Excavation and Off-Site Disposal

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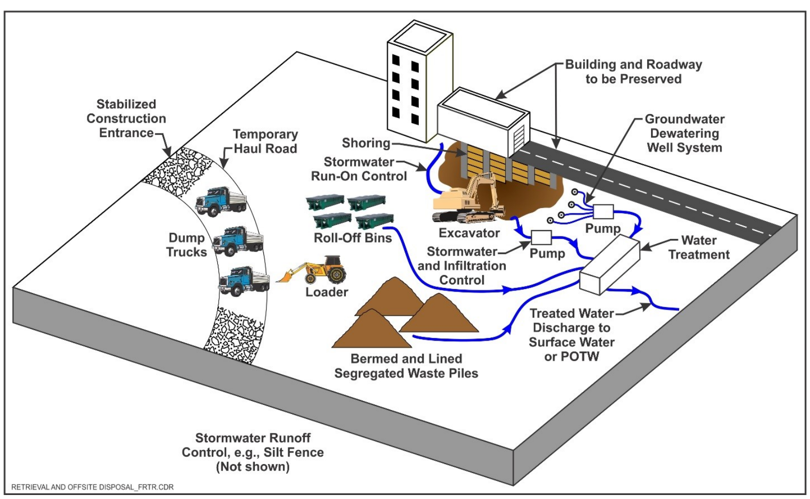
Schematic



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Schematic of Excavation and Off-Site Disposal

Introduction

Contaminated material can be removed and transported to permitted off-site treatment and/or disposal facilities. Some pre-treatment of the contaminated media is sometimes required at the project site or the receiving facility in order to meet land disposal restrictions. This profile focuses on removal of terrestrial media. Subaqueous removal (dredging) is described in a separate profile.

Other Technology Names

Excavation
Dig-and-haul

Description

The excavation and off-site disposal process involves selecting the appropriate method along with the appropriate methods for dewatering, handling, transport, pre-treatment, and disposal. The information below describes these processes. Excavation and off-site disposal is a proven and readily implementable technology. Prior to 1984, excavation and off-site disposal was the most common method for cleaning up hazardous waste sites. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) includes a statutory preference for treatment of contaminants, and excavation and off-site disposal is now less prevalent than in the past. Excavation is the initial activity in all ex situ treatments.

Excavation
Excavation is the mechanical removal of waste or contaminated soil from the subsurface. Mechanical removal is most commonly performed with a variant of an excavator or backhoe. Other earthmoving equipment (e.g., clamshell buckets, bulldozers) may also be used based on the size and configuration of the excavation. Air knife techniques followed by a hi-tech vacuum (e.g., Vactor®, Guzzler®) are used for precise removal of soil from around sensitive structures, utilities, or plant roots.

The rate of excavation depends on a number of factors, including the types of materials being excavated, selected excavation technique, soil type, access constraints to the site, underground utilities or other sensitive structures, and dewatering and slope control requirements, number and size of excavators and loaders, and the number of trucks operating.

Dewatering

Dewatering can refer to control of groundwater in the area of excavation, removal of water (stormwater or infiltrated groundwater) from within an excavation, and draining of excavated material to meet transport and disposal restrictions. All water generated from dewatering requires on-site management, and typically requires treatment prior to discharge. In some cases, the removed water is classified as a hazardous waste and must be managed as such. Portable water treatment systems to manage stormwater at standard grading sites can be used in some cases, but often additional treatment must be performed, and discharge requirements must be met based on the site contaminants and receiving facility (typically storm drains or a publicly owned treatment works [POTW]).

Dewatering for the purpose of minimizing or preventing groundwater from entering the excavation area sometimes can include elaborate and costly systems consisting of well points or large diameter dewatering wells which are continuously pumped to maintain the groundwater level below the bottom of the excavation. Excavation below the groundwater surface in certain soil types can require additional dewatering measures for groundwater control to prevent slope stability failure and less commonly liquefaction ("boiling" or "quick" conditions) in the bottom of the excavation. Some shoring systems such as sheet piling, grouting, soil mixing, or freeze walls (which require experienced contractors with specialized equipment, advanced engineering, accurate drilling, as well as refrigeration and instrumentation equipment) can be used for structural reinforcement and to prevent groundwater intrusion into an excavation.

Dewatering from the open excavation and in stockpile areas is frequently necessary to remove accumulated stormwater that falls as rain directly into the excavation, enters the excavation as overland flow from the adjacent land surface, or infiltrates into the excavation from groundwater. Berms, temporary covers, or other engineering controls are typically used to minimize the overland flow of stormwater entering the excavation.

Dewatering of the excavated waste or soil is often required to meet transport and disposal requirements, which prohibit the discharge of free phase liquids from the waste in transit and require that any liquids be handled separately or stabilized (solidified) prior to land disposal. Dewatering of the excavated soil or waste is commonly performed on a purpose-built dewatering pad, or within roll-off boxes equipped with under-drain systems for removal of water.

Handling and Transport

Soil handling at a cleanup site can range from relatively simple (e.g., direct loading of trucks by the excavator performing the excavation), to very complex (e.g., segregation of hazardous and non-hazardous waste streams, segregation of debris and other waste, lead recovery, on-site stabilization or other ex situ treatments, dewatering, and stockpiling). Planning the soil handling and transport during the design phase is critical to a successful excavation project. For example, sufficient land area must be identified near the excavation to provide for soil handling, and temporary haul roads must be routed around the changing excavation configuration, providing a stable surface for on-road dump trucks that bring them near the load-out area. For some projects a combination of truck and rail transport is warranted. For sites with mixed hazardous and non-hazardous waste with different transport restrictions, careful management of truck traffic and manifesting is necessary. For large projects during peak construction season, securing adequate transport resources (e.g., a sufficient number of trucks each day) should be planned well in advance.

Handling and transport of contaminated soil requires precautions to ensure safety. The tires and exteriors of trucks and other earth-moving equipment are also washed before leaving the site so that the soil is not tracked through neighboring streets. Workers monitor the air to make sure dust and contaminant vapors are not present at levels that may pose a breathing risk, and monitors may be placed around the site to ensure that dust or vapors are not leaving it. Site workers close to the excavation may need to wear "respirators," which are face masks equipped with filters that remove dust and contaminants from the air. Contaminated soil is usually covered until it can be treated or disposed of to prevent airborne dust or being washed away with rainwater. Contaminant vapors may be suppressed with foams or other materials (EPA, 2012).

Pre-Treatment and Disposal

The type of contaminant and its concentration will impact off-site disposal requirements. Soil characterization as dictated by land disposal restrictions (LDRs) is required. Most hazardous wastes must be treated to meet either Resource Conservation and Recovery Act (RCRA) or non-RCRA treatment standards prior to land disposal. Pre-treatment, generally consisting of stabilization by mixing with fly ash or similar amendments to reduce contaminant leaching potential, is often conducted at the receiving facility but is sometimes performed on site under the Treatment by Generator Rule, 40 CFR 262.34. Pretreatment or placement of hazardous waste outside the area of contamination (on site or off site) may require development of a Corrective Action Management Unit (CAMU) so as to not violate LDR requirements. Radioactive wastes would have to meet disposal facility waste form requirements based on waste classification.

The disposal of hazardous wastes is governed by RCRA (40 CFR Parts 261-265), and the U.S. Department of Transportation (DOT) regulates the transport of hazardous materials (49 CFR Parts 172-179, 49 CFR Part 1387, and DOT-E 8876).

Development Status and Availability

The following checklist provides a summary of the development and implementation status of retrieval and off-site disposal:

☐ At the laboratory/bench scale and shows promise

☐ In pilot studies

☒ At full scale

☐ To remediate an entire site (source and plume)

☒ To remediate a source only

☒ As part of a technology train

☒ As the final remedy at multiple sites

☒ To successfully attain cleanup goals in multiple sites

Retrieval and off-site disposal is available through the following vendors:

☒ Commercially available nationwide

☐ Commercially available through limited vendors because of licensing or specialized equipment

☐ Research organizations and academia

Applicability

Contaminant Class Applicability Rating for Retrieval and Off-site Disposal

(Rating codes: ● Demonstrated Effectiveness, ◐ Limited Effectiveness, ○ No Demonstrated Effectiveness,
◊ Level of Effectiveness dependent upon specific contaminant and its application/design, I/D Insufficient Data)

Nonhalogenated VOC	Halogenated VOC	Nonhalogenated SVOC	Halogenated SVOC	Fuels	Inorganics	Radionuclides	Munitions	Emerging Contaminants
●	●	●	●	●	●	●	●	●

Retrieval and off-site disposal is applicable to the complete range of contaminant groups with no particular target group. Excavation and off-site disposal consists of relocating the waste to a regulatory approved waste disposal site. The type of contaminant and its concentration will impact off-site disposal requirements.

Cost

Upfront costs for excavation and disposal can be high compared to in situ treatment technologies. However, excavation can result in substantially shorter restoration timeframes, resulting in lower lifetime costs when operation and maintenance (O&M) and monitoring costs for in situ systems are considered. An overall life cycle assessment of costs can be challenging. A multi-criteria assessment tool for sustainability appraisal of remediation alternatives for a contaminated site methodology is included in the references. Major cost drivers include:

Upfront Costs

- Degree to which existing infrastructure (e.g., buildings, pavement, and utilities) is present within the removal footprint, and must be either removed or protected.
- Need for sufficiently detailed characterization of the lateral and vertical extent to allow accurate and comprehensive design of impacts to the site, and volume of material to be removed, handled, and disposed.
- Degree to which stormwater enters the excavation and stockpile areas, which may increase the water content and therefore transportation and disposal costs of the excavated material.
- Need for sampling and analysis to characterize the waste stream and demonstrate compliance with LDRs.
- Degree to which removed material must be segregated and/or characterized on site during removal.
- Extent of confirmation sampling required, and probability of confirmation sample failures.
- Site climate, which impacts the implementability of removal based on seasonal limitations.
- Type and quantity of backfill, and complexity of site restoration
- The potential need for sequential excavation and backfill to manage groundwater entering the excavation through selective plugging of higher permeability units exposed in upgradient walls and by minimization of the open excavation.

Operation and Maintenance Costs

- There are no O&M costs incurred at the site after excavation is performed. However, on-site O&M might be required to assess residuals associated with follow-on treatment (e.g., treatment of a groundwater plume downgradient of a removed source).
- Off-site O&M required at the disposal facility must be performed over the life of the facility. Activities consist of sampling and analysis and maintenance of containment systems such as dewatering systems, landfill/soil caps, and liners. These costs are associated with the lifetime management of the facility to maintain regulatory compliance and are included in the one-time disposal costs.

The list above highlights those cost dependencies specific to removal and off-site disposal and does not consider the dependencies that are general to most in situ remediation technologies. Click here for a general discussion on costing which includes definitions and repetitive costs for remediation technologies. A project-specific cost estimate can be obtained using an integrated cost-estimating application such as RACER® or consulting with a subject matter expert.

Duration

Durations of removal actions vary widely, depending on factors including volume and accessibility of contaminated media, availability and logistics of waste transport, daily capacity at the receiving facility, and weather. In general, removal and off-site disposal occurs over weeks or months, which is determined by the size of the site, and complexity and requirements of the excavations. Large residential soil removal projects and tailings projects can take years to complete. However, excavation and off-site disposal generally is faster than many in situ technologies which can take years to meet cleanup goals.

O&M duration for removal and off-site disposal pertains to the off-site disposal facility, which extends for the life of the facility.

Implementability Considerations

The following are key considerations associated with implementing retrieval and off-site disposal:

- Accessibility of contaminated media to standard excavation equipment.
- Presence of infrastructure that needs to be removed or protected.
- The need for dewatering for groundwater control, maintaining a dry excavation, and draining of the removed media, as well as treatment of recovered water.
- Health and safety requirements for on-site workers and off-site population.
- Restoration requirements.
- LDRs, disposal facility acceptance criteria.

Resources

EPA. Green Remediation: Best Management Practices for Excavation and Surface Restoration (2008) (PDF) (4 pp, 0.4 MB)
This fact sheet focuses on describing best management practices (BMPs) for

green remediation using excavation, including a cleanup project's (1) energy requirements, (2) air emissions, (3) impacts on water, (4) impacts on land and ecosystems, (5) material consumption and waste generation, and (6) long-term stewardship actions.

EPA. A Citizen's Guide to Excavation of Contaminated Soil (2012) (PDF)
(2 pp, 0.7 MB)
This document, which is meant for the public, provides an overview of excavation.

Søndergaard, G. L., Binning, P. J., Bondgaard, M., & Bjerg, P. L. Multi-criteria assessment tool for sustainability appraisal of remediation alternatives for a contaminated site. Journal of soils and sediments, 18(11), 3334-3348. (2018)
This article supports decision-making for the selection of remedial techniques for contaminated sites by developing a multi-criteria assessment (MCA) method. The MCA framework is structured in a decision process actively involving stakeholders, and compares the sustainability of remediation alternatives by integrating environmental, societal, and economic criteria in the assessment.