

Chapter 3 Excavation, Removal, and Off-Site Disposal

3-1. General

The process of excavation of contaminated solids/sludges, dewatering, pretreatment, and technology applications are briefly discussed in the first section of the chapter. The second portion of the chapter is a hazard analysis with controls and control points listed.

3-2. Technology Description

a. Process.

Contaminated solids/sludges are excavated, dredged, or pumped from surface or sub-surface areas, typically staged for loading (treated if required), and loaded into transport vehicles for shipment to an approved receiving facility (usually a licensed land-fill). Soils can be excavated with backhoes, front loaders, continuous excavators, scrapers, or other equipment. Sludges can be removed with open-face (impeller) centrifugal pumps, backhoes, or similar equipment. Submerged sediments are often removed using a dredge.

Material may be dewatered during staging operations. Settling and decanting, filter or belt pressing, or centrifuging, if needed, can perform dewatering.

Pretreatment (stabilization, fixation, or encapsulation) of material may be required to bind free water and prevent leachate development from the excavated wastes once disposed of off site. Pretreatment processes are usually done during staging. Liquids generated during dewatering may also require treatment prior to shipment or discharge.

Loading may be direct (e.g., from the bucket excavator) but is more typically done with front-end loaders after stockpiling, classifying, and pretreating solids and sludges. Waste materials are typically disposed of in permitted treatment, storage and disposal facilities (TSDFs).

b. Applications.

Landfill disposal typically requires that no free liquid be present in the material or that the materials meet TCLP (Toxic Characteristic Leaching Procedure) leaching criteria, or both. Volatile organic compounds (VOCs) may be volatilized from the solids or sludges during excavation; consequently excavation, transport, and disposal off site are not usually appropriate for wastes high in hazardous volatiles such as BTEX (benzene, toluene, ethylbenzene, xylene), ketones, or chlorinated solvents (e.g., methylene chloride) unless pretreated in some manner to minimize volatile loss to the environment. Semi-volatile organic materials and inorganic contaminants can also be released into the air as particulate matter.

3-3. Hazard Analysis

Principal unique hazards associated with excavation, removal, and off-site disposal, methods for control, and control points are described below

a. Physical Hazards.

(1) *Equipment.*

Description. During soil excavation, workers may be seriously injured or killed by heavy equipment such as front-end loaders and scrapers. This equipment may also generate excessive noise during operation.

Control. Controls for equipment hazards include:

- Use heavy equipment with a backup alarm to alert workers.
- Approach operating equipment from the front and within view of the operator, preferably making eye contact.
- Wear hearing protection when working around operating equipment.
- Train workers in the potential operational hazards and the safety features provided for heavy equipment operation.

CONTROL POINT: Construction, Operations, Maintenance

(2) *Fire and Explosion or Utility Hazards.*

Description. During excavation into soil contaminated with explosive, flammable, or combustible materials (e.g., carbon disulfide, hydrogen sulfide, methane) under unusual or extraordinary conditions, the bucket of a backhoe or cutting blade of a crawler may spark from rocks, buried metal, or other objects and ignite a flammable vapor. During excavation, a backhoe or other earth-moving equipment may rupture an underground utility, such as electrical or gas lines, and cause a fire, explosion, or electrocution.

Control. Controls for fire and explosion hazards include:

- Train the operators in the hazards of excavating in highly flammable or explosive material and in the vicinity of underground or overhead utilities.
- Train the operators in emergency procedures in the event of a catastrophic event, in life saving first aid procedures for electrocutions, burns, and extinguishing flames, extracting, extinguishing and stabilizing victims, and in emergency excavation isolation procedures.
- Locate underground electrical utilities using electromagnetic surveys, inductance surveys, installation maps and drawings, locating services, interviews with utilities personnel, and hand excavation prior to machine excavating.
- Adhere to the excavation safety requirements of 29 CFR 1926.650-652.
- Equip earth-moving equipment with a non-sparking bucket or blade when highly flammable excavation environments are suspected.
- Wet or foam the active work area periodically with water or a foam fire suppressant to prevent vapor ignition. The addition of foam to control vapors

may also create a slip and fall hazard. Do not allow workers where foam has been applied.

- Conduct area monitoring when airborne combustible chemical concentrations may reach Immediately Dangerous to Life or Health (IDLH) or potentially exceed 10% of the Lower Explosive Limit (LEL).

CONTROL POINT: Design, Construction, Operations

(3) *Excavation Wall Collapse or Flooding.*

Description. Entry into an excavation may expose workers to confined-space atmospheric dangers and risk of excavated wall collapse. Flooding of an excavation may cause drowning or electrocution if electrical equipment is in use.

Control. Controls for wall collapse or flooding include:

- Wear inflation vests, use lockout procedures for wet environments, and develop a plan to evacuate workers in basins or impoundments with the potential for rapid flooding where other means of controlling the water hazards are not available.
- Slope the walls of all excavations greater than 5 feet away from the edge or properly shore in accordance with Occupational Safety and Health Administration (OSHA) guidance (29 CFR 1926.650-652).
- Do not allow workers to enter an unstable excavation.
- Provide excavation/trench emergency egress at distances not to exceed every 25 feet of the excavation/trench perimeter. See EM 385-1-1, Section 25.
- Train workers in the unique hazards of excavations, including wall collapse, and in recognized hazard controls such as sloping or shoring the sides prior to worker entry. See EM 385-1-1, Section 25.

When confined-space hazards are known or suspected, appropriate health and safety steps include:

- Ventilate the area and perform entry using confined-space procedures and supplied air (29 CFR 1926.21) for eliminating the hazard.
- Implement a confined-space atmospheric testing program using an oxygen meter, combustible gas meter, and other gas-specific meters as part of the confined-space entry program. A confined space is defined as any space with the potential to hold toxic, asphyxiant, or explosive concentrations of gas whether more dense (e.g., sump, basement, tank, or excavation) or less dense (e.g., low canopy or roofed tank) than air.
- Follow confined-space entry procedures (29 CFR 1926.21) for excavations greater than 4 feet. Regardless of the depth, a competent person must assess the excavation prior to each entry.

CONTROL POINT: Design, Construction, Operations

(4) *Skin Puncture/Cut Hazards.*

Description. Workers may also be exposed to skin puncture and cut hazards during the excavation and transport of sharp or abrasive objects contained in waste material.

Control. Controls for skin puncture/cut hazards include:

- Use personal protective equipment (PPE), including boots and gloves made of cut-resistant, puncture-resistant materials. Work boots should be equipped with steel-reinforced shanks to help prevent puncture when walking over waste materials.
- Handle materials with appropriate equipment, not hands or feet, to avoid injury.
- Carefully remove materials posing a clear potential hazard (e.g., framing lumber with nails, broken glass) to avoid later, inadvertent contact hazards.
- Train workers in the unique waste material handling hazards associated with the excavation of the materials.

CONTROL POINT: Construction, Operations, Maintenance

(5) *Steam Pressure Washing.*

Description. Steam pressure washing of equipment may expose workers to thermal, burn or injection hazards, eye hazards from flying projectiles dislodged during pressure washing, slip hazards from wet surfaces, and noise hazards.

Control. Controls for steam pressure washing include:

- Use insulated gloves (e.g., silica fabric gloves) and keep all body parts away from the ejection point of the steam pressure discharge nozzle.
- Wear safety goggles and hearing protection.
- Equip the washer with a deadman or kill switch if not provided by the manufacturer.
- Wear slip-resistant boots.
- Drain water away from decontamination operations into a tank or pit. Drain walking surfaces and keep free of standing liquids and mud.
- Only allow trained and authorized operators to operate the steam pressure washing equipment.

CONTROL POINT: Construction, Operations

(6) *Unstable Soil Conditions.*

Description. Operating heavy equipment over unstable ground (ground that has been affected by pumping or involved in subsurface treatments) may cause the ground surface to subside or sink. The result may cause an injury to the operator of the equipment or to nearby workers.

Control. Controls for unstable soil conditions include:

- Use a qualified engineer to assess soil to ensure safe site conditions for equipment operation.
- Only allow trained and authorized operators to operate the equipment.

CONTROL POINT: Design

(7) *Respirable Quartz Hazard.*

Description. Depending on soil types, exposure to respirable quartz may be a hazard. Consult geology staff to confirm the presence of a respirable quartz hazard (e.g., to determine if soil types are likely to be rich in respirable quartz). As an aid in determining respirable quartz exposure potential, sample and analyze site soils for fines content by ASTM D422 (R2002): “Standard Test Method for Particle Size Analysis of Soils” followed by analysis of the fines by X-ray diffraction to determine crystalline silica quartz content.

Control. Controls for respirable quartz hazards include:

- Wet the soil periodically with water or amended water to minimize worker exposure. Consult 29 CFR 1910.1000, Table Z-3, to calculate acceptable respirable dust concentrations based on percent silica in the quartz.
- Use respiratory protection, such as an air-purifying respirator equipped with a N, R or P100 particulate air filters.
- Train workers in the potential inhalation hazards associated with exposure to crystalline silica quartz containing dust.

CONTROL POINT: Construction, Operations

(8) *UV Radiation.*

Description. During site activities, workers may be exposed to direct and indirect sunlight and the corresponding ultraviolet (UV) radiation. Even short-term exposure to sunlight can cause burns and dermal damage. Hot and humid conditions may also result in heat stress, which can manifest itself as heat exhaustion and heat stroke.

Control. Controls for UV radiation include:

- Minimize direct sun exposure by wearing sun hats, long-sleeved shirts, full-length pants, and by applying UV barrier sunscreen. Loose clothing and sun hats should not be worn around moving parts or close to operating equipment that may snag the worker and draw him or her into a danger zone. All UV skin barrier creams should be pre-approved. Some creams contain zinc and other constituents that can cause false readings in analytical samples.
- Shade the work and break areas if possible.
- Minimize exposure to heat stress by taking frequent breaks, drinking adequate fluids, and working during the early morning and late afternoon hours.
- Use the Buddy System.
- Monitor for heat stress using the physiological or Wet Bulb Globe Temperature (WBGT) Index protocol provided in the most recent publication of the American Conference of Governmental Industrial Hygienists (ACGIH) “TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices.”

CONTROL POINT: Construction, Operations

(9) *Utility Contact Hazards.*

Description. Workers may be exposed to electrocution hazards when working around electrical utilities such as overhead power lines.

Control. Controls for utility contact hazards include:

- Note the location of overhead power lines, either existing or proposed, in the pre-design phase.
- Keep all lifting equipment, such as cranes, forklifts, and dragline rigs at least 10 feet from the power line according to OSHA regulations 29 CFR 1926.550 and EM 385-1-1, Section 11.

CONTROL POINT: Design, Construction, Operations

(10) *Traffic Hazards.*

Description. During field activities, equipment and workers may come in proximity to traffic. Also, drilling rigs and other equipment may need to use public roads. The general public may be exposed to traffic hazards and the potential for accidents during loading and transporting soil.

Control. Controls for traffic hazards include:

- Post warning signs where equipment crosses roads according to the criteria of the "Department of Transportation Manual on Uniform Traffic Devices for Streets and Highways."
- Develop a traffic management plan before remediation activities begin to help prevent accidents involving site trucks and automobiles. EM 385-1-1, Section 21, provides plan details. Equip traffic guides with fluorescent orange or lime green safety vests.

CONTROL POINT: Design, Construction, Operations

(11) *Design Field Activities.*

Description. Design field activities associated with subsequent construction may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminated groundwater sampling, and other actions. Each of these field activities may expose the survey personnel to physical, chemical, radiological, and biological hazards.

Control. Controls for hazards resulting from design field activities include:

- Prepare an activity hazard analysis for design field survey activities. EM 385-1-1, Section 1, provides guidance on developing an activity hazard analysis.
- Train workers in hazards that are identified.

CONTROL POINT: Design

b. Chemical Hazards.

Contamination Hazards.

Description. Workers involved with excavation activities may be exposed to VOCs and particulate matter contaminated with semi-volatile organic or inorganic contaminants, or both. Inhalation hazards are particularly evident during warm and dry periods when there is a greater chance for airborne dusts to be generated. The addition of foam to control vapors or dust may create a slip hazard. Workers may also be dermally exposed to waste materials during excavation and transport of waste materials. Workers may inadvertently ingest contaminants or waste materials that collect on hands and clothing in the form of dust during excavation. Dust may also be ingested when workers take water or meal breaks, or after they have left the work area if established hygiene procedures (e.g., washing hands) are not followed.

Control. Controls for chemical contamination hazards include:

- Use proper types of PPE as necessary. Examples of PPE include nitrile gloves for dermal exposure to petroleum distillates such as gasoline or diesel fuel, an air-purifying respirator equipped with approved N, R or P100 or N, R or P95 particulate air filters, organic vapor (OV) cartridges for vapors, or combination filter/cartridges for dual protection, and chemically resistant disposable coveralls.
- Use experienced workers, repeated health and safety awareness meetings, decontamination stations, and other standard procedures.
- Suppress dust and other emissions using water or foam suppressants if needed. Workers should not walk on areas where foam has been applied.
- Test soils for reactive, highly flammable, or corrosive materials. In extreme conditions (e.g., carbon disulfide CS₂) non-sparking tools and intrinsically safe equipment may be required if emissions are expected to be high.

CONTROL POINT: Construction, Operations

c. Radiological Hazards.

Radioactive Material.

Description. Naturally occurring radioactive material (NORM) is found in all soils, groundwater, and surface water. At typical background levels, this radioactive material poses neither an internal nor an external hazard during excavation, removal, or off-site disposal. Elevated levels of naturally occurring radioactivity, however, have been found in materials such as sewage sludge, fossil fuels, fertilizers, and evaporation ponds. Excavation, removal, or off-site disposal of radioactive material at greater than background concentrations may pose an internal hazard if radioactive particles are inhaled or ingested. Certain devices containing radioactive material may also be present in the soils or rubbish to be excavated and handled (e.g., U.S. Army and U.S. Air Force gauges painted with radium-226, compasses, and radar devices). Intact radium gauges will not yield an unacceptable extremity dose. Broken gauges may present an internal hazard if radium paint chips are inhaled or ingested.

An external hazard may also exist, depending upon the type and extent of contamination. Small particles of uranium metal and some uranium alloys are pyrophoric. They can ignite spontaneously in air as a function of surface to volume ratio. They burn rapidly at very high temperatures.

Control. Controls for radioactive materials include:

- Consult a qualified health physicist whenever significant radioactive hazards above background are suspected.
- Review site history thoroughly for evidence of concentrated NORM or for the presence of devices containing radioactive material.
- Use time, distance, and shielding to control external hazards from ionizing radiation.
- Use PPE to prevent external contamination.
- Use respiratory protection (N, R or P100 particulate air filters) and engineering controls for internal hazards.
- Use decontamination procedures/facilities as necessary to reduce radiation exposure.
- Suppress dust and other emissions as described above for chemical hazards.

CONTROL POINT: Design, Construction, Operations

d. Biological Hazards.

(1) *Biological Contaminants.*

Description. Microorganisms in the groundwater and soil may cause exposure hazards at sites containing medical wastes or sewage sludge. Workers may be exposed to inhalation/ingestion and dermal contact with pathogens such as *Coccidioides sp.*, *Histoplasma sp.*, and *Mycobacterium sp.*

Control. Controls for biological contaminants include:

- Test the microorganisms in the groundwater and soil and determine the appropriate PPE to prevent exposure. The appropriate PPE may include an air-purifying respirator equipped with N, R or P100 or N, R or P95 particulate air filters approved for microbial inhalation hazards. Most rubber gloves (e.g., nitrile or PVC) provide protection against microorganisms; however, the type of glove used must also be compatible with contaminants at the site. The use of latex gloves may aggravate or cause allergic reactions in some people.
- Use dust suppression with water or amended water sprays.
- Enforce (strictly) eating, drinking, and smoking restrictions prior to washing and decontamination. Decontamination with water and or disinfectant soaps may be used to control exposure.
- Wear chemically resistant protective overalls to prevent clothes from becoming grossly contaminated with wastes, soils, and contaminated water. If contaminated clothing is to be laundered, use a commercial laundry familiar with cleaning procedures for industrial clothing. These procedures

include employee hazard warnings and cleaning solution disposal requirements.

CONTROL POINT: Design, Construction, Operations

(2) *Pests.*

Description. Workers may be exposed to a wide array of biological hazards, including snakes, bees, wasps, ticks, hornets, and rodents during any phase of remediation. The symptoms of exposure vary from mild irritation to anaphylactic shock and death. Deer ticks may cause Lyme disease. Rodents can transmit Hanta virus. Mosquitoes can transmit the West Nile virus.

Control. Controls for pests include:

- Periodically inspect the site to identify stinging insect nests and to check for snakes and rodents.
- Use professional exterminating companies for removal.
- Use tick and insect repellents containing N,N-diethyl-m-toluamide (DEET) 25% as an active ingredient, for exposure control. Clothing may be treated with permethrin clothing repellent BEFORE donning, for added protection. Workers should check their skin and clothing for ticks periodically throughout the work day.

CONTROL POINT: Construction, Operations, Maintenance