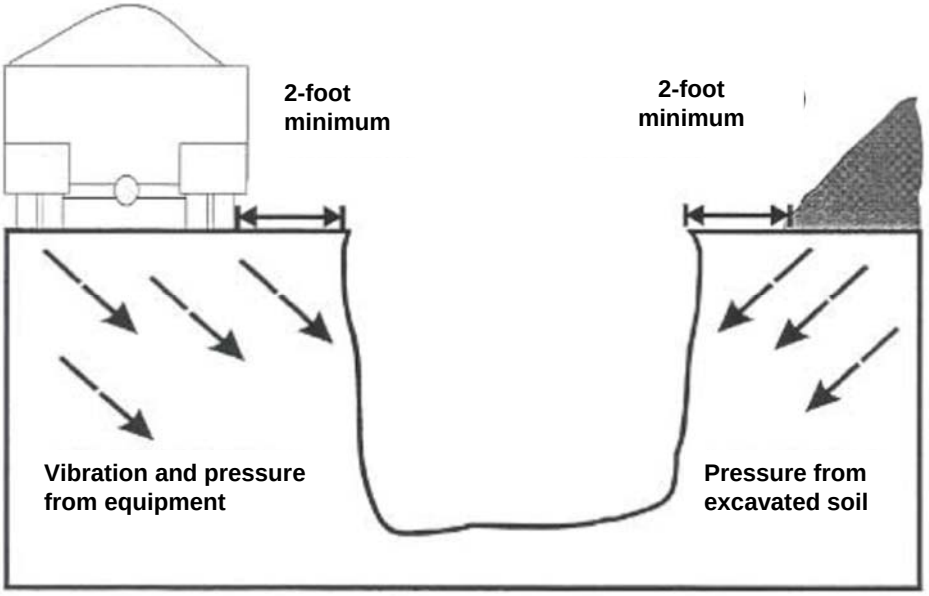
The type of soil to be excavated affects the type of protective system(s) that will be used.



- **Previously disturbed soil.** Soil that has already been excavated and then replaced is not as stable as the same type of soil that is not disturbed.
- **Soil weight.** As the soil weight increases, the downward force increases. Soil that is dry does not weigh as much as the same soil that is wet.
- **Moisture.** Moisture increases the downward force and decreases the soil strength.
- **Freezing and thawing.** Freezing and thawing causes the soil to expand and contract, which can cause fissures and stress cracks.
- **Fissures and stress cracks.** Fissures and stress cracks indicate that a cave-in could happen soon.
- **Trench depth.** As a trench gets deeper, the downward force of the earth around it increases.
- **Weight and location of the spoil pile.** Placing the spoil piles too close to the excavation increases the downward force and so increases the risk of collapse.
- **Weight and location of nearby equipment.** As with the spoil piles, operating heavy equipment too near to an excavation increases the risk of collapse.
- **Vibration.** Heavy or close vehicle traffic, heavy equipment operations, and some activities, such as pile driving, contribute to soil instability.

Fissures increase the risk of cave-in.

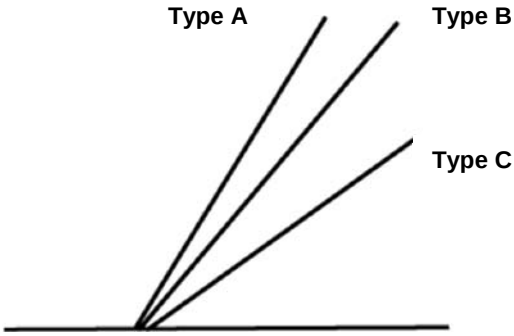
Vibration, nearby equipment, and excavated soil are all factors that can affect the risk of an excavation collapse.



Protection Systems for Excavations in Various Soil Types

The information presented here is NOT intended to train individuals in the design or approval of cave-in protection but rather to provide an awareness of the requirements for cave-in protection.

Benching, sloping, shoring, and shielding are types of controls that are designed to prevent cave-ins. Such controls must always be inspected and approved by a competent person and, in some cases, a professional engineer.



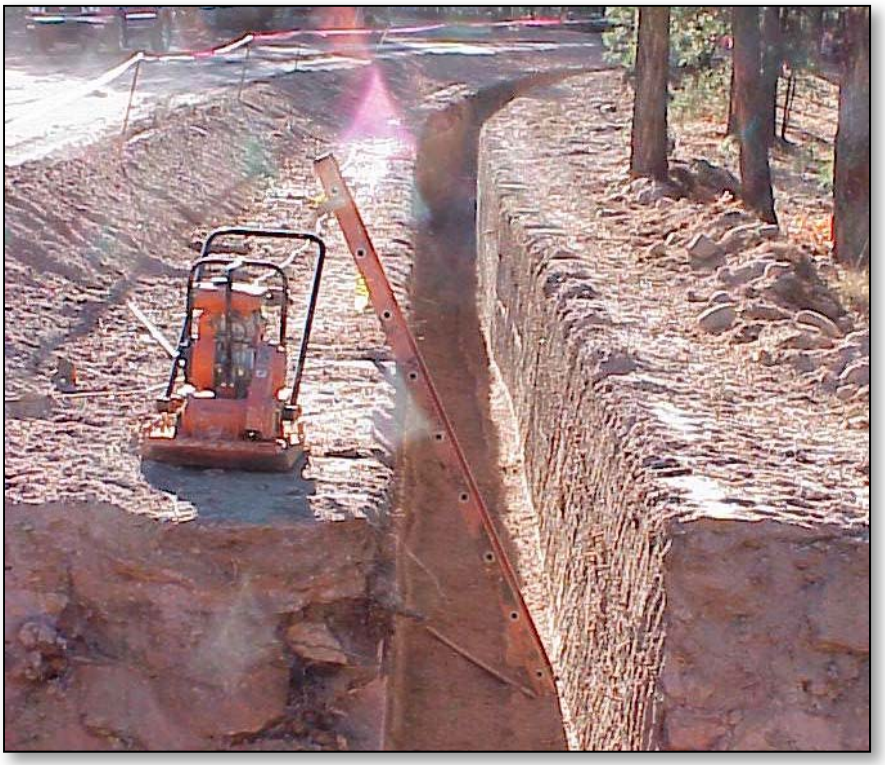
Comparison of allowable slope angles for A, B, and C soil types.

Benching is defined as creating one or more horizontal levels or steps along the sides of an excavation to reduce the risk of a cave-in. Specific benching requirements are not presented in this course. *Benching is NOT allowed in Type C soil.*

Sloping is defined as angling the sides of an excavation to reduce the risk of a cave-in. The angle of slope that is allowed varies according to the type of soil. Acceptable sloping and benching requirements are shown on pages 19–21.

Benching or sloping is NOT required when an excavation is made in stable rock UNLESS cracks, fissures, water seepage, bulging, or other similar conditions cause the soil to be downgraded to Type A or Type B.

In the photo at right, note how the topsoil has been removed down to stable rock, the soils have been piled at least 2 feet from the edge of the trench, and the ladder extends at least 3 feet out of the trench.



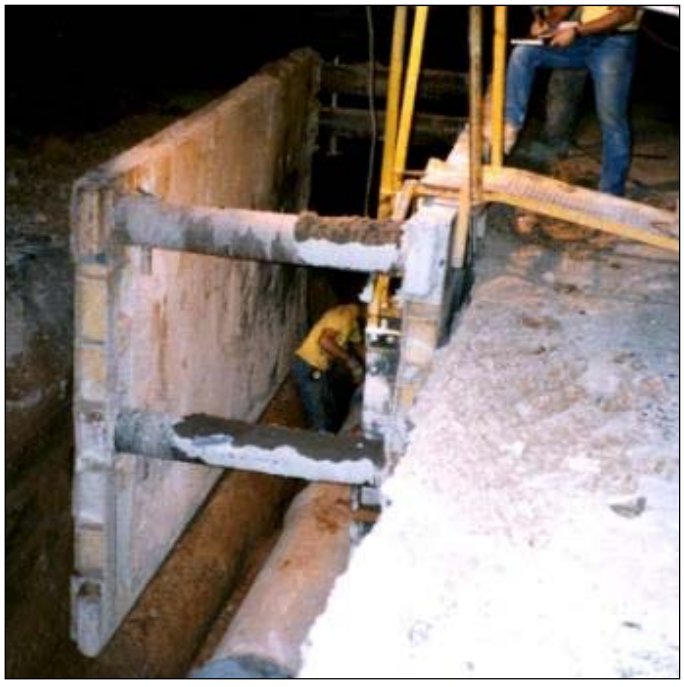
Shoring and Shielding

Trench shield.

Shoring is defined as a structure that supports the sides of an excavation and protects against cave-ins. Types of shoring include wood shoring, hydraulic shoring, and trench shields. Specific shoring requirements exist but are not presented in this course. Tables that specify shoring requirements for different types of materials can be found in 29 CFR 1926, Subpart P, *Excavations*.

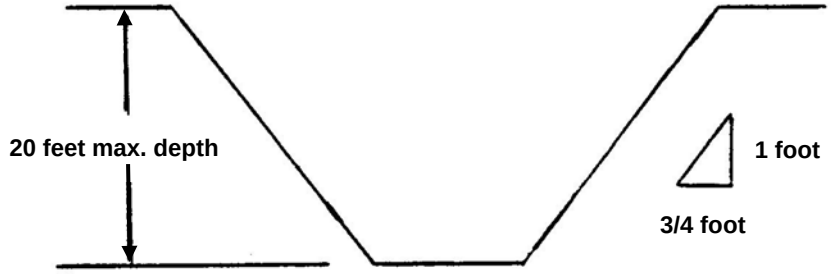
Shielding is defined as a structure able to withstand a cave-in and protect employees. Shielding is often considered as a type of shoring. The excavated area between the outside of the trench shield and the face of the trench should be as small as possible.

Specific requirements for benching, sloping, shoring, and shielding are found in 29 CFR 1926, Subpart P, *Excavations*. Remember that as with benching and sloping, shoring and shielding must always be approved of and inspected by a competent person.



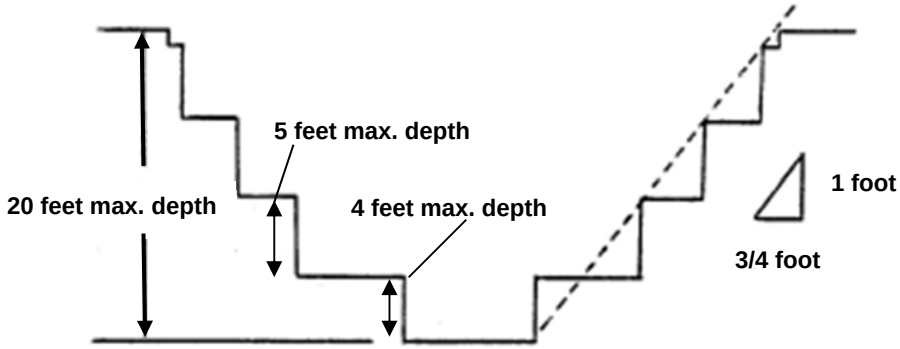
A trench shield in use (above). The picture at right is an example of unacceptable shoring.

Approved Sloping for Type A Soil



In Type A soil, the maximum allowable slope of simple slope excavations 20 feet or less in depth is 3/4:1. This means that for every 3/4 of a foot in the horizontal (flat) direction, the slope can rise no more than 1 foot in height.

Approved Benching for Type A Soil

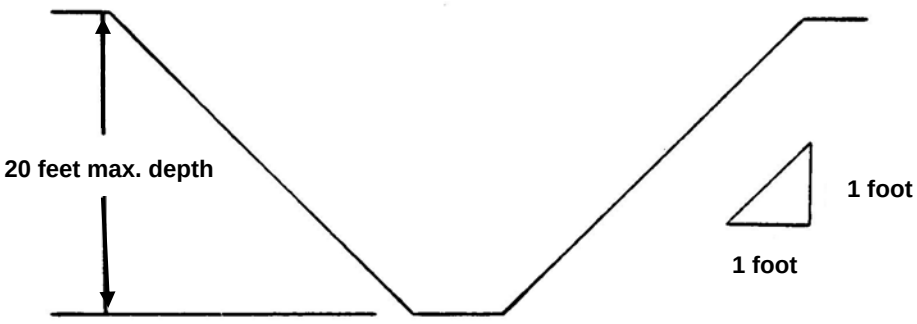


In Type A soil, the maximum allowable slope of benched excavations that are 20 feet or less in depth is 3/4:1. Note also that the maximum allowable height for the lowest bench is 4 feet and for subsequent benches is 5 feet.

Note: *Other combinations of benching and sloping in Type A soil are permitted by OSHA. For more information, see Appendix B of 29 CFR 1926, Subpart P.*

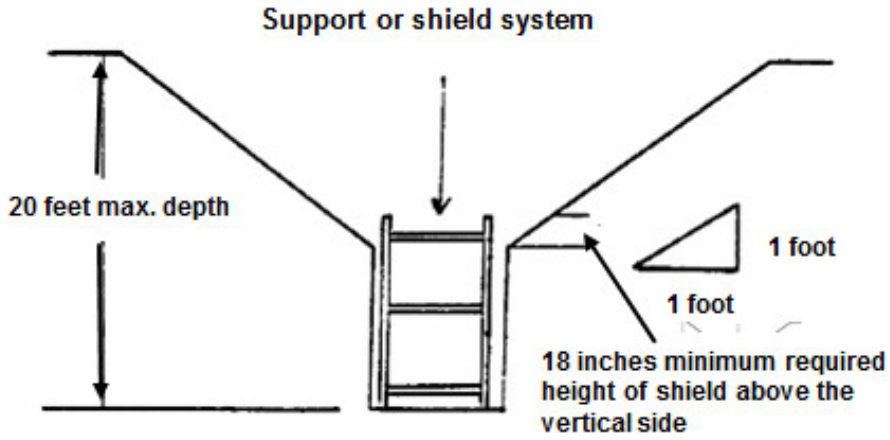
Examples of benching along the sides of an excavation to reduce the risk of a cave-in.

Approved Sloping for Type B Soil



In Type B soil, the maximum allowable slope of simple slope excavations 20 feet or less in depth is 1:1. This means that for every 1 foot in the horizontal (flat) direction, the slope can rise no more than 1 foot in height.

Approved Sloping with Support or Shield for Type B Soil

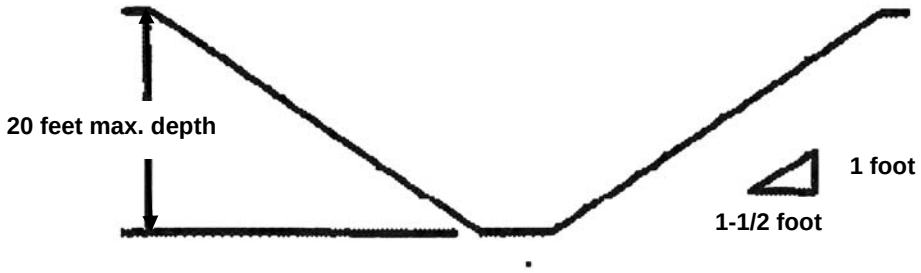


In Type B soil, excavations that are 20 feet or less in depth that have vertically sided lower portions must be shielded or supported to a height at least 18 inches above the top of the vertical side. The maximum allowable slope of such excavations is 1:1.

Note: *Other combinations of benching, sloping, and shielding in Type B soil are permitted by OSHA. For more information, see Appendix B of 29 CFR 1926, Subpart P.*

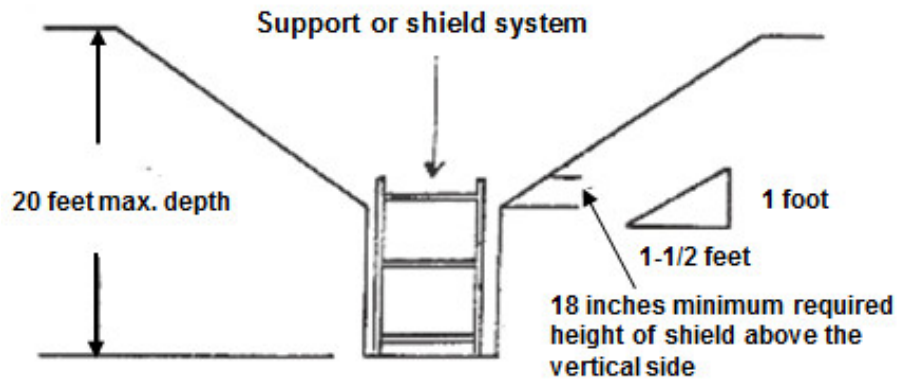
Excavation with proper sloping.

Approved Sloping for Type C Soil



In Type C soil, the maximum allowable slope of simple slope excavations 20 feet or less in depth is 1.5:1. This means that for every 1.5 feet (18 inches) in the horizontal (flat) direction, the slope can rise no more than 1 foot in height.

Approved Sloping with Support or Shield for Type C Soil



In Type C soil, excavations that are 20 feet or less in depth that have vertically sided lower portions must be shielded or supported to a height at least 18 inches above the top of the vertical side. The maximum allowable slope of such excavations is 1.5:1.

Note: *Other combinations of sloping and shielding in Type C soil are permitted by OSHA. For more information, see Appendix B of 29 CFR 1926, Subpart P.*

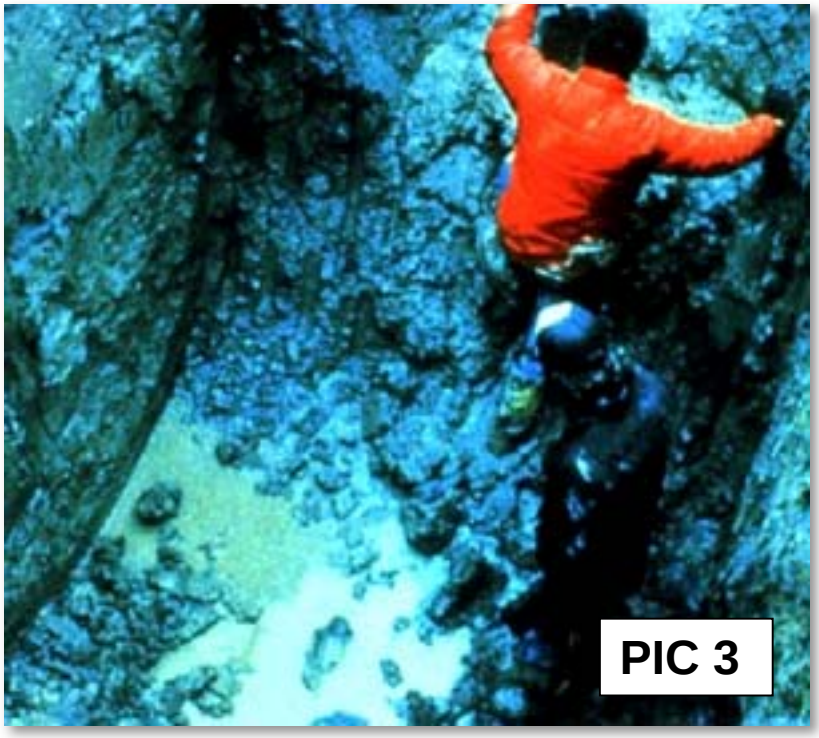
Activity—Review of Good and Bad Excavation Practices

Look at the pictures on this and the next few pages and think how you would perform the work more safely.

How many potential hazards can you spot? How many controls can you spot? How many controls are missing?

Answers are on page 53.

What hazards do you see in the photo at right? What controls are missing? Answers are on page 53.



In the photo below, wooden pallets are used to cover a 9-foot-deep excavation. Are the controls seen here enough? If you were working on this site, what controls would you look for? Answers are on page 54.

What, if anything, is wrong with these pictures? What hazards and controls do you see? What, if anything, would you do differently? Answers are on page 54.

Human Performance Improvement

Human Performance Improvement – Trench Collapse under Trackhoe

Human performance improvement (HPI) is an approach that is used to address human error in the workplace. HPI treats human error as a sign of deeper problems within a system. One of the five basic principles of HPI is that events can be avoided by understanding the reasons mistakes occur and applying the lessons learned from past events. An example based on *DOE Lesson ID: Y-2002-OR-BJCPORTS-1001* is given below.

A subcontractor was using a trackhoe and a backhoe to complete trench work. The trackhoe operator would sometimes track forward over the trench to level sand in the bottom of the trench or place backfill into the trench. This method was used during most of the project work. On the day of the event, the trackhoe was straddling a 2-foot-wide trench that was about 9–10 feet deep when the trench side collapsed under the trackhoe.

Review of the event indicated the following:

- Personnel, including the competent person, did not recognize the hazard of straddling/tracking over an open trench. They said that straddling open trenches was a common practice.
- The work plan did not indicate that straddling trenches would be performed.
- The event took place in an area where there were three parallel trenches, each 10 feet apart. The equipment made multiple passes over the trench area.

After the event occurred, the work plan was modified to prevent the open trench from being longer than the reach of the excavator's arm. This action allowed the sand to be leveled and backfill placed without the need to straddle the trench.

How does the knowledge of this event help us work more safely? It helps us work more safely when we apply the lessons learned to proposed work. Consider the following:

- Common work practices that are thought to be routine and safe should be reviewed and questioned from time to time. Even if "it's always been done that way and nobody ever got hurt," there might be a better, safer way.
- People are fallible, and even the best make mistakes. [This philosophy is another basic principle of HPI.] Do not take the attitude that just because a competent person has reviewed the project you are working on, nothing could possibly go wrong.
- Take the time to review and understand your work documents. If you see someone using a method that is not addressed in your work documents, tell them. If necessary, pause or stop work to change the method or the work document if needed.
- Pay attention to changing conditions. In this event, the equipment making multiple passes over the trench area may have added to the soil's instability and the trench collapse.

Module 2: LANL Excavation Permit Process

Module Objectives

When you complete this module, you will be able to recognize

- LANL excavation/fill/soil disturbance requirements and the LANL EXID permit-approval process, including request priorities, expiration, scope and location of activity, revalidation requirements, and conditional and unconditional exclusions;

EXID - Excavation/Fill/ Soil Disturbance

- responsibilities of RLMs, PICs, alternate PICs, authorized workers/operators, spotters, and competent persons in excavation/fill/soil disturbance projects at LANL;
- requirements that affect excavation/fill/soil disturbance activities at a LANL PRS;
- LANL-specific controls that affect excavation/fill/soil disturbance activities, including pre-job briefings and walkdowns, hold points, soil transfer and fill management, excavating near powered mobile equipment, barricades, and signs; and
- what to do if an excavation-related abnormal event or emergency occurs.

LANL Excavation Program Concerns

A review of excavation-related events was released in 2017 and found the following concerns in the LANL excavation/fill/soil disturbance program:

- **incomplete utility locates and documentation of active and abandoned secondary* utility lines**
- **inconsistent barriers and signs** to identify excavation activities
- **poorly defined responsibilities that address PIC turnover**, including field walkdowns, briefings, and formal hold points in work control documents
- **lack of formal responsibilities and training for operators and spotters**
- **lack of a formal process that specifies what to do if an unknown utility or line is encountered or breached**
- **inadequate oversight of subcontractor excavation activities**

The above concerns are addressed in the revised LANL P101-17, *Excavation/Fill/Soil Disturbance*, and in this training self-study.

*An example of a **primary utility line** is electric power that is fed from a main power line to a transformer. An example of a **secondary utility line** is electric power that is fed from a transformer to a facility.

LANL Excavation/Fill/Soil Disturbance Permit Requirements

EXID activities on LANL property must meet the requirements of the following documents:

- LANL Procedure P101-17, *Excavation/Fill/Soil Disturbance;* and
- OSH-ISH-FSD-OP-003, *Potholing Procedures.*

Information on how to access these documents is found on page 52

The requirements in the above documents apply to

- excavations;
- soil penetration;
- mowing;
- vegetation removal and tree removal;
- cutting, chipping, or removing concrete or asphalt, where soil underneath can be disturbed;
- soil transfer or filling, where soil underneath can be disturbed; and
- penetrations through slabs on grade in buildings, where the soil is disturbed.

An EXID permit must be requested and approved before beginning any indoor or outdoor excavation/fill/soil disturbance activity on LANL property and within PRSs located in Los Alamos County or surrounding communities, such as counties and pueblos. Review and approval of an EXID permit request follows a specific process. The excavation/fill/soil disturbance request process and additional requirements that affect the EXID permit are presented in the following pages, as shown in the table below.

Information about the EXID permit…	…is found on page…
Request and Approval Process	28
Request Priorities	29
Expiration	29
Scope and Location of Activity	29
Revalidation	30
Unconditional Exclusions	30-31
Conditional Exclusions	32

Permit Request and Approval Process

See P101-17 for complete details of the permit request process.

P101-17 provides a detailed procedure for the request, review, and approval of an EXID permit. The process is summarized below:

ES-UI-IIT - Engineering Services-Utilities and Infrastructure-Infrastructure Information Team

FOD – Facility Operations Director

IIT – Infrastructure Information Team

IRT - Integrated Review Tool

SDRT - Soil Disturbance Review Team

TA – Technical Area

1. The requester submits an EXID permit request using the IRT.
   - One permit request may be made for a project performed in more than one TA, as long as the conditions of P101-17, Section 3.2 are met.
   - Permit reviews for work in multiple TAs may exceed the review period (see page 29).
   - Changes to permit requests will extend the review period by 2 days.
   - A one-time change to an approved permit may be allowed by the SDRT on a case-by-case basis.
2. The SDRT processes the request, then notifies affected personnel and organizations [subject matter experts (SMEs), the ES-UI-IIT, and the FOD] of the planned work.
3. The SMEs review and submit comments.
4. The PIC requests utility locates from ES-UI-IIT.
5. The PIC marks the proposed excavation boundary with white paint, flags, or whiskers. ES-UI-IIT utility locators and any affected organizations locate and mark all known utilities, complete their portion of the EXID permit, then generate a map of the area. The map must be attached to the EXID permit package.

Proposed excavation boundaries must be marked with with white paint, flags, or whiskers.

6. If any utilities are found, a potholing plan must be completed and approved (see OSH-ISH-FSD-OP-003, *Potholing Procedures*).
7. If utilities are present within the area, ES-UI-IIT provides a sketch of the utility locates and boundary area to the SDRT.
8. The Utility Locator ensures that all utility organizations have located and signed off on the EXID permit. The Utility Locator then sends the information to the SDRT.
9. The SDRT combines the EXID permit, SME review, and ES-UI-IIT sketches, then notifies the requester, PICs, and STR that the EXID permit is ready for issuance.
10. The SDRT reviews SME comments with the PIC(s) and STR.
11. If all requirements are met, the SDRT issues an EXID permit. Final review and approval of the EXID permit occurs when all SME comments have been addressed.
12. The PIC or Project Coordinator must send an e-mail to excvation@lanl.gov to notify the SDRT of the planned start at least 3 days before activities begin.

Permit Request Priorities

Routine Priority – SME review will be completed within **7 business days.**

Unconditional Exclusion – SME review will be completed within **2 business days**. See pages 30–31 for a list of unconditional exclusions.

Conditional Exclusion – SME review will be completed within **2 business days**. See page 32 for a list of conditional exclusions.

Emergency Priority – SME review will be completed within **2 business days**. Note the following requirements for emergency excavations:

- During off-hours, call Emergency Management at 667-6211 or call 911.
- For an excavation that must be completed immediately, such as a major break in a utility, contact ES-UI-IIT at 665-1051 (665-4763 after normal working hours) for emergency utility locates. Work may begin without the EXID permit, as long as utility locates have been obtained from ES-UI-IIT.
- The emergency work must be completed to create a safe working environment.
- An EXID permit request must be submitted the next working day.
- All emergency repair work must be conducted as if the excavation boundary area were a PRS. See pages 37–38 for PRS excavation requirements.

Permit Expiration

A Routine or Conditional Exclusion EXID Permit expires **1 year** from the approval date, as long as the scope, location, and depth have not changed. The Project Coordinator must maintain the expiration date of the excavation permit.

An Emergency EXID Permit expires **2 weeks** from the approval date. No extension may be granted for an Emergency EXID Permit. If the activity will exceed 2 weeks, a Routine Priority EXID Permit is required. SMEs will provide a review within 2 business days from the submission date, if the Emergency excavation/fill/soil disturbance number is provided with the Routine Priority EXID Permit request.

Permit Scope and Location of Activity

Using the IRT website, the EXID Permit Requester must provide

- a detailed map using the online mapping system, which shows the excavation/fill/soil disturbance boundary. *Maps with incorrect excavation boundaries will be rejected;*
- all proposed activities to take place within the defined boundary;
- the exact location, referencing the nearest structure or landmark; and
- the maximum depth of excavation.

Note: *Guidance for the using the mapping system and making changes to the submission is provided in P101-17.* ***Any changes to the original activity scope, location, or maximum depth of excavation will require a new EXID permit request.***

Permit Revalidation

Revalidation is the process of reverifying the utility locates for a project area to allow the continuation of an existing EXID permit. The EXID permit must be revalidated by ES-UI-IIT before excavation may proceed if any of the following conditions occur:

- The utility field marking is no longer in place or cannot be seen.
- The PIC or alternate PIC has changed.
- A depth increase is requested, but the scope has not changed.
- Thirty days have passed from the date the utility locate markings were made.
- Ten working days have elapsed from the date of New Mexico One Call (NMOC) locates (if NMOC locates are required for the area being excavated).

Note: *Information on who the PIC must contact for a request to increase depth, who the PIC must contact for the refreshing of utility markings, and revalidation exceptions is found in P101-17.*

Unconditional Exclusions

For more information about **unconditional exclusions**, see P101-17.

Unconditional exclusions DO NOT require ES-UI-IIT to conduct utility locates or issue an EXID permit. HOWEVER,

- the requester must first complete the EXID permit request for unconditional exclusion and obtain approval; AND
- activities that are considered unconditional exclusions MUST NOT be closer than 100 feet from known PRS boundaries; treatment, storage, and/or disposal units; watercourses; or any other environmental concern.

Examples of unconditional exclusions are listed below.

- Perform utility locates using ground rods or hand tools (ES-UI-IIT only).
- Ground test existing lightning protection systems, to a maximum of **6** inches deep.
- Remove existing power poles only.
- Install or replace concrete collars around valve boxes or manholes, using hand tools or vacuum excavation, to a maximum of **18** inches deep.
- Raise, reset, or replace manhole or ring with grade rings, using hand tools or vacuum excavation, to a maximum of **18** inches deep.
- Install or replace concrete collars around sewer clean-outs to grade, using hand tools or vacuum excavation, to a maximum of **12** inches deep.
- Raise or replace existing sewer cleanouts to grade, using hand tools or vacuum excavation, to a maximum of **12** inches deep.
- Uncover surface buried valve boxes and manholes, using hand tools or vacuum excavation, to a maximum of **12** inches deep.

Manhole, sewer clean-out, and utility valve box activities

- Raise, reset, or replace existing utility valve boxes using hand tools or vacuum excavation, to a maximum of **4** feet deep.
- Patch potholes on paved roadways and parking lots, NOT to exceed the existing base course depth.
- Patch asphalt utility cuts to a maximum of **6** inches deep.
- Remove and replace existing concrete or asphalt sidewalks, curbs, or gutters (including the use of a saw cutter for sidewalk panels) to a maximum of **6** inches deep.
- Maintain paved roadways, including asphalt overlays, crack sealing, and nails, NOT to exceed 6 inches in depth.
- Place and pick up base course, NOT to disturb the soil below grade.
- Perform route survey using wooden stakes, hubs, pin flags, and lath or grade markers that will penetrate the surface. Does NOT include metal stakes, rebar, etc.
- Remove snow on existing dirt roads. Soil disturbance to a maximum of **6** inches deep.

Roadway and sidewalk activities

- Prepare soil surfaces for seeding or erosion control to a maximum of **3** inches deep.
- Install or maintain erosion control (silt fences, erosion control blankets, etc.): wood stakes to a maximum of **12** inches deep, metal pins to a maximum of **6** inches deep.
- Fill erosion rills to a maximum of **6** inches deep.
- Replace lawn sprinkler heads, using hand tools, to a maximum of **6** inches deep.
- Rake dirt for seeding to a maximum of **6** inches deep.
- Control vegetation around buildings, using standard mowing equipment, weed whackers, or hand removal, NOT to disturb soil below grade.

Erosion control and vegetation activities

- Sample surface soils, using hand tools for environmental monitoring only, to a maximum of **12** inches deep.
- Clean-up of spills to the environment, using hand tools, to a maximum of **12** inches deep.
- Conduct continued environmental monitoring, using existing monitoring stations or in existing sites. Does NOT include installation of new monitoring equipment or best management practices.

Environmental monitoring and spill activities

Conditional Exclusions

For more information about **conditional exclusions**, see LANL P101-17.

Conditional exclusions REQUIRE an expedited EXID permit review and require ES-UI-IIT to conduct a utility locate before the activity begins. Conditional exclusions include the following:

- Use a gas probe to measure leaks from faulty gas lines to a maximum of **18** inches deep.
- Perform fill activities (fill material must be free of contamination).
- Replace lawn sprinkler head riser pipe and/or riser pipe connection tees, using hand tools, to a maximum of **18** inches deep.
- Remove and replace existing concrete or asphalt parking stop bumpers, including driving metal stakes, to a maximum of **18** inches deep.
- Install fence "T-posts."
- Install signs.
- Install bollards at existing utilities, using hand tools or a vacuum excavation machine, to a maximum of **3** feet deep.
- Repair primary and secondary potable waterlines where water discharge has the probability to impact the environment, including a PRS, which could trigger reporting requirements.
- Install utility line markers to a maximum of **18** inches deep.
- Maintain existing fire roads or firebreaks, including blading the roadway, blading the base course, and maintaining shoulders, NOT to exceed 6 inches in depth.
- Transfer a clean soil pile from one TA to another. Soil may NOT be disturbed below grade.
- Install rip-rap on slopes or drainage areas.
- Mow vegetation to a maximum of **3** inches deep.

Conditional exclusions include replacing parking stop bumpers (top), replacing lawn sprinkler head riser pipes and/or tees (above), installing fence T-posts (right), and maintaining fire roads or firebreaks (below).

Responsibilities of LANL Excavation Personnel

Roles and responsibilities for excavation/fill/soil disturbance activities at LANL are specified in P101-17. **Some** of the responsibilities of the RLM, PIC, alternate PIC, operator, spotter, and competent person are presented. For a complete list of roles and responsibilities, refer to P101-17.

Responsible Line Manager (RLM)

Additional roles and responsibilities are identified in P101-17.

An RLM has the following responsibilities:

- ensure that excavation/fill/soil disturbances are evaluated and that required controls are used;
- ensure that workers have the knowledge, skills, abilities, and training needed to address the hazards with the proposed controls;
- recommend whether a practice drill will be helpful, based on the complexity of the work and field conditions;
- evaluate the use of trenchers next to exposed utilities and identifies controls to prevent inadvertent contact;
- ensure that excavation activities meet OSHA and LANL requirements; and
- ensure that the PIC receives an official handoff of the excavation permit package and a walkdown before starting an excavation project and before each PIC change.

Authorized Worker/Operator

An authorized worker/operator has the following responsibilities:

- complete all required excavation training;
- take part in a discussion with the PIC, addressing a visual overview of the utility sketch, potholing plan, scope depth, boundary limits, and controls;
- inspect excavation/fill/soil disturbance equipment before each use;
- inspect potholes before introducing mechanical excavation equipment;
- ensure that a spotter is present, and agree on hand signals with the spotter before beginning mechanical excavation;
- follow required excavation/fill/soil disturbance controls when performing work;
- inspect barriers and signage and obtain approval and a hold point release from the PIC before starting the use of mechaical excavation equipment; and
- when mechanical excavation equipment must be within ~18 inches of fully exposed underground utilities, ensure that fully exposed underground utilities are protected with a plank, shovel, or other physical barrier so that the equipment operator can clearly see and avoid contact. Protect underground utilities when mechanical equipment is closer than 18 inches.

Person in Charge (PIC)

For a complete list of PIC responsibilities, see P101-17.

The PIC coordinates the excavation/fill/soil disturbance activity. Some of the responsibilities of the PIC are listed below:

- provide as-built maps of primary and secondary utilities for all new construction projects to ES-UI-IIT;
- address all SME comments on the EXID permit, the integrated work document (IWD), and pre-job briefing;
- sign the EXID permit, if designated by the project coordinator, as the signatory to whom the permit is issued, and retain a copy of the request and comments onsite, as well as an original map with utility locates marked by ES-UI-IIT;
- ensure that all workers performing excavation activities have completed all required excavation training;
- ensure the proper locations of underground installations or utilities, and ensure that the proper utility group has been contacted;
- conduct pre-job briefings and walkdowns with workers. Pre-job briefings MUST ADDRESS an overview of the EXID permit, scope, depth, boundary limits, utility locate markings, potholing plans, and hold points;
- identify and correct existing and predictable hazards to workers arising from the excavation, surroundings, or working conditions;
- determine and inspect worker protection systems (sloping, shoring, shielding, etc.);
- ensure that air monitoring is conducted for potential hazardous atmospheres;
- approve the design of structural ramps, if used;
- ensure that water removal equipment is installed where needed;
- remain onsite or readily available when excavation work is taking place;
- ensure that excavation activities meet all applicable safety standards and requirements;
- ensure that work progression limits and controls are in place and maintained;
- ensure that the potholing plan is followed (if needed) for potholing activities;
- ensure that the pothole markings of exposed utilities are protected, visible, maintained, and clearly identifiable to all project workers;
- inspect potholes before using mechanical excavation equipment;
- ensure that excavation boundaries are identified and controlled with barriers and postings (see pages 42–43) and that all barriers and postings are maintained. Notify ES-UI-IIT if revalidation and relocation are required because of any discrepancies;
- ensure that all utility markings, PRS boundary markings, and archaeological site markings are maintained;
- manage the fill material and/or spoils according to P101-17; and
- ensure that appropriate utility-specific personal protective equipment (PPE) is worn for each hand-excavated utility.

Alternate PIC

An alternate PIC has the same responsibilities as the PIC. BEFORE assuming responsibilities, the alternate PIC must

- ensure that a permit revalidation is performed;
- review the EXID permit, SME requirements, map/boundary/depth, utility locates/revalidations, and potholing plan;
- receive a formal turnover from the primary PIC, to include a walkdown; and
- brief the crew on the change.

Competent Person

A *competent person* is one who can identify existing and predictable hazards at the site or conditions that are unsanitary or hazardous to workers AND who has the authority to take prompt action to control them. A competent person must be approved by the ISH Excavation/Fill/Soil Disturbance Program Lead. A competent person has the following responsibilities:

- understand the applicable safety standards and acceptable hazard controls for excavations,
- perform visual and manual tests to determine the excavation soil type,
- ensure that the boundaries of excavation work are identified and controlled with barriers and signs (see pages 42–43),
- conduct excavation inspections before authorizing worker entry (see below), and
- document inspections and maintain copies of the inspections at the excavation site.

The *Excavation Inspection Daily Log* form (#2218) can be accessed from the Excavation/Fill/Soil Disturbance homepage or the LANL Forms Center. See page 52 for more information.

A competent person MUST INSPECT the entire excavation site where workers must enter as follows:

- initially before any workers enter the excavation;
- daily and before the start of each shift;
- as dictated by the work being done in the excavation;
- after every rain storm;
- after the soil has frozen or thawed;
- when fissures, tension cracks, sloughing, undercutting, waster seepage, bulging at the bottom, or similar conditions occur;
- when the size, location, or placement of the spoil pile changes; and
- when any change or movement in adjacent structures is indicated.

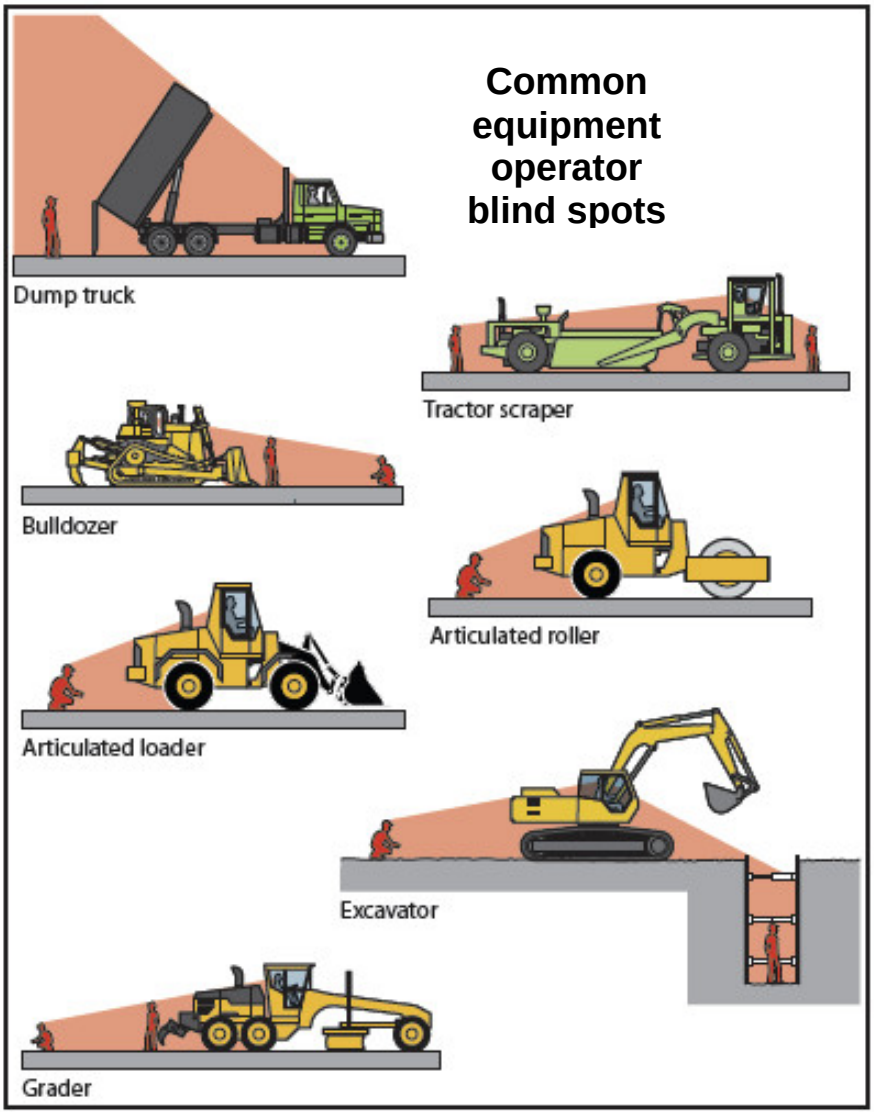
Spotter

A spotter looks for and reports any possible problem during the excavation process. A spotter helps to prevent contact with utilities, prevents accidents caused by backing, and assists the operator with blind spots. A spotter must be aware of the hazards, anticipate situations that may lead to an accident, and understand hand signals.

A spotter assists an operator with a lft *(above* and with digging (below).

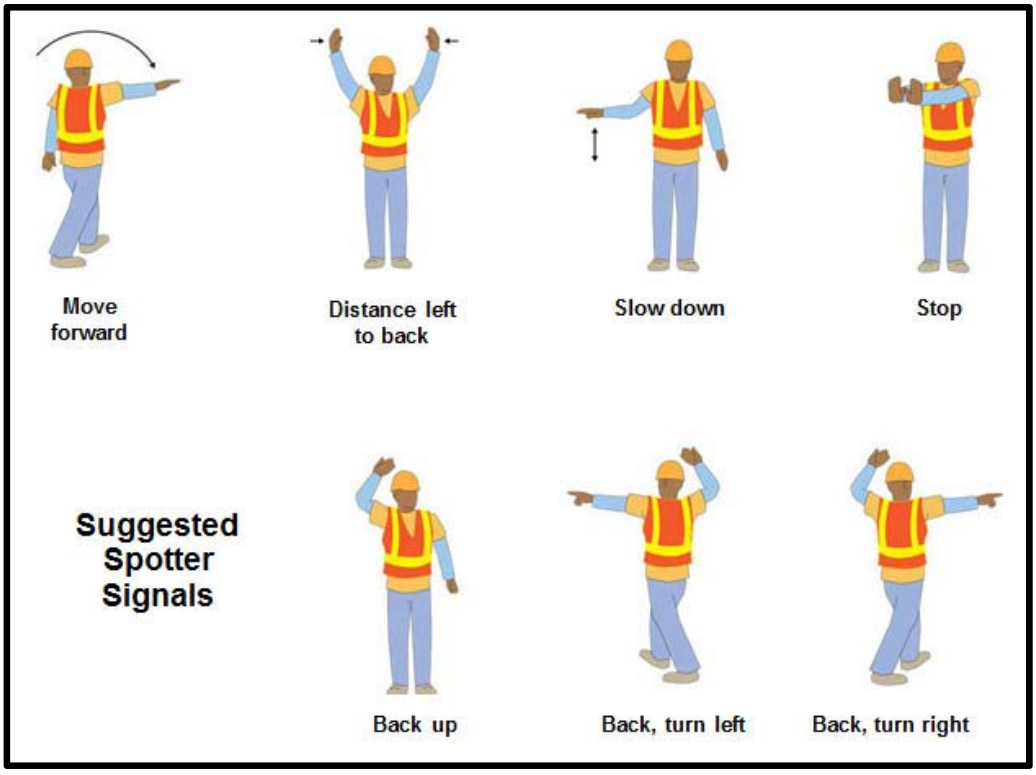
A spotter is used when

- equipment operators are approaching or working near a potholed utility,
- the equipment operator's vision is obstructed, or
- mechanical equipment is working close to exposed utilities.



A spotter has the following responsibilities:

- decide (along with the equipment operator) on the hand signals that will be used before excavation activities begin,
- monitor the position of equipment before and during mechanical excavation,
- maintain visual contact and constant communication with the equipment operator,
- maintain a minimum distance of 5 feet from excavation equipment to avoid machinery contact,
- ensure that equipment is stopped before an inspection is performed,
- DOES NOT use any item (such as mobile phones, earphones, etc.) that may distract from spotting activities, and
- perform NO OTHER DUTIES during the operation.



Potential Release Sites

A PRS can be defined as a location or unit where hazardous material from past activities have been placed and from which a risk of release of hazardous waste or hazardous waste components may exist. A solid waste management unit (SWMU) is an example of a PRS, as is an area of concern (AOC).

P101-17 requires that excavation/fill/soil disturbance projects conducted within the boundary of a PRS address (as applicable) the following requirements:

- a site-specific safety plan;
- limited site access;
- industrial hygiene monitoring;
- PPE;
- radiological surveillance;
- medical surveillance; and
- compliance with federal, state, and LANL regulations, requirements, and training.

Excavation of Materials Disposal Area B, a potential release site at LANL.

In addition, the following requirements must be met when excavating within a PRS:

- vacuum truck potholing within a known PRS must be evaluated through the EXID permit review process;
- documentation of the activity, to include the length, width, depth, location, and amount of soil excavated/disturbed, must be maintained;
- copies of the waste characterization and disposal records for any soil or other material removed from the excavation must be maintained;
- all fill/soil excavated must be managed within the boundary of the PRS and, upon completion, should be returned to the precise point and depth of excavation;
- any removed soil or material that is not returned to the excavation must be managed, characterized, and disposed of in accordance with P409, *LANL Waste Management*, unless it can be demonstrated to be free of contamination;
- no excavated material may be removed from the immediate site until an excavation/fill/soil disturbance review has been completed and any requirements from SME comments are met;
- documentation of the final disposition of any soil or material that is removed from the excavation location must be retained;
- soils and materials must NOT be allowed to be dispersed from the site by wind, storm water runoff, vehicle or pedestrian traffic, etc.;
- wastewater (including potable water and storm water) cannot be discharged from the PRS to the environment without first meeting federal and state regulations;
- storm water retention ponds cannot be located within the boundary of a PRS, nor can a retention pond be constructed of fill material from a PRS; and
- storm water and soil erosion controls must be in place before the start of any soil disturbing activities within a PRS to minimize potential contaminant migration.

LANL-Specific Excavation Controls

More information about specific locations and controls can be found in LANL P101-17.

Specific locations and controls that affect excavation/fill/soil disturbance activities at LANL are presented on the pages shown in the table below.

The location or control regarding…	…is found on page…
Pre-job briefings and walkdowns	39
Hold points	39
Soil transfer and fill management	40
Use of powered mobile equipment near excavations	41
Barricades and signs	42-43

Pre-Job Briefings and Walkdowns

Pre-job briefings and site walkdowns are used ensure that the PIC and the workers understand the scope of the work, the tasks that will be performed, and the conditions in which the work will take place. Pre-job briefings MUST ADDRESS

- an overview of the EXID permit;
- scope, depth, and boundary limits;
- utility locate markings;
- potholing plans; and
- hold points.

Hold Points

Planners must specify excavation hold points in writing. An excavation hold point can be released by the PIC only after conditions have been assessed based on a field walkdown. More than one hold point may be needed for complex work, such as when mechanical equipment is introduced or when certain distances or depths are reached. Some hold points may trigger walkdowns with specified personnel, such as operators, spotters, or locators.

Soil Transfer and Fill Management

Fill material is often concrete, asphalt, or dirt from other LANL projects.

Any fill or material transfer project located on LANL property or within a PRS requires *an EXID permit that specifies the origin and destination* of the fill or material to be transferred. If the original EXID permit does not address fill or material transfer in the scope of work, a separate EXID permit must be requested. The following requirements apply to fill or material transfer projects at LANL:

- Excavated soil must be staged as depicted on the map and returned to the point of excavation upon completion of the project.
- Any soil removed from the excavation that is not returned to the excavation must be managed according to P101-17 and LANL waste management procedures.
- Fill material must not be placed in a watercourse and must not create a public nuisance or impact the environment.
- Fill material must be free of contamination. Fill material or soil might be contaminated if
    - activities at the location of origin, such as a parking lot or a product storage area, might have contaminated the material;
    - the material looks stained;
    - the material came from a radiological control area; or
    - the material has an unusual odor.

  Note: *If any of the above conditions apply or there is other reason to suspect material contamination, the material must be managed as waste until testing is performed and results are received. P101-17 has information about how to request analysis of suspect material.*
- Before moving any excavated material from one TA to another within LANL, the FOD/designee at the receiving location must approve the transfer request, in writing, on the EXID permit.
- Before fill material or soil is released offsite from LANL, documentation must state that the fill material or soil is not contaminated and a request must be made for written approval. P101-17 has information about whom to contact for the offsite release of material.
- NEVER abandon excavated material, debris, or equipment onsite at LANL! Upon completion of a project, excavation materials from the project must be taken care of in one of the following ways:
    - send clean concrete, asphalt, or soil to the Los Alamos County Landfill for recycling;
    - send clean soil to the Clean Fill yard;
    - use clean concrete, asphalt, or soil onsite at LANL;
    - manage contaminated excavated material as waste; or
    - submit a request for a different option.

  Note: *Each of these options has specific requirements and approvals. See P101-17 for more information.*

Use of Powered Mobile Equipment Near Excavations

Powered mobile equipment includes backhoes, track hoes, concrete trucks, and trucks removing excavated material. Such equipment may expose workers to hazards when they are used near an excavation site. Equipment placed close to the edge of an excavation may cause the excavation walls to become unstable because of the additional load and vibration placed on the excavation.

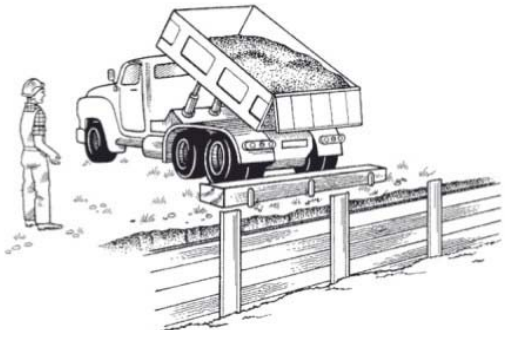
Regulations that address the use of powered mobile equipment near an excavation include the following:

- equipment can operate near the edge of an excavation if a support structure, designed to consider the overload from the equipment, is used;
- equipment operating near the edge of an excavation must have a rollover protective structure (ROPS);
- workers can ride on equipment ONLY using approved seats;
- workers are NOT allowed to work under raised loads;
- operators may stay in their equipment during loading and unloading if the equipment has a cab shield or canopy;
- workers must wear high-visibility clothing, such as warning vests, when working around mobile equipment;
- if the operator's view of pedestrians, structures or utilities is compromised, a spotter must be used;
- workers must maintain a safe distance from moving equipment and any equipment that is being loaded or unloaded. Operators must be aware of all workers near their work area; and
- portable lighting may be used as needed to allow operators to see the excavation in dark conditions.

(Above) A ROPS is required for equipment operating near the edge of an excavation. *(Below)* A cab shield or canopy allows operators to stay in their equipment during loading and unloading.

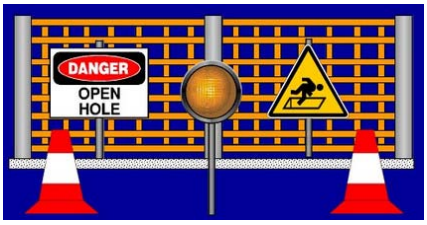
To prevent powered mobile equipment from falling into the excavation:

- install barricades,
- use hand or mechanical signals,
- install stop blocks *(shown at right), and*
- grade soil away from the excavation.



Barricades and Signs

Barricades and signs, which are required by P101-7, are used to



- identify excavation area boundaries;
- help ensure the safety of excavation workers and nearby personnel;
- ensure the segregation of potholing activities and areas approved for the introduction of mechanical excavation equipment;
- control simultaneous excavation-related activities within the boundary area; and
- help ensure a clear understanding of the activities allowed within a certain area.

The PIC is responsible for using barricades and signs to control work activities according to site conditions and the complexity of collocated work. P101-17 contains examples of acceptable barricades and signs for excavation activities at LANL and identifies the following requirements:

- barricades and signs must remain in place and legible throughout the duration of the project and must be easily removable in case of emergency;
- barricades, guardrails, or fences must be installed between excavations and nearby walkways, roads, paths, or other traffic areas. *The use of barricade tape alone is NOT considered a sufficient method of isolation when the excavation is unattended.*
- Wells, holes, pits, potholes, and similar excavations must be barricaded or covered and posted. Covers must be strong enough to prevent a person from falling into the well, hole, or pit.

Examples of acceptable signs for excavation activities at LANL.

Examples of acceptable barricades for excavation activities at LANL

Abnormal Events and Emergencies

Examples of abnormal events include, but are not limitied to

- damaging a utility;
- finding a utility not identified in the permit package;
- finding unexpected material, contamination, or equipment;
- finding archaeological deposits or human remains;
- finding a utility or structure marked in the wrong location; and
- exposing or damaging a secure communication line (see next page).

If archaeological deposits or human remains are found, stop work and contact the LANL **Cultural Resources Team** at 5-8855.

If an abnormal event occurs, the PIC must ensure that

Initial abnormal event actions

- work is paused or stopped,
- personnel are removed from the immediate area,
- the proper personnel and organizations are notified, and
- the area is barricaded to a safe distance.

After initial abnormal event actions:

Follow-up abnormal event actions

- the FOD or Emergency Response personnel begin corrective measures;
- personnel not trained for emergency response, such as utility locators, must NOT enter the area until allowed by the PIC;
- utility locators must NOT direct connect to a severed utility line until the line has been safety isolated by an SME and isolation has been confirmed by the PIC; and
- any severed utility line that was not identified within the EXID permit must be located to the beginning and ending source and then incorporated into the Geographic Information System map database.

Secure Communication Lines

Secure communication lines and cables are marked with a red band every 5 feet and are buried using the following methods:

- duct bank encased in concrete along unsecure communication lines,
- inner duct,
- polyvinyl toluene (PVC) conduit, and
- direct buried cable.

If a secure communication line is exposed or damaged at any time during potholing, excavation, or any other soil disturbance, IMMEDIATELY notify the Protected Transmission System (PTS) personnel at 665-1795. PTS personnel will then determine what protective measures will need to be implemented.

If a secure communication line is exposed or damaged, IMMEDIATELY call **Protected Transmission System (PTS) personnel** at 665-1795.

Emergencies

If a worker is trapped or seriously injured, call 911 and then notify your supervisor. DO NOT place yourself at risk by attempting to rescue someone trapped because of a cave-in unless you are trained to perform trench rescues.

While waiting for emergency response personnel, consider the following actions:

- try to identify the location of the victims if they are not visible;
- dig by hand to locate the victim if the excavation is stable and can be approached safely. To avoid causing additional injury to the victim, DO NOT dig with mechanical equipment; and
- assemble materials that can help with a rescue, such as shovels, plywood, ladders, and buckets.

Module 3: LANL Potholing Requirements

Module Objectives

When you complete this module, you will be able to recognize

- requirements for excavation potholing at LANL, including methods, locations, and intervals;
- mechanical excavation limitations at LANL;
- what to do if you fail to find utilities while potholing;
- color coding of utility markings for proposed excavations; and
- how to contact or access LANL excavation resources.

Potholing Methods, Locations, and Intervals

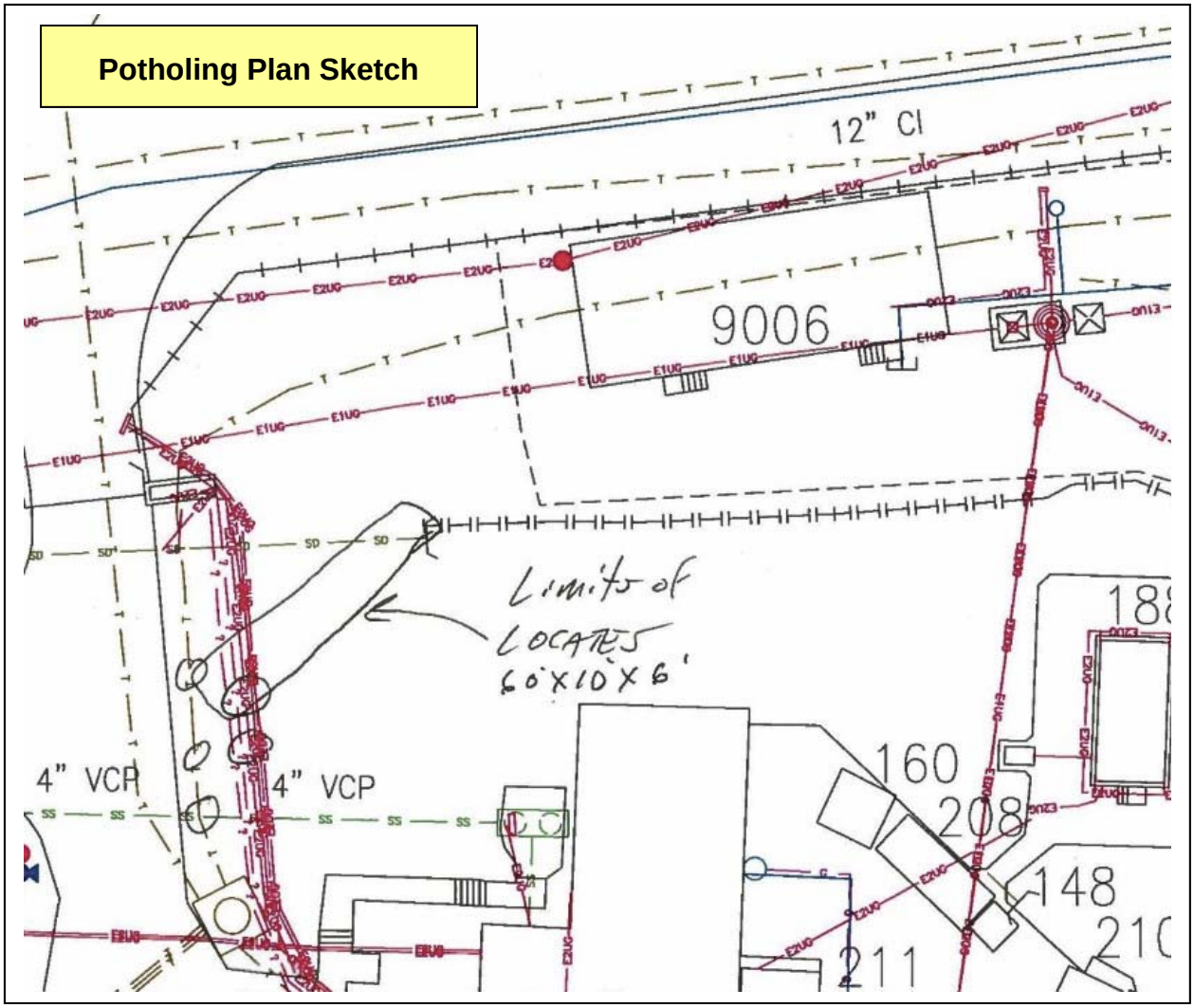
Potholing is the practice of digging one or more test holes using hand tools or vacuum excavation equipment to find out exactly where and how deep an underground utility is located. LANL requirements for potholing are found in LANL OSH-ISH-FSD-OP-003, *Potholing Procedures*.

A **potholing plan** is a sketch that shows where existing buried utility lines are located within and near the excavation boundary. A potholing plan is **required** whenever known buried utility lines exist within an excavation boundary or within 5 feet outside the boundary. Potholing is performed outside of the excavation boundary to confirm line locations and allow mechanical excavation equipment up to the boundary edge. A potholing plan must

- include a sketch or drawing of the
  - o located underground utilities,
  - o excavation boundaries, and
  - o locations of all potholes to be made;
- be signed and dated by the PIC and Infrastructure Information Team (IIT) representative;
- be attached to the work package and be available at the work site; and
- be included with the EXID permit package when underground utility lines have been located.

Potholing is used to find buried utility lines.

All potholing must follow the potholing plan. Valves, manholes, and vaults can be used as potholes. Any changes must be discussed and approved by the safety professional assigned to the project and the PIC and then documented in the Potholing Plan. Workers must be briefed on the potholing plan during the pre-job briefing.



A potholing plan must have a sketch *(as shown above)* that shows located underground utilities, excavation boundaries, and the locations of all potholes to be made. A potholing plan may also have a series of questions in the form of a checklist *(shown below).*

Questions that are asked when developing a potholing plan include

- Are all underground utilities and the excavation boundary sketched?
- Are potholes proposed at utility entrance and horizontal points?
- Are potholes proposed for utility lines within 5 feet outside of the excavation?
- Are additional potholes required due to a sloped excavation area where utility depths may vary?
- Were excavation workers briefed on the pothole plan?
- Are potholing plan deviations/exceptions approved and documented?
- Do any utility lines parallel the excavation?

Potholing Methods

In most cases, potholing must be performed manually with handheld tools, such as shovels, or with vacuum excavation*. Each method has limitations and restrictions.

Manual (hand) potholing is the use of hand tools, such as shovels, picks, and digging bars, to locate buried utilities. Care must be taken while hand excavating beside any utility line because shovels, picks, and digging bars can damage utility line materials. If hand digging will be performed near known electrical lines, the responsible FOD Electrical Safety Officer must assess the situation and then review and approve the proposed controls.

Vacuum potholing is one of the safest methods to locate buried utilities. Vacuum potholing uses water to create a slurry that is then removed by a vacuum system. Vacuum truck potholing within a known PRS is allowed ONLY if it is evaluated and approved through the EXID permit review process.

Manual potholing *(above)*, vacuum potholing *(below).*

*Potholing with mechanical equipment, pneumatic (compressed air) tools, hand augers, and electric-powered tools is NOT allowed UNLESS

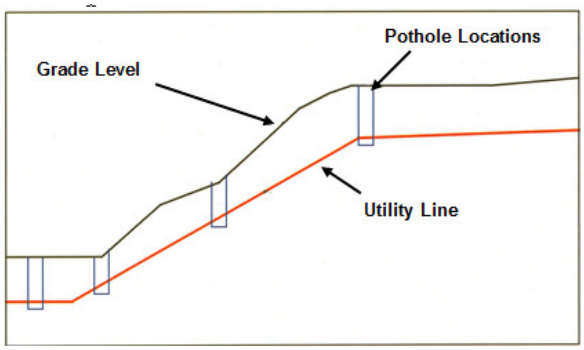
- the depth of the utility line exceeds the limit of hand or vacuum excavation AND
- the use of such equipment is specified in the potholing plan.

Once digging is within 18 inches of the anticipated location of the utility, hand tools or vacuum equipment must be used. The potholing plan may also include the use of jackhammers and/or asphalt/concrete saws as needed. See OSH-ISH-FSD-OP-003, *Potholing Procedures*, for more information.

Potholing Locations and Intervals

- Potholes are required at all vertical and horizontal utility angle points.
- Additional potholes are required where utility depths are unknown or in sloped excavation areas where utility depths may vary.
- Potholes must be large enough for IIT members to visually verify the material, utility type, and size of the utility.
- If potholes must be covered because of traffic or other safety issues, they must be marked with a PVC pipe (or other suitable method) that indicates the location, depth, utility type, size, and material of the utility line. If marking is not possible, the pothole can be surveyed using a Global Positioning System (GPS) receiver and documenting the coordinates. See OSH-ISH-FSD-OP-003, *Potholing Procedures* for specific requirements that must be met if a GPS method is used.

  Note: *IIT must visually inspect and approve potholes before they are covered.*
- At sites where workers are potholing next to areas where the use of excavation machinery has been approved, signs and barricades must be set up to separate the areas clearly to prevent the use of excavation machinery in areas not yet approved for mechanical excavation.



More potholes are required in sloped areas where utility depths may vary *(above)*. Potholes must be large enough to verify utility type and size. *(below).*

Signs must identify areas where excavation machinery is and is not allowed to be used.

- Potholes must be located at 5-foot intervals for **nonconductive** lines located within 2 feet of the excavation boundary (or the nonconductive lines can be fully exposed for the entire length).
- Potholes must be located at 5-foot intervals when existing utility lines parallel the excavation and an existing **conductive** line is located within 5 feet outside of the excavation boundary,

  Note: *The system engineer or system SME must be consulted when the pothole intervals affect the integrity of piping joints on pressurized utility lines.*

- If an existing utility runs perpendicular across a trench, the location and depth of the utility must be identified across the entire width of the trench. In such cases:
  - for trenches up to 3 feet wide, potholing must fully expose perpendicular utilities.
  - for trench widths more than 3 feet wide, potholes must be dug at the entrance and exit points on both borders of the excavation trench, at a minimum. More potholes may be required by the PIC.

Utility running perpendicular across a trench *(above)*.

- All obstructions to be removed within the excavated area must first, before removal, be hand excavated to determine their relationship to existing marked utilities, guy wires, anchors, bollards, fence posts, etc.
- Personnel working near potholes must be protected from pothole hazards by the installation of fences, barricades, or adequate covers at each completed open pothole if a danger of falls exists.
- Fully exposed utilities may need to be protected, supported, or removed to protect workers and utilities.

Fully exposed utilities may need to be be protected, supported, or removed.

Mechanical Excavation Limitations at LANL

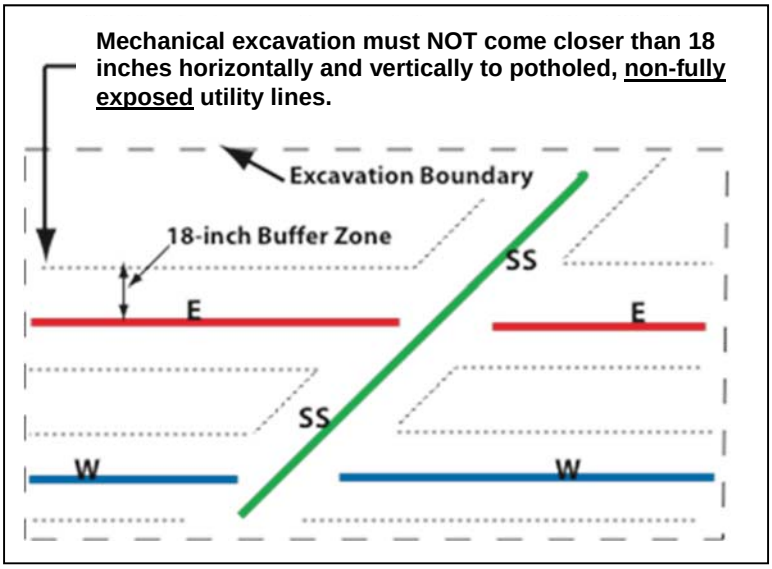
NO excavation machinery is allowed within 5 feet of the excavation area, and mechanical excavation is NOT allowed UNTIL

- the IIT representative has inspected the potholing, verified in writing on the potholing plan that potholing is complete, and signed the potholing plan authorizing mechanical excavation; AND
- the PIC or designee has authorized the start of excavation.

Non-fully exposed lines

Mechanical excavation must NOT come closer than 18 inches horizontally and vertically to potholed, ***non-fully exposed*** utility lines. All excavation within 18 inches vertically or horizontally to a potholed, non-fully exposed utility line must be performed by hand or vacuum excavation.

W – water line
E – electric line
SS – sewer system



Fully exposed lines

Mechanical excavation may be performed within 18 inches of a ***fully exposed*** line IF the line is protected with a physical barrier such as a plank or shovel that the equipment operator can clearly see and so avoid contact with the line.

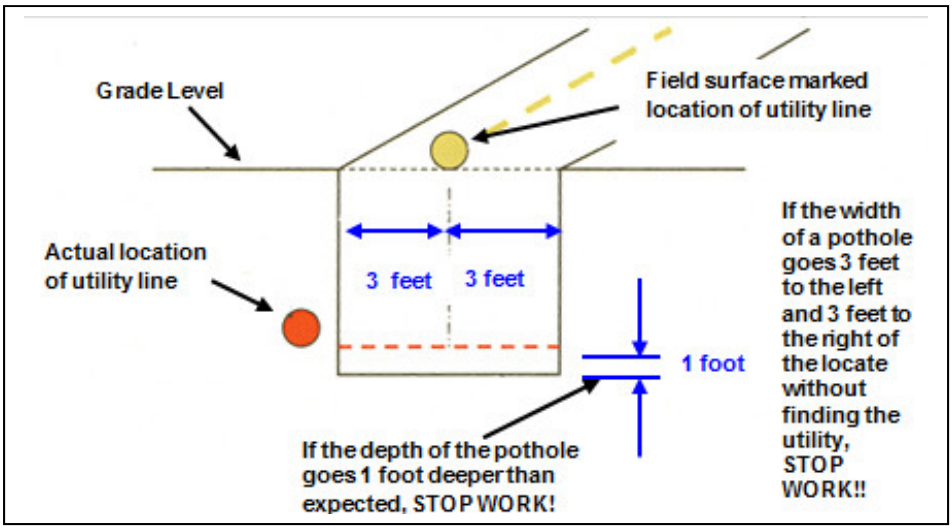
At right, a digging bar is used to help the equipment operator avoid contact with the exposed electrical conduit.

Failure to Find Utilities

If a pothole is dug 1 foot deeper than the expected location of the utility, STOP WORK and call the IIT locators for remarking.

If a pothole is dug 3 feet to the left AND 3 feet to the right of the locate mark without finding the utility, STOP WORK and call the IIT utility locators for remarking.

Note: *To contact the IIT utility locators, call 665-1051.*



Color Coding of Utility Markings

Utility locate marks must be maintained before and during the excavation process. LANL uses the color code of the American Public Works Association (APWA) for the temporary marking of underground utilities. APWA color coding is shown at right.

Spray paint, flags, and whiskers are used to mark anticipated utility locations. At LANL, always use APWA color coding.

APWA Uniform Color Code

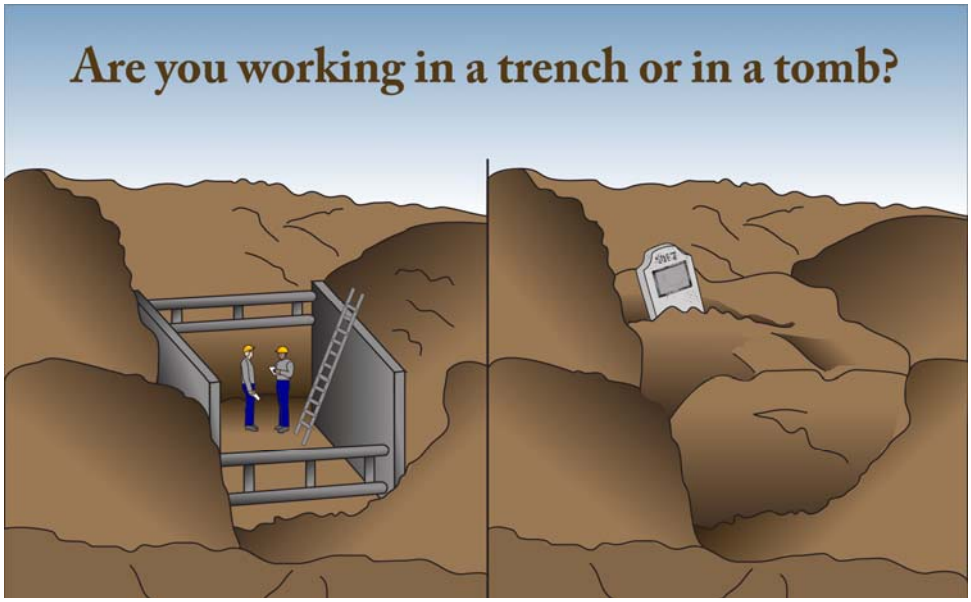
- White - Proposed Excavation
- Pink - Temporary Survey Markings
- Red - Electric Power Lines, Cables, Conduit and Lighting Cables
- Yellow - Gas, Oil, Steam, Petroleum or Gaseous Materials
- Orange - Communication, Alarm, or Signal Lines, Cables or Conduit and Traffic Loops
- Blue - Potable Water
- Purple - Reclaimed Water, Irrigation and Slurry Lines
- Green - Sewer and Drain Lines

LANL Excavation Resources

Refer to the LANL Excavation/Soil Disturbance Safety homepage at http://int.lanl.gov/safety/industrial_hygiene_and_safety/ihs_programs/excavation-soil-disturbance-safety.shtml for access to the following:

- LANL P101-17 *Excavation/Fill/Soil Disturbance,*
- LANL OSH-ISH-FSD-OP-003, *Potholing Procedures,*
- Excavation/Fill/Soil Permit Review Request, and
- Excavation Inspection Daily Log form (#2218).

To contact…	…call…
the LANL Soil Disturbance Review Team (SDRT)	665-SOIL (665-7645)
the Infrastructure Information Team (IIT) IIT also provides utility locates for emergencies, such as for a major break in a utility.	665-1051 (normal workday) OR 665-4763 (after hours)
Emergency Management	667-6211
the LANL Cultural Resources Team (if archaeological deposits or human remains are found)	665-8855
Protected Transmission System (PTS) personnel (in case a secure communication line is exposed or damaged)	665-1795



Answers to Activities

Laborer Injured by Backhoe (page 4)

Actions that could have reduced the risk of accident:

- Ensure that personnel are trained to work safely around heavy equipment and are knowledgeable of communication methods such as hand signals.
- Ensure that the operator visually verifies the location of all personnel before operating heavy equipment.
- Review project roles, responsibilities, hazards, and controls during pre-job briefings.
- Ensure that the spotter stays at least 5 feet away from moving excavation equipment.

Answers to Questions Accompanying Pictures (pages 22–24)

Excavation Picture 1 (page 22)

- No safety vests are worn.
- No barricades or signs are seen around the excavation.
- No indication of locates or potholing.
- Additional hazards and controls must be considered.
- Noise concern—is hearing protection needed?

Excavation Picture 2 (page 22)

- The stepladder is used incorrectly for access/egress.
- Housekeeping could be improved.
- Barricades and signs do not comply with P101-17.
- One person in the background is not wearing a hardhat.

Excavation Picture 3 (page 23)

- Workers are not wearing hardhats.
- No proper means of egress is visible.
- Water has accumulated in the excavation, but no water controls (such as pumps, shielding, or worker safety harness and lifeline) can be seen.

Excavation Picture 4 (page 23)

The hole that the pallets are covering is unmarked. Flags and/or caution tape could be used to warn personnel of a fall hazard.

Excavation Picture 5 (page 24)

Yikes! The worker in the trench is using a tamper (which creates vibrations that can increase the risk of a cave-in) beneath a large weight, which also increases the risk of a cave-in.

Excavation Picture 6 (page 24)

This excavation looks good! Notice the pylons to warn vehicle traffic and the caution tape to warn pedestrian traffic. Personnel are wearing safety vests and hardhats, and the housekeeping looks pretty good.

References

Code of Federal Regulations. 29 CFR 1926, Subpart P, *Excavations.* US Department of Labor. US Government Printing Office, Washington, DC, 20402.

Los Alamos National Laboratory. Laboratory Procedure (P) 101-17, *Excavation/Fill/Soil Disturbance* (December 2017).

Los Alamos National Laboratory. Occurrence Report. ALO-LA-LANL-PHYSTECH-1995-0006.

Los Alamos National Laboratory. *Site-Wide Excavation Utility Strikes Corrective Action Plan*, PFITS #2017-534 (May 2017).

Failure to Dig Potholes Leads to Breached Electrical Line

In August 2016, a construction subcontractor and team excavating an area at the Pittsburgh Energy Technology Center with a backhoe and shovels during a water line installation project when they hit an underground electrical conduit. The conduit was breached, and a 110-volt electrical line was severed. A digging permit had been obtained before excavation operations began, and the electrical conduit had been indicated on the soil's surface. No potholes had been dug for locating underground structures, lines, or equipment. An appropriate utility detection service had not been used to verify if any utility lines were present. The lines had not been locked and tagged out before excavation activities began.

-from ORPS Report FE--NETL-GOPE-NETLMGN-2016-0004

Taking the Quiz

To receive credit for this self-study, you must complete the associated quiz in UTrain. You can access the quiz in either of two ways.

CRYPTOCard

If you have a CRYPTOCard that is assigned to you with administrative authorities to LANL's Integrated Computing Network (ICN):

1. Click on the link below to return to UTrain.
2. Click on the "Return to Content Structure" button.
3. Click on the "Quiz" link to begin the quiz.

To return to UTrain, click on the following link:

http://int.lanl.gov/training/tools/wrapper/submit.html

No CRYPTOCard

If you *do not* have a CRYPTOCard or if you have a CRYPTOCard *without* administrative authorities to LANL's ICN, you will need to locate a worker with UTrain proxy authority to grant you access to the quiz.

Call or email your training administrator for assistance. The following link should help you find your training administrator.

http://int.lanl.gov/services/training/admin-proctor-proxy.shtml